AAPT
PHYSICS EDUCATION®

2025 AAPT SUMMER MEETING

AUGUST 2-6 WASHINGTON D.C.

MASTERING PHYSICS

Learn More

What is Mastering Physics?

Pearson's teaching and learning platform empowers you to reach every student, teach difficult topics, and promote active learning. Built for flexibility, Mastering Physics allows you to create a course to best fit the unique needs of your curriculum and your students. Check out some of our favorite digital tools:

Gap Finder: Physics Diagnostic
Assess your students' readiness for Physics and identify at-risk students early on so they spend less time on remediation and more time on key Physics content.

Physics Primer
This tutorial series aids students in mastering essential math and physics skills for their first college physics course. Assign pre-built modules for timely remediation as needed.

AI Study Tools
Provides individualized support using a scaffolded approach that guides learning and eliminates the need to leave the required course material when stuck.

Dynamic Study Modules
Stimulate learning and improve retention using cognitive and adaptive triggers proven to help students succeed. Includes discipline- specific concepts and study skills.

Study Area
Self-study area for students that includes videos, practice quizzes, flashcards, summaries, and more.

Learning Catalytics
Engage every student through their own device while encouraging critical thinking and team-based learning with real-time analytics.

Early Alerts
Use predictive analytics from MyLab® and Mastering to identify and support struggling students early.

Learning Activities
Tutorials, coaching activities, and videos with **hints and feedback** guiding students to the correct answer without revealing it.

Freehand Grader
Grading technology in MyLab and Mastering® that creates an authentic assessment experience for both instructors and students.

Pre-lecture videos
Interactive quantitative and conceptual videos expose students to concepts before class and help them learn how problems for a specific concept are solved.

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AAPT wishes to thank the following persons for their dedication and selfless contributions to the Summer Meeting:

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Facebook/Twitter at Meeting

We will be posting updates to Facebook and Twitter prior to and during the meeting to keep you in the know! Participate in the conversation on Twitter by following us at **twitter.com/AAPTHQ** or search the hashtag **#aaptsm25**. We will also be posting any changes to the schedule, cancellations, and other announcements during the meeting via both Twitter and Facebook. Visit our Pinterest page for suggestions of places to go and things to do in the Boston area. We look forward to connecting with you!

Facebook: facebook.com/AAPTHQ
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Spatiality, Learning, and Liberation in Physics Education

by Hillary Moore

These four pieces of artwork show a progression toward more liberated spaces in physics education. As part of a recent collaborative project exploring spatial justice in physics teaching and learning, researchers engaged an illustrator to create artistic renderings of reimagined learning spaces. The artist chose keywords from the interviews, case study analyses, and other dialogue generated by the project. She sorted those words into four categories representing, 1) injustice in traditional physics education spaces, 2) disrupting and reimagining those spaces, 3) a more embodied, collaborative approach to learning, and 4) dreams for the future of physics education. Each of these categories is the basis for a piece of artwork that invites the viewer to examine their own experiences in physics classrooms and their vision for learning spaces where every student belongs.

Fragmented & Apart

SEPARATE, REMOVED, HIERARCHICAL, CONTAINED, INDIVIDUAL, EXHAUSTED

This piece was created with watercolor, ink, and graphite. It depicts current or traditional spaces in physics education. The composition is a grid of uniform boxes containing individual learners who, with closer inspection are each different, but the repetitive boxes evoke mass production or a factory assembly line that produces students who are proficient in the field. Students contained in identical boxes also implies a separation between learners and that each person is on their own.

Disruption

ACTION, DISRUPT, DISPEL, REIMAGINE, REORGANIZE, REORIENT

The second piece was created with color pencil, graphite, watercolor, and cut paper. The central form is a hand in silhouette that is popping a bubble. This piece is about initiating change. It evokes a quiet disruption. What happens when we dispel and then rethink traditional forms of knowledge? If we reimagine the way we exist in educational systems, how are we oriented to one another as learners? How are we organized around a teacher/professor? Where does the motivation to learn come from?

Embodied & Together

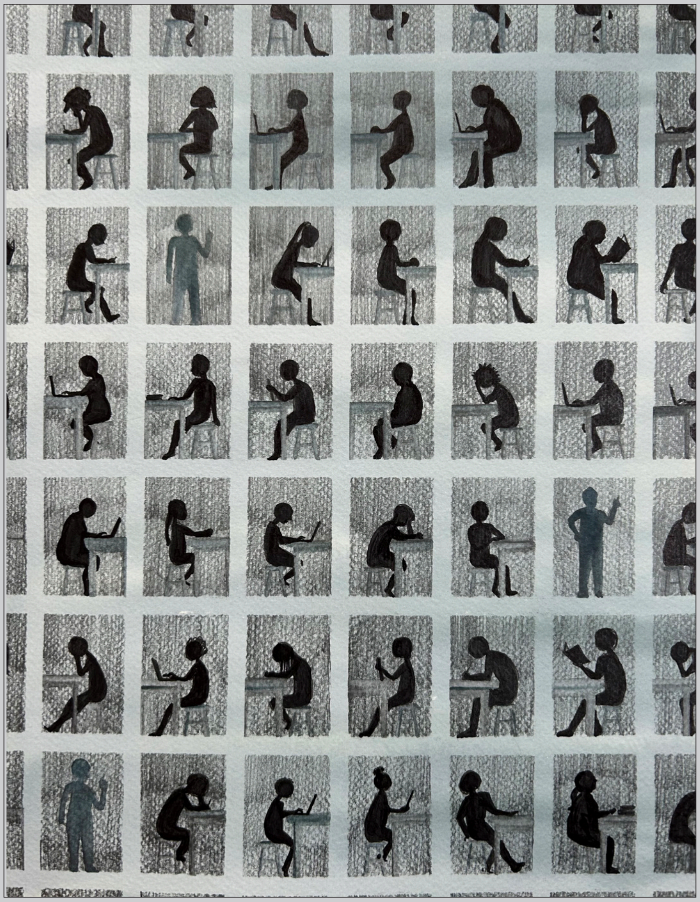
EXPERIMENTATION, CURIOSITY, PLAY, COLLABORATION, INTERACTION, INQUIRY, CONNECTION

The third piece is made from cut paper, white ink, and color pencil. It shows many learners overlapping in silhouette, interacting, working, and learning together. The silhouetted forms are filled in with a pattern of stars that suggest there are galaxies and infinite possibilities within them. The people are tangled together, the learning process may be messy, but there is evidence of more energy and joy compared to the first two pieces.

Freedom Dreaming

BELONGING, LIBERATION, PEACEFUL, JOYFUL, FREE, FUTURE, IMAGINE, SOAR, CELEBRATE

The fourth piece was painted in watercolor with details drawn in color pencil. As the piece that represents dreams for the future, it was created to evoke feelings of freedom and belonging. It depicts a person sleeping peacefully surrounded by soft whimsical feathers. Above, people are moving joyfully as they watch a flock of birds flying up into the sky. These images were chosen to reflect layers of consciousness: repose, lucid dreaming, collective awareness, and a liberated state of taking flight and soaring above.



Fragmented & Apart

Disruption

Embodied & Together

Freedom Dreaming

Nadya Mason is 2025 Recipient of Richtmyer Memorial Lecture Award

Nadya Mason

"Graphene Nano-Electronics

Monday, August 4

11:30 a.m.–12:30 p.m.

Constitution Ballroom AB

Nadya Mason has been selected to receive the 2025 Richtmyer Memorial Lecture Award. Dr. Mason, who currently serves as Dean of the UChicago Pritzker School of Molecular Engineering, is being recognized with the award for outstanding contributions to physics and for effectively communicating those contributions to physics educators. The award will be presented at a Ceremonial Session of the AAPT 2025 Summer Meeting.

Dr. Mason is recognized "For her outstanding communication to physics educators and wide-ranging impact on students and faculty across the country, particularly those from underrepresented groups in physics, and for her pivotal work in launching the APS National Mentoring Community, and for her work with the National Quantum Initiative Advisory Committee."

Dr. Mason is an experimental physicist who works at the intersection of complex materials, superconductivity, and nanotechnology, an area relevant to applications involving nanoscale and quantum computing elements. She is particularly recognized for her work elucidating the electronic properties of low-dimensional correlated materials, such as hybrid superconducting devices containing metal, graphene, or topological insulators. She is a member of both the National Academy of Sciences and the American Academy of Arts and Science.

In addition to her teaching and research, Dr. Mason's passion for communicating physics to a wide variety of audiences through public lectures, a TED talk, on television, and at conferences, her teaching and advising of students, her work on increasing diversity in the physical sciences through mentoring, and her continuous encouragement of and engagement with underrepresented students and educators in physics make her an exemplary choice for this award. Given her research accomplishments in nanoscale systems and her role in the National Quantum Initiative Advisory Committee, she will receive this award during the Year of Quantum.

Dr. Mason achieved her B.S. in physics at Harvard University, Cambridge, MA (1995) and her Ph.D. in physics at Stanford University, Palo Alto CA (2001). She was a Postdoctoral Fellow at Harvard University, Cambridge MA (2001-2002) and a member of the Society of Fellows at Harvard University (2002-2005).

As a member and then chair of the APS Committee on Minorities, her leadership was pivotal in launching the National Mentoring Community (NMC), which works to "provide historically underrepresented undergraduate and graduate students in physics with professional development and resources, by pairing Black/African, Latinx, and Indigenous students with mentors."

Named for **Floyd K. Richtmyer**, distinguished physicist, teacher, and administrator and one of the founders of AAPT, the Richtmyer Memorial Lecture Award recognizes those who have made outstanding contributions to physics and their communication to physics educators. The recipient delivers the Richtmyer Lecture at an AAPT Meeting on a topic of current significance and at a level suitable for a non-specialist audience and receives a monetary award, an Award Certificate, and travel expenses to the meeting.

Bree Barnett Dreyfuss to Receive 2025 Paul W. Zitzewitz Excellence in K-12 Teaching Award

Bree Barnett Dreyfuss

The 2025 Paul Zitzewitz Excellence in K-12 Physics Teaching Award winner is Bree Barnett Dreyfuss, Science teacher at Amador Valley High School, Pleasanton, CA.

This award is in recognition of her exceptional work in diversifying physics and making classrooms more inclusive and accessible to all students, her empowerment of girls and underrepresented groups to pursue careers in physics, her enrichment of the AAPT community with her expertise and passion for inclusive teaching, and her significant contributions to the STEP UP Physics project.

Regarding her selection for this award Barnett Dreyfuss said, "I was very surprised but pleased to receive this recognition. Throughout my career I have had friends and mentors in the physics community that helped me feel welcome and included so I've tried to make the most of opportunities to help everyone enjoy physics as much as I have."

Barnett Dreyfuss's B.S. in Physics is from California State University, Hayward. She earned her M.A. in Teacher Leadership at Saint Mary's College of California. A former Mentor and Coach to new teachers in the Exploratorium's Teacher Institute, she strongly believes that the physics education community is stronger through reflection and collaboration.

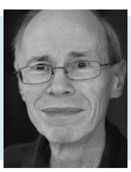
A member of AAPT since 2009, Barnett Dreyfuss has demonstrated an exceptional commitment to diversifying physics and making classrooms more inclusive and accessible to all students. Barnett Dreyfuss currently serves as the President of the Northern California/ Nevada section of AAPT, previously serving as the Secretary and the VP of Marketing. Her work, particularly as Ambassador Program Coordinator with the STEP UP project, has been pivotal in advancing equity in physics education, empowering girls and underrepresented groups to pursue careers in physics. As a long-standing member of AAPT, she has taken on numerous leadership roles within the community, enriching every group she's part of through her expertise and passion for inclusive teaching.

"Getting By With A Little Help From My Friends"

Monday, August 4

5:30–6:30 p.m.

Constitution Ballroom AB



Established as the Excellence in Pre-College Teaching Award in 1993 then renamed and endowed in 2010 by Paul W. and Barbara S. Zitzewitz, the Paul W. Zitzewitz Award for Excellence in K-12 Physics Teaching recognizes outstanding achievement in teaching pre-college physics.

PhysTEC National Teacher of the Year 2024: Lynn Jorgensen

Lynn Jorgensen

I have spent the past 10 years at Gilbert High School in Gilbert, Arizona teaching Physics, AP Physics 1, and AP Physics 2. I started off with very limited supplies and no curriculum. This allowed me to create a curriculum from scratch for the physics program that relies heavily on modeling instruction-with lots of hands-on activities and an inquiry based approach. Which has taken the program from 2 sections of on-level physics when I started, to 9 sections this year. The AP Physics has grown as well in that time, from 2 sections up to 4, with 50% of the students from underrepresented groups. Most of my students have gone on to study science or engineering related fields in college. I firmly believe that science is not a spectator sport, and that no one learns physics alone. In my classroom you will most likely find my students at lab stations using whiteboards to convey ideas and facilitate discussions of physics topics. No two class periods are identical, because no two classes have the same questions and needs. I have to be able to explain the same idea/concept in multiple ways, through multiple modalities, to be able to reach as many students as I can. Over the course of my 10 years at Gilbert HS, I have been awarded over $40,000 in grants for lab equipment and supplies. This has allowed my students to have more hands-on experiences in science. And has made learning more real and approachable for many.

Monday, August 4

5:30–6:30 p.m.

Constitution Ballroom AB

Sean Carroll to Receive 2025 Klopsteg Award

Sean Carroll

"The Many Worlds of Quantum Mechanics"

Tuesday, August 5

11:30 a.m.–12:30 p.m.

Constitution Ballroom AB

Sean Carroll, physicist, teacher, and writer, is the 2025 recipient of the Klopsteg Memorial Lecture Award. The lecture and award will be presented during the AAPT Summer Meeting.

This award recognizes educators who have made notable and creative contributions to the teaching of physics. Carroll is recognized specifically "For his significant efforts sharing the excitement and promise of modern physics with a broad audience, his work in conveying intricate aspects of contemporary physics clearly and thoroughly without cutting corners or oversimplifying, and for his innovative efforts in science outreach spanning almost two decades, Dr. Sean M. Carroll is hereby named as the recipient of the 2025 Klopsteg Memorial Lecture Award."

Homewood Professor of Natural Philosophy at Johns Hopkins University, Baltimore, MD and a Fractal Faculty at Santa Fe Institute, Santa Fe, NM, Carroll is a renowned and successful theoretical physicist with expertise in the areas of cosmology, quantum gravity, and general relativity that are at the heart of our understanding of the universe. Throughout his career, he has made outstanding efforts to communicate contemporary physics to the public in broad and diverse ways. His ability to express the excitement of physics with clarity and enthusiasm makes him an excellent candidate for this award.

He is the author of six highly successful popular science books (translated into over 20 languages): From Eternity to Here; The Particle at the End of the Universe; The Big Picture, Something Deeply Hidden, The Biggest Ideas in the Universe: Space, Time, and Motion and Quanta and Fields: The Biggest Ideas in the Universe, Vol. 2. Each has been enthusiastically received, with Particle winning the Royal Society's Winton Prize for Science Books in 2013, and The Big Picture, Something Deeply Hidden, The Biggest Ideas in the Universe: Space, Time, and Motion, and Quanta and Fields: The Biggest Ideas in the Universe, Vol. 2 all reaching the New York Times Hardcover Bestseller list immediately upon their release.

Carroll has also written for a variety of popular publications, including *The New York Times, Discover*, *New Scientist*, *Scientific American*, *Physics Today*, *Sky & Telescope*, and *The Wall Street Journal*.

A pioneer in using the internet for outreach, he began his blog, Preposterous Universe in 2004, making it one of the first blogs by a professional physicist that frequently hosts interesting scientific discussions. He is an energetic organizer of public events, co-founding Los Angeles's Science Soirée, while video recordings of his workshop Moving Naturalism Forward have become a popular online resource.

Carroll continues to explore new venues for science communication and public engagement. His podcast, Sean Carroll's Mindscape, began in 2018 and has over 340 episodes which regularly attract over 100,000 listeners per podcast. In addition to interviewing physicists (from post-docs to Nobel Laureates), he has invited a broad range of scientists and thinkers, including neuroscientists, economists, and philosophers, demonstrating that, rather than being a separate aspect, science is an integral part of our broader culture.

He has developed a new series of videos titled The Biggest Ideas in the Universe, with many of the videos being viewed over 200,000 times. Here again, Carroll goes deeper into topics than most other popularizers, discussing for example, in an open and accessible manner, how fields turn into particles (such as the Higgs field becoming the Higgs boson) when they are quantized.

He is a frequent public lecturer, at venues from Science in the Pub events to the World Science Festival and the Gifford Lectures on Natural Theology. His TEDx talk has received over a million and a half views online. His recorded lectures for The Great Courses have received excellent reviews. He was a featured speaker at the March for Science event in April 2017 in Los Angeles, CA.

Named for Paul E. Klopsteg, a principal founder, a former AAPT President, and a long-time member of AAPT, the Klopsteg Memorial Lecture Award recognizes outstanding communication of the excitement of contemporary physics to the general public. The recipient delivers the Klopsteg Lecture at an AAPT Summer Meeting on a topic of current significance and at a level suitable for a non-specialist audience and receives a monetary award, an Award Certificate, and travel expenses to the meeting.

Bruce Mason to receive 2025 Lillian McDermott Medal

Bruce Mason

"Com is for Communities"

Wednesday, August 6

12 – 1 p.m.

Constitution Ballroom AB

Bruce Mason is the 2025 recipient of the Lillian McDermott Medal. This award recognizes those who are passionate and tenacious about improving the teaching and learning of physics and have made intellectually creative contributions in this area.

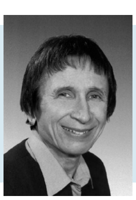
Mason is specifically recognized "for his pioneering work on digital libraries and curriculum development, including ComPADRE as well as Physlet-based and Open Source Physics-based curricular development, all of which has influenced hundreds of teachers and thousands of students around the world". Regarding his receipt of the McDermott Medal, Mason said, "I am honored by this recognition by the AAPT and those who have nominated me for it. Any successes of the projects supported by ComPADRE are due to the many individuals and groups who have worked on them. My technical and editorial colleagues have made it all possible."

Mason got his B.A. in Physics from Oberlin College, graduating in 1980 with High Honors. Both his M.S. and Ph.D. in Physics were completed at the University of Maryland, College Park. His enthusiasm for physics and physics education were apparent throughout his undergraduate career, including his senior year experience as a teaching assistant for the electronics laboratory and his thesis project on building a cloud chamber.

Mason recognized the potential of the internet early on working on behalf of MERLOT in 2000 as the physics editor, a position he held for about a decade, cataloging and organizing an extensive collection of physics software and curricular material. His talent as digital library innovator was recognized by the physics societies and he was recruited by the American Association of Physics Teachers (AAPT), the American Institute of Physics (AIP), and the American Astronomical Society (AAS) to lead the development of a multi-society National Science Digital Library (NSDL) known as ComPADRE gaining him an international reputation as a knowledgeable and skilled administrator/teacher. He was asked to serve as a member of the Board for the European Multimedia in Physics Teaching and Learning (MPTL) conference series. He was also asked to serve on the international organizing committee for Groupe International de Recherche sur l'Enseignement de la Physique (GIREP) conferences.

In his capacity as the ComPADRE Principal Investigator and as a leading representative of the US digital library initiative, Mason was often invited to give papers at international conferences describing his work and the work of others developing digital education.

After his work in theoretical condensed matter physics and winning several University of Oklahoma awards for his excellence in teaching, Mason's interests shifted to the use of computers and information technology in physics education. Mason joined AAPT in 2000 and became the director of the ComPADRE network of educational resource collections (http://www.compadre.org), an ecosystem of electronic resources and services of the American Association of Physics Teachers that hosts the online components and proceedings of the annual Physics Education Research Conference and the Advanced Labs Topical Conferences, and the Open Source Physics community. Recent projects supported by ComPADRE include the Partnership for Integration of Computation into Undergraduate Physics, PICUP and the Living Physics Portal for community development and sharing of learning resources for introductory physics for life sciences majors courses.



Named for Lillian C. McDermott, the Medal recognizes those who are passionate and tenacious about improving the teaching and learning of physics and have made intellectually creative contributions in this area. In 2021 AAPT Board of Directors voted unanimously to remove Robert A. Millikan's name from the award that recognizes "those who have made notable and intellectually creative contributions to the teaching of physics." The AAPT then sought nominations from AAPT members for renaming the award. Based upon nominations from members, the BOD unanimously approved renaming the award to Lillian C. McDermott.

Commercial Workshops at Summer Meeting

Visiting these hosted Commercial Workshops during the 2025 AAPT Summer Meeting in the Washington DC offers an invaluable opportunity for educators and physics enthusiasts to explore the latest advancements in teaching tools and resources. These workshops, hosted by leading industry vendors, provide hands-on demonstrations of innovative technologies and educational materials designed to enhance classroom experiences. Attendees can engage directly with product developers, gain insights into practical applications, and network with fellow professionals, all of which contribute to a richer understanding of contemporary physics education trends and methodologies.

Inside Pearson's New Physics Products: A Conversation with Authors on Content, Teaching & Technology

Monday Aug. 4, 10–11 a.m., Constituiton C

Join the Pearson Physics team and three leading authors—Eugenia Etkina, PhD, Brian Jones, PhD, and Roger Freedman, PhD—for an inside look at what's new in College and University Physics. This session will highlight major updates across new editions, including enhancements to Mastering Physics, the integration of AI and emerging technologies, and new features designed to better align with student engagement and learning expectations. The Authors will share insights into the pedagogy behind their revisions, how they've integrated digital tools to support instruction, and what they see as the future of teaching physics. Whether you're focused on improving engagement or navigating new platforms, this session offers practical ideas, meaningful dialogue, and a first look at Pearson's newest physics resources.

Logger Pro is Retiring! Make a Plan for What's Next (Vernier Science Education)

Josh Ence

Monday Aug. 4, 2–3 p.m., Constitution C

Logger Pro users—if you haven't made the switch yet, this workshop is a great opportunity to explore what's next. While you can continue using Logger Pro, planning your transition now will help you avoid unexpected loss of functionality as computer OS systems regularly update. In this workshop, we'll introduce you to our easy-to-use suite of Analysis apps, give you an opportunity to try them out, and help you explore many of the familiar analysis features you value in Logger Pro. These apps are supported on a wider range of devices (including computers, Chromebooks, tablets, and mobile devices) and evolve with regular updates to introduce new and expanded features.

Renewable Energy in the Physics Classroom (Vernier Science Education)

Fran Poodry

Monday, Aug. 4, 3–4 p.m., Constitution C

Explore how small-scale wind turbines and solar panels can bring renewable energy topics to life in your physics classroom. Investigate energy transformation, energy storage, induced EMF, series and parallel circuits, and the photoelectric effect—all with accessible, hands-on tools. You'll use the Go Direct® Energy Sensor to collect real-time data and connect core physics concepts to real-world energy solutions. This session highlights how energy-focused investigations can support sensemaking, systems thinking, and engineering design—and offers practical ways to enhance your units on electricity, magnetism, and energy.

Idealized Science Institute: Helping Students and Teachers Engage in Science Authentically

Brian M. Wargo, Ph.D. co-Founder of the Idealized Science Institute

Tuesday, Aug. 5, 10–11 a.m., Constitution C

This workshop will introduce the teachers to the work of the Idealized Science Institute and the resources available. Participants will first engage in a Quick Quiz, with the explicit purpose of establishing discourse between the participants (students) and have them voice their preconceptions before the outcome is demonstrated and the explanation provided. This motivating event will inevitably be generative and seed ideas for further investigations (i.e. long- term projects). A large bank of these Quick Quizzes are available for teachers use and are designed to be viewed and then implemented the very next class period. The ultimate goal of the Idealized Science Institute is to have students engage in long-term projects that will be presented at a science conference. Accomplishing this requires guidance. Our book, Idealized Science: A Framework for Practicing Science Authentically, is a discursive text that models teacher implementation, explicitly, and in a manner that teaches inquiry, nature of science, and scientific practices, and does so authentically through mimicking the work of scientists, albeit in an idealized fashion. Most importantly, the Idealized Science framework shows how to start a school year with a whole class long-term project that has the potential to transform a classroom that is solely focused on content, to one that addresses all of aspects of the Next Generation Science Standard, and in the spirit that it was intended.whole class long-term project that has the potential to transform a classroom that is solely focused on content, to one that addresses all of aspects of the Next Generation Science Standard, and in the spirit that it was intended.

Meter Stick Physics! Teach More Labs Using the Meter Stick! (PASCO scientific)

Jonathan Hanna

Tuesday, Aug. 5, 2–3 p.m. Constitution C

Rediscover the most versatile tool in your physics lab: the meter stick! Get hands-on with PASCO's new inexpensive accessories that use a meter stick with sensors to perform a variety of mechanics labs. In this workshop, we'll perform experiments in dynamics, projectile motion, centripetal force, and torque.

Saturday, Aug. 2, 2025

Teaching Strategies that Work: FTI Workshop for Educators

Date: Aug. 2 Time: 8:00 AM to 5 PM Wilson Organizer(s): Rachel Scherr, W. Tali Hairston

Looking for ways to help your students to improve their problem solving skills? We have all felt the frustration that comes from modeling how to solve problems in class, only to have students demonstrate during office hours, on homework questions, and on exams that they failed to improve their problem solving abilities. In this full-day workshop led by facilitators from the AAPT/APS/AAS Physics and Astronomy Faculty Teaching Institute (FTI), participants will learn principles of teaching and learning to guide teaching choices, gain access to valuable resources, and get support to plan a feasible classroom change that will improve learning for all students. Come learn a variety of effective teaching practices such as how to effectively facilitate whole-class and small-group discussions, implement in-class voting, tutorials, ranking tasks, and other active-learning curricula, and how to motivate students' understanding of the role of science in society. We have specifically designed the workshop to provide a safe and supportive environment that leverages your existing expertise, fosters open discourse, and promotes reflection on your identities, beliefs, and local context..

Learn Physics While Practicing Science: Introduction to ISLE

Date: Aug. 2 Time: 8:00 AM to 5 PM Offiste Organizer(s): David Brookes, Eugenia Etkina ,Yuhfen Lin , Yuehai Yang, Joshua Rutberg

Participants* will learn how to modify introductory physics courses at any level to help students develop a good conceptual foundation, apply this knowledge in problem solving, and engage them in science practices. The framework for these modifications is the Investigative Science Learning Environment (ISLE) approach. We provide tested curriculum materials including: (a) The second edition of College Physics Textbook by Etkina, Planinsic and Van Heuvelen, the Physics Active Learning Guide and the Instructor Guide; (b) a website with over 200 videotaped experiments and questions for use in the classroom, laboratories, and homework; (c) a set of innovative labs in which students design their own experiments, and (d) newly developed curriculum materials that implement the ISLE approach in both online and in-person settings. During the workshop the participants will learn how to use the materials in college and high school physics courses to help their students learn physics by practicing it.

*Please bring your own laptop to the workshop if you own one. If you do not own a computer, you will be paired with somebody who does.

Lunch on your own: 12-1PM

Graphical Methods for Problem Solving in Kinematics, Forces & Circuits

Date: Aug. 2 Time: 8:00 AM to Noon Roosevelt Organizer(s): Michael Lerner, Kelly O'Shea

Few students can use equations as a sensemaking tool. Multiple representations help build conceptual understanding and give students greater access to making sense of physical situations. But how can we connect student problem solving to their conceptual understanding of the topics—giving more students access to finding success in our classes? We will explore graphs and diagrams as sense-making tools that allow students to make their own situation-specific calculations for each scenario in addition to visualizing the concepts involved. Specifically, we will use slopes and areas on velocity-time graphs for kinematics, force vector addition diagrams for dynamics, and voltage-position graphs for electric circuits to show how challenging problems can be solved using graphical methods. Although we hope that this workshop will be interesting to a wide audience, our target audience is high school teachers of all levels. (These tools provide a more robust understanding and skill set for all students—from those who have typically struggled with traditional problem solving to the top students in our classes.) Bring a calculator and a pencil; you will be using these techniques during the workshop.

Authentic Astronomy Data Analysis and Research with js9

Date: Aug. 2 Time: 8:00 AM to Noon Arlington Organizer(s): Pamela Perry

Js9 web-based software allows the display and analysis of authentic astronomical data archived from observatories in all bands of the EMS. Js9 includes tools such as light curves, energy spectra, and more. In this workshop, you will be introduced to the js9 interface and tools by working through a series of activities such as x-ray spectroscopy of type 1a and type 2 supernova remnants, determining the source of ultra- and hyperluminous x-ray objects in colliding galaxies, using light curves to determine if an object could be a white dwarf or neutron star and the expansion rate of SNR. We will also demonstrate how users can find FITS files and upload them to use the tools they have learned to conduct their own research projects. Participants should bring laptops. Participants will be reimbursed for the cost of the workshop. Appropriate for instructors of Physics/Astronomy from grade 9 up.

PTRA: Teaching Physics for the First Time

Date: Aug. 2 Time: 8:00 AM to Noon Burnham Organizer(s): PTRA

You have received your teaching schedule and I am teaching Physics for the first time in a long time. Teaching Physics For the First Time is a Learning Cycle approach to address the core concepts of a first year lab course. So if your physics or physical science preparation needs a refresher or a place to start, this hands-on workshop will provide you with labs, demonstrations, background knowledge and misconceptions that many students have with respect to physics.

PTRA: Quantum Cryptography

Date: Aug. 2 Time: 1:00 PM to 5 PM Burnham Organizer(s): PTRA

Data such as our financials like credit card numbers are constantly being moved around as we exist in our 21st Century world. Quantum physics can help keep this data safe and even detect an eavesdropper!. Quantum cryptography can be taught in highschool physics classrooms with equipment as simple as polarizers and can fit neatly into the HS curriculum. Quantum physics is a huge part of the modern era and needs to be taught to our students..

Hands-on Particle Physics and Engagement Strategies

Date: Aug. 2 Time: 1:00 PM to 5:00 PM Roosevelt Organizer(s): Chad Ronisha

Do you know where the quiet kid is in your classroom? Do you have a student who seems to do all the work in their group? In this workshop you will experience student engagement strategies will help you reach all of your students with every activity. Concepts like Particle Physics, Dark Matter and Neutrinos will be experienced through student-driven, hands-on activities that you can adapt and apply to your entire curriculum. K-12 Science Teachers

Quantum Computing: What's the Buzz?

Date: Aug. 2 Time: 1:00 PM to 5:00 PM Arlington Organizer(s): Beth Thacker

Are you interested in learning more about Quantum Computing? Have you been asked to teach it or introduce some of the concepts into courses you are already teaching? What's the state of the field anyway? Do you want to be more informed about this fascinating, relatively new field? Should it be taught in Physics or Computer Science or Chemistry or Math or all of them!? If you find yourself interested in these questions, this workshop is for you. We will give an overview of the present state of the field, present a working introduction to Quantum Computing, taking you through some of the basic introductory concepts, introducing you to our mini-tutorials and exercises we do in class, as well as discussing our experiences learning and and teaching the topics, course coverage, format and learning materials, research we have done on students' strengths and difficulties, and the development of evidence-based materials to teach the course. We will share information on freely available online resources, our own evidence-based materials, and possible texts. We will focus on an undergraduate course, but it will be relevant for classes above and below that level, too.

Intermediate and Advanced Labs workshop

Date: Aug. 2 Time: 1:00 AM to Noon Offsite Organizer(s): Juan Burciaga

The Living Physics Portal (LPP) is an effort by the physics and biology faculty and PER/BER researchers to design, develop, and disseminate new curricular materials for the courses in introductory physics for the life sciences. The first part of the workshop will focus on finding, adapting, and using curricular resources on the LPP. Several sample key resources will be identified and studied. The last part of the workshop is designed to introduce the concepts, practices, and standards of educational scholarship. Faculty who adopt curricular resources from the LPP or other sources will therefore be better able to offer insightful critiques to the developers of the curricular resources. Interested faculty may also learn how to develop curricular materials for their own classrooms for use by the LPP community. Attendees will find having a laptop useful but not required.

Sunday, Aug. 3, 2025

Improving Access & Anti-Ableist Practices in Physics Courses

Date: Aug. 3 Time: 8:00 AM to 5:00 PM Wilson Organizer(s): Daryl McPadden, Erin Scanlon, Matt Guthrie, Xian Wu, Theo Bott

In this workshop, we will explore disability language and models, with a focus on disability in STEM & academia. Using tools like the Variation Planning Tool and Universal Design for Learning, activities will focus on thinking critically about how to build flexibility and accessibility into a physics course. Our three primary goals for workshop attendees are: 1) to gain familiarity with language and discourse on disability, 2) to think critically about access for your particular course on a holistic level, and 3) to leave the workshop with a tangible action plan to improve access in your course. There will be a variety of activity types in the workshop, including presentations, a panel with disabled physics students, small group activities, and individual reflections. This workshop is appropriate for high school teachers, postsecondary instructors, and students with an interest in teaching. Please bring your own computer to use during the workshop, with access to some of your own teaching materials (e.g. syllabus, worksheets, slides, homework assignments). Lunch: 12PM-1PM

Physics Investigations using Sensors in Smartphones

Date: Aug. 3 Time: 8:00 AM to Noon Roosevelt Organizer(s): David Rakestraw, Dan Burns

This hands-on workshop offers participants the opportunity to explore a variety of physics concepts through engaging activities suitable for both high school and introductory university physics courses. By leveraging the advanced sensors integrated into smartphones, participants will experience over 100 powerful experiments spanning topics in mechanics and electromagnetism. Each participant will receive a kit that, when paired with their smartphone, enables students to conduct a remarkable number of investigations. Throughout the workshop, attendees will perform select experiments using smartphone sensors, such as the accelerometer, gyroscope, magnetometer, pressure transducer, microphone, camera, microwave antenna, and display. These experiments will showcase the wide range of applications made possible by the technology in their phones. Participants are encouraged to bring a laptop, as they will use spreadsheets for data analysis during the session.

PICUP Workshop A: Integrating Computation into Introductory Physics

Date: Aug. 3 Time: 8:00 AM to Noon Cabin John Organizer(s): Walter Freeman, Larry Engelhardt, Todd Zimmerman

In this workshop, we will show you some ways in which computation can be integrated into your introductory courses. The PICUP partnership has developed a variety of computational activities for introductory physics, and we will show you how you can take these PICUP materials and adapt them to fit your needs. This workshop will focus on the actual implementation of computational physics in the classroom; attendees will work on several exercises in a similar way that students might do so. These will use spreadsheets and browser-based Trinkets, so attendees will not need any software installed, but will need to bring their own laptop computer. Attendees do not need any prior experience with computer programming or computational physics. Participants are invited to also register for PICUP Workshop B, titled "Integrating Computation at the Curricular Level", which will involve a more indepth exploration of curriculum design, integration across courses, and assessment involving computation. PICUP will provide a partial reimbursement of $40 of the workshop registration fee to those who attend and complete this workshop. This workshop is supported by NSF grant number 2337049.

Understanding Quantum Computing Using an Augmented Reality App

Date: Aug. 3 Time: 8:00 AM to Noon Arlington Organizer(s): Michele McColgan

2025 is the year of quantum science and technology and this workshop is designed to give teachers tools to explore these concepts with their students. Participants will be introduced to a MARVLS smartphone App that includes augmented reality models on the topic of quantum computing. Participants will also be introduced to additional augmented reality apps available on the Apple Store and Google Play Stores that students can engage with to support their learning about 3D and abstract concepts in physics. Participants will download the Quantum Computing App from the App Store or Google Play Store. Each participant will receive an target cube to view the 3D AR models with their smartphones. Participants will also be given a set of lessons to accompany the AR models in the App. We will work through the lessons so participants understand how to use the App and lessons in class and understand the quantum computing concepts and other topics such as electric and magnetic fields covered by the Apps.

Bridging Classical and Quantum Realms Using Nuclear Magnetic Resonance

Date: Aug. 2 Time: 8:00 AM to Noon McPherson Square Organizer(s): Merideth Frey

Nuclear magnetic resonance (NMR) can bridge the classical and quantum realms and is underutilized in the undergraduate science curriculum. We have developed a set of curricular materials to cover the theory, practice, and applications of NMR in a truly multidisciplinary way as well as have the flexibility for use in a variety of different courses, classroom environments, and institutions. In this workshop, attendees will experience firsthand some of the developed class activities, learn about our research findings assessing implementations of these modules, and finally discuss how these modules may be implemented into coursework at their home institution. A laptop will be helpful to access the full set of online materials being discussed.

200+ Physics Simulations to Inspire Classroom Engagement

Date: Aug. 3 Time: 8:00 AM to Noon Farragut Square Organizer(s): Andrew Duffy, Manher Jariwala

In this workshop we will start with a discussion and questions on ways we have used demonstrations in the past. We'll work together to make a list of what has and has not worked regarding how demonstrations were used. In particular, we will focus on the format and methods of presentation, rather than the specific equipment. From there, we'll learn about the Demonstration Framework model, and how to use it for demonstration development. We will then break into pairs, and each attendee will use the model to develop their own hypothetical demos. In the end, everyone who attends will get their own printed copy of the framework to take home so they may continue to use it.

PIRA Lecture Demonstrations

Date: Aug. 3 Time: 8:00 AM to Noon Franklin Square Organizer(s): Daniel Davis, Sam Sampere, Michele Lau, Dale Stille

During this ½ day workshop, we will introduce you to the Physics Instructional Resource Association (PIRA) and the PIRA 200. Almost every demonstration one can think of has a catalog number within the Demonstration Classification System (DCS); we will introduce you to this system and the comprehensive bibliography that details journal articles and demonstration manuals for construction and use in the classroom. The PIRA 200 are the specific 200 most important and necessary demonstrations needed to teach an introductory physics course. We will also show a subset of approximately 50 demonstrations explaining use, construction, acquisition of materials, and answer any questions in this highly interactive and dynamic environment. Ideas for organizing and building your demonstration collection will be presented. We especially invite high school physics teachers and faculty members teaching introductory physics to attend. NOTE that this is a paperless workshop. All information and materials will be distributed on a USB thumb drive (if requested) or other method. A computer, tablet, or other device capable of viewing and/or recording the workshop will be needed.

Surface Mount Electronics How-To (Design with KiCAD)

Date: Aug. 3 Time: 8:00 AM to Noon Offsite Organizer(s): Eric Ayars

This workshop will give participants a guided opportunity to design their own circuitboard using the open-source KiCad package. It will cover how to make a schematic, how to turn the schematic into a board layout, and creation of Gerber files to turn the design into a physical device. It is intended to be taken with the "Surface Mount How-To (Techniques for building)" workshop, but can be taken by itself if desired..

AI in Support of Physics Labs

Date: Aug. 3 Time: 1:00 PM to 5:00 PM Roosevelt Organizer(s): David Rakestraw, Dan Burns

In this workshop participants will conduct a series of simple experiments and then use natural language prompts with AI tools to perform computational analysis on their data. Participants will conduct statistical analysis of large data sets, perform coordinate transformations on GPS data, fit periodic data to simple harmonic oscillator models, transform time domain measurements to the frequency domain, and conduct other complex data analysis tasks that have historically required computer programming skills. Participants will need a smartphone to collect data, a computer to conduct analysis, and potentially a $20 license to one of the leading foundation AI models depending on changes in capabilities at the time of the workshop.

PICUP Workshop B: Integrating Computation at the Curricular Level

Date: Aug. 3 Time: 1:00 PM to 5:00 PM Cabin John Organizer(s): Andy Gavrin, Gautam Vemuri

IIn this workshop, we will focus on how computation "fits" into the undergraduate curriculum. We will begin with a practical "how to" on incorporating computational exercises in a variety of courses. We will provide working code samples for a range of assignments and projects but will not focus on coding during the workshop. We will discuss and help participants develop student learning goals at the department level, and assessment tools to evaluate the effectiveness of the curriculum. We will also consider how to assure coverage of the goals across the curriculum and consider the curriculum for an "introduction to computational methods" class intended to establish a "baseline" capability in computation that faculty in other courses can rely upon. No prior programming experience is needed. We will provide resources in multiple formats including excel spreadsheets, MATLAB, and Python. This workshop is supported by the NSF, grant DUE-2021209. Participants are also invited to also register for PICUP Workshop A, titled "Integrating Computation into Introductory Physics," though attending either session is not necessary for the other. Workshop A will focus on "hands-on" efforts to work through introductory level exercises as a student would.

Introductory Labs to Promote Scientific Reasoning

Date: Aug. 3 Time: 1:00 PM to 5:00 PM Arlington Organizer(s): Kathleen Koenig, Krista Wood, Lei Bao

cientific reasoning and decision-making abilities are highly sought educational outcomes, particularly in a time characterized by rapid technological advancements and complex global challenges. Using a curricular framework that integrates research in scientific and causal reasoning, we developed and evaluated a comprehensive inquiry-based lab curriculum that explicitly promotes these abilities by engaging students in activities that include designing and conducting controlled experiments, analyzing data, modeling, and synthesizing results to construct meaningful evidence-based claims. The curriculum aligns with the AAPT Lab Guidelines and cultivates an inclusive culture to support a diverse population. In this workshop, participants will engage with several lab activities, gaining insight into the curricular framework that emphasizes key sub-skills such as controlling variables in multi-variable contexts, data analytics, and causal reasoning. Participants will learn how assessments can be used to measure important scientific reasoning skills-based outcomes, and our own results will be shared. Participants will be provided access to all lab materials (both in-person and online versions) and assessments and will learn strategies to adapt their existing labs to fit these approaches.

Reasoning Chain Construction Tasks for Assessing Student Reasoning

Date: Aug. 3 Time: 1:00 PM to 5:00 PM Farragut Square Organizer(s): MacKenzie Stetzer, J. Caleb Speirs, Beth Lindsey, Mila Kryjevskaia

Online reasoning chain construction assessment (ORCCA) tools have been shown to be powerful instruments for probing student reasoning and may be flexibly incorporated into physics and chemistry courses. These tools present students with reasoning elements (i.e., statements about the physical situation as well as related concepts and mathematical relationships) and prompt the students to assemble them into an argument to answer a physics question. In this workshop, participants will gain firsthand experience with ORCCA tools. They will also have the opportunity to engage with data showing how these tools may be used to gain insight into student reasoning and to better support the development of reasoning skills. Laptops are recommended.

This material is based upon work supported by the National Science Foundation under Grant Nos. DUE-2142416, DUE-2141975, DUE-2142276, and DUE-2142436.

Preparing for Student Discussions about Physics and Society

Date: Aug. 3 Time: 1:00 PM to 5:00 PM Franklin Square Organizer(s): Brianne Gutmann, Jonathan Alfson, Alice Olmstead

The discipline of physics often intersects with ethically challenging topics such as global climate change, nuclear weapons, environmental impacts, etc. Discussions about the ethical responsibilities that physicists have in relation to society are important but difficult to facilitate. This workshop creates space for instructors to participate in these discussions as a student, to collaboratively develop initial ideas for lessons within their own teaching contexts, and to practice implementing their ideas with peers.

Surface Mount Electronics How-To (Techniques for Building)

Date: Aug. 3 Time: 1:00 PM to 5:00 PM Offsite Organizer(s): Eric Ayars

This workshop will give participants a guided opportunity to build a circuit board using modern surface-mount components. It will cover a variety of techniques including hand-soldering, hot-air reflow, solder paste and stencils, and reflow ovens. It is intended to be taken with the "Surface Mount How-To (Design with KiCad)" workshop, but can be taken by itself if desired.

Community Meetings

*All interested attendees are invited and encouraged to attend the Committee meetings with asterisks (*).*

Sunday, Aug. 3

Awards Committee (Invite)	1–2 p.m.	Banneker
Meetings Locations Committee	1–2 p.m.	Tiber AB
MPC and AMP 25	2–3 p.m.	Banneker
Membership & Benefits Committee	2–3 p.m.	Tiber AB
Nominating Committee	2–3 p.m.	Lafayette Park
ALPhA Open Meeting	3–4 p.m.	Lafayette Park
Publications Committee	3–4 p.m.	Tiber AB
PERLOC	3–4 p.m.	Banneker
Community Leadership Meeting I	8–9p.m.	Banneker
Governance Structure Committee	8–9 p.m.	Tiber AB

Monday, Aug. 4

Community on Physics in Two-Year Colleges *	7:45–8:45 a.m.	Declaration A
Community on Contemporary Physics *	7:45–8:45 a.m.	Declaration B
K-Physics in HS & Pre-HS Communities *	7:45–8:45 a.m.	Burnham
Community on Research in Physics Education *	7:45–8:45 a.m.	Wilson/Roosevelt
Community on International Physics Education *	7:45–8:45 a.m.	Cabin John/Arlington
Community on Apparatus *	7:45–8:45 a.m.	Bulfinch/Renwick
Community on Professional Concerns *	7:45–8:45 a.m.	Faragut Square
Investment Committee	6:30–8 p.m.	Douglass

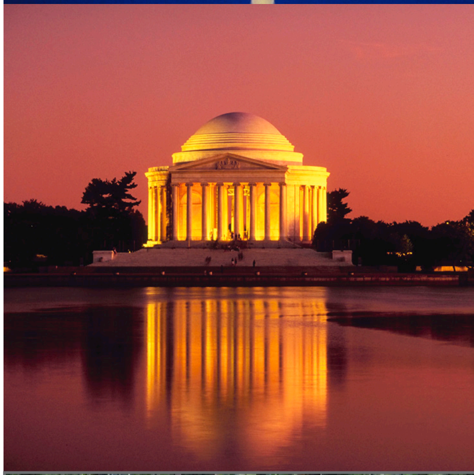
Tuesday, Aug. 5

Physics Bowl Advisory	7:45–8:45 a.m.	Declaration A
Community on Space Science and Astronomy *	745–8:45 a.m.	Penn Quarter AB
Community on Teacher Preparation *	7:45–8:45 a.m.	Wilson/Roosevelt
Community on Women in Physics *	7:45–8:45 a.m.	Cabin John/Arlington
PERLOC*	7:45–8:45 a.m.	Bulfinch/Renwick
Community on Physics in Undergraduate Education *	7:45–8:45 a.m.	Lafayette Park
Community on Graduate Education in Physics *	7:45–8:45 a.m.	Franklin/McPherson
PIRA	7:45–8:45 a.m.	Farragut Square
PTRA Oversight	7:45–8:45 a.m.	Burnham
Bauder & Venture Fund	4:30–5:30 p.m.	Declaration A
Community on Educational Technologies *	4:30–5:30 p.m.	Declaration B
Community on Science Education for the Public *	4:30–5:30 p.m.	Penn Quarter AB
Community on Diversity *	4:30–5:30 p.m.	Cabin John/Arlington
PERG Town Hall *	4:30–5:30 p.m.	Bulfinch/Renwick
Community on Laboratories *	4:30–5:30 p.m.	Faragut Square
Community on History and Philosophy in Physics*	4:30–5:30 p.m.	Franklin/McPherson

Wednesday, Aug. 6

Community Leadership Meeting II	7:45–8:45 a.m.	Banneker






POSTER SESSION I:

Location: Independence Ballroom **Sponsor:** AAPT

Time: 5:30–6:30 p.m. **Date:** Sunday, Aug. 3

Astronomy

S-01: Central Idaho Dark Sky Reserve STEM Network: 2024

Presenting Author: Chandler Beasley, Boise State University,

Additional Authors | Arianna Japalucci, Sean Halford, Allison Howard, Braydon Dietrich, Killian Richardson, Brian Jackson, Kaitlyn Austin, Rachel Huchmala, Janette Smith, Matthew Wigglesworth, Ahalya Sabaratnam, Jake Wright, Samantha Sisitsky, Joseph Serafino, Travis Longcore

The Central Idaho Dark Sky Reserve STEM Network (CIDSRSN) is a funded partner of NASA's Science Activation Program. The network aims to connect learners of all ages by sharing the importance of space science and dark skies around Idaho. Our network has collaborations between Boise State University (BSU), the University of California, Los Angeles (UCLA), and the Central Idaho Dark Sky Reserve. The CIDSRN consists of four strands: work with the Central Idaho Dark Sky Reserve (CIDSR) and the "Astronomer-In-Residence" program, light pollution monitoring research with UCLA, BSU's outreach team: AstroTAC (Astronomers in Training Assisting the Community), and K-12 teaching resources. Additionally, our program hosts a Space-themed summer camp for grades 3rd-6th. Over the past three years, our network has raised awareness and provided support in various rural and urban Idaho communities by sharing information about the CIDSR, hosting events to inform about Idaho's dark skies, providing educational opportunities within communities and classrooms, monitoring light pollution trends, and adapting NASA curriculum to Idaho Science Standards. In 2024, we conducted 102 events and served over 10,000 people. Our program has had significant impacts, with anecdotal evidence of increased interest in space science and light pollution awareness across all age groups. This poster will highlight the effectiveness of the CIDSRN, our positive influence on Idaho communities, and the growth observed in its third year.

S-02: Integration of Deliberation into an Introductory Astronomy Course

Presenting Author: Kristen Thompson, Davidson College

Astronomy is a rich topic full of situations on which individuals may disagree. For example, are Starlink satellites beneficial, or are they harmful? Should telescopes be built on sacred ground? How should the astronomy community approach the naming of telescopes and astronomical objects? Contentious topics such as these may be omitted altogether, mentioned in passing with little engagement, introduced as a discussion during which opinions are shared without resolving conflict, or confronted as a debate in which students criticize the arguments of others with the goal of finding a winner. While discussion and debate both offer students the opportunity to learn about a topic, deliberation allows students to deeply engage with topics in an environment that normalizes disagreement, encourages students to share honest perspectives gained from their diverse backgrounds, and seeks a solution that will be best for everyone. I have designed my introductory astronomy course to include a significant deliberative component. Students are introduced to deliberation as a mode of collaborative interaction that explores the relative merits of all expressed perspectives and seeks to find common ground upon which a solution can be built.

S-03: Hands-on High School Astronomy

Presenting Author: Ben Gillen

This poster showcases a series of hands-on labs and project-based learning activities designed to engage high school students in the study of astronomy, developed during 2 years of teaching an elective astronomy class at the Seattle Academy of Arts and Sciences. Examples of projects include crater counting, walking out a to-scale solar system, using data to calculate Hubble's Constant, developing novel galaxy classifications, creating their own star system and calculating gravitational forces, and designing a planetary defense system to deflect a near earth object. The curriculum is still being developed with the intention of moving student work from "understand" and "apply" to "analyze", "evaluate", and "create."

S-04: Leveraging NASA Astronomical Data with SciAct for Community Colleges

Presenting Author: Mojgan M Haghanikar, City Colleges of Chicago, SETI Institute

Additional Author | Deanna Johnson

NASA open source offer expansive opportunities for discovery, experimentation, and research. Many of these resources have yet to be fully utilized, highlighting the potential for further exploration and educational engagement. These tools hold significant promise for education purposes and project-based teachings in STEM courses. In this presentation, I share the lab activities and capstone projects that I designed under the grant funded by the NASA SCoPE with the partner NASA SCiACT team NASA Community College Network (NCCN). Partnership with NCCN, provided access to subject matter experts (SME) consultation who help me to best utilize NASA SciACT resources. By integrating NASA's resources into our curriculum, we aim to transform traditional lecture-based teaching into a more engaging learning experience that fosters exploration and discovery among students and to promote widespread public outreach and exposure. We utilized open-source data for our spectroscopic projects, employing photometric image analysis to generate light curves. We used Solar System Treks which are online, browser-based portalsto visualize, explore, and analyze the surfaces of other worlds landscapes of other planets and assessed their landscapes. To unleash students' artistic expression we incorporate 3D tactile resources for both 3D printing and virtual reality visualizations. This approach allows students to engage accross different repressenations with more chances to embody asrtonomical concepts.

Acknowledgement: Leveraging NASA Astronomical Data with SciAct for Community Colleges is a collaboration between NASA SciAct Team, NASA Community College Network, and scientist Mojgan M Haghanikar, supported by Arizona State University in partnership with NASA's Science Activation Program. For more information on this and other Seed Grants, visit scope. asu.edu/the-seed-grant.

S-05: Simplified Analytical Models of Exoplanet Transit Light Curves

Presenting Author: Ernest Behringer, Eastern Michigan University

Additional Author | Deva O'Neil

The discovery of the first exoplanet spurred significant effort and interest in detecting more such worlds using different techniques such as measuring radial velocity, gravitational microlensing, and transit light curves. Here, we describe a set of exercises involving a series of simplified analytical models of exoplanet transit light curves. This exercise set has been used in an upper-level computational physics course and could be used as the basis for an individual or group project. Because the models rely almost entirely on geometry, one or more of the exercises can be used at the beginning of a course to extract physical insight and connect to contemporary exoplanet research and demonstrate the use of models in research.

S-06: Showcasing Stories of Scientists and the Scientific Process with NASA's Universe of Learning

Presenting Author: Nana Amah

Co-presenting Authors| Rutuparna Das, Kimberly Arcand, Kathleen Lestition, April Jubett, Timothy Rhue II, Varoujan Gorjian

Improving public engagement with science is essential for building trust in research, fostering critical evaluation of information, and inspiring interest in STEM careers. Those without formal scientific backgrounds interact with data and scientific concepts regularly, making it all the more important to cultivate this trust. Learners should, in particular, recognize that seemingly abstract scientific laws and theories have been developed by real people with everyday lives who have dedicated themselves to research and discovery. This allows them to see themselves reflected in these fields and sparks interest. Additionally, the scientific process is a complicated cycle of questioning, hypothesizing, analyzing evidence, and revising ideas based on data. By breaking down its complicated nature, we can enable general audiences to see science as more than just isolated numbers or a simple linear process. Towards these goals, NASA's Universe of Learning is developing audio stories to highlight the scientific process and the people behind it. These stories explore the human side of astronomy–how we learn about the universe today. In one narrative, we discuss cosmological surveys to answer questions such as "How do we learn about the universe's beginning and evolution?" and "What is dark matter and how do we study it?" In another story, we interview Gemini Observatory's Chief Scientist on topics such as stellar classification and formation, and what it's like designing and running an observatory. We present an overview of this project, with emphasis on the importance of sharing stories of those involved in the scientific process. This presentation is based on work performed as part of NASA's Universe of Learning project and is supported by NASA under cooperative agreement award number NNX16AC65A. This project received Federal support from the Smithsonian American Women's History Initiative Pool, administered by the Smithsonian American Women's History Museum.

K-12

S-07: Quick & Easy Elastic Labs that Support Conceptual Understanding

Presenting Author: Susan Allison, Benton High School

Co-presenting Authors | Magan Atkinson, Shane Reed, Liz Schiefer, Master's in ChemistryCo-presenting Author | Anita Dunsmore, United States Air Force Academy

Planning a Lab on the fly? Engage students through hands-on investigations relating to elastic forces and oscillations. There will be links to paper copies of labs that will give your students experiences to help them understand inverse and directly proportional relationships..

S-08: From Crater to Classroom: Modeling the Chicxulub Impactor for High School Physics

Presenting Author: Patrick Englehardt, BScH Environmental Geoscience, The Winchendon School

The Chicxulub impact event rocked the Mesozoic landscape and has completely shaped our world today. One of the first questions asked about the event is how big was the impactor and is it likely to happen again soon? While it is up to Astronomers to determine the occurrence of impactors on earth, we can come up with rough estimates of their characteristics in the classroom. By exposing students to the Physics that dictate crater size they can make estimates of one of the most existential threats to life as we know it. Students were tasked with determining how the size, speed, mass, density, and angle of the impactor affected the crater diameter, depth and ejecta distance. By assigning slightly different variables to each student and aggregating their data with google sheets, the class collaboratively derived a formula for estimating the original characteristics of the Chicxulub impactor. Students can investigate drag forces, energy, impulse and kinematics while conducting this research and this study is made to be reproduced with low costs and can be done by highschool students. Thus, providing students with the real world example to test their theories of Physics concepts (kinematics, dynamics, and energy transfer). Bring planetary science to life in your classroom with this engaging and impactful experiment.

S-09: Experiments Using Highlighter Ink to Show 3D Light Paths

Presenting Author: TAE HEE KIM

Recently, Yu Chen et al made the path of laser light visible in geometric optical experiments by mixing a little fluorescent highlighter ink with water. Using this, experiments were shown to show how light refracts, reflects, and diffracts from lenses, mirrors, and a diffractive grating. Paths of several rays by using laser pointers were visible, however, the experiments did not show all paths of light in three dimensions. In this study, we have developed a way to visualize the path of light in three dimensions. Students can see with their eyes the process of propagating after gathering only the light passing through the lens among the light emitted in all directions from the point light source, that is, the process of image formation. Also, in the experiment about total internal reflection, students can see how light propagates in three dimensions. If students learn through experience through the method proposed in this paper, they will be able to form scientific concepts more easily than if they learn using a few light rays. The path of light through the air cannot be observed until it hits the screen, as long as it does not pass through scattering particles such as smoke. Physics teachers used milk mixed in water or incense-filled smoke as scatters to make the path of light visible to students. However, almost all experiments still use several laser beams and have not been able to actually visualize the light coming out in all directions from a point light source. Materials include green highlighter ink, a 76cm rectangular water tank filled with water, a green laser pointer, and a convex lens with a focal length of 5 mm and 45 mm, respectively. Bottle ink was purchased from a German highlighter ink manufacturer. A transparent rectangular water tank made of acrylic plates was filled with 1/2 of water, and 10 ml of ink was dropped and mixed evenly. The concentration of the ink can be adjusted by mixing water so that the light from the laser pointer can be seen more clearly in contrast to the highlighter solution. In this experiment, one green laser pointer with a strong output of 5 mW was used, which is relatively high power. When conducting experiments with students, it is recommended to use a laser pointer as weak as 1 mW. Even with this low power, there is no problem seeing the path with the human eye.

S-10: Mentorship Electronic Journey: Measuring the Probability Density of Random Noise

Presenting Author: Mary R. Putnam, Anne Arundel County Mentorn

Additional Author | Murray S. Korman, PhD Physics

Mentorships during early Covid-19, through the current post Covid years provided many challenges. Here, middle school and high school mentees required vital parental involvement as locations shifted to public restaurants or libraries which provided AC outlets, well-lit tables and welcomed patrons to study, work or hold tutoring sessions. During this period a parent [MRP], with home schooling experience, provided guidance and helped mentor a 5th and 8th grader transition to their next grades. Their Do It Yourself (DIY) electronic projects became the building blocks of a circuit to generate electronic white Gaussian noise and plot the probability density function (pdf), voltage bin vs. # of counts. The pdf circuit included (a) a sequence stepped voltage window comparator, (b) chopped (multiplied) by a fast (100 microsecond) clock, (c) coupled to a digital counter (6 segment display), such that (d) a binned hystogram pdf could be plotted.

S-11: Research-Inspired Curriculum for Secondary and Early College Physics and Engineering

Presenting Author: Christine Broadbridge, Engineering, Southern Connecticut State University

Additional Authors | Andrew Mansfield, Thomas Sadowski, Elliott Horch

Science, technology, engineering, and mathematics (STEM) occupations are projected to grow by 10.5% over the next decade—three times the rate of non-STEM professions—yet current graduation rates fall short of meeting industry demands. To address this gap, new pedagogical approaches are needed to attract, retain, and graduate more physics and engineering students. Advanced topics such as quantum mechanics, nanotechnology, and astrophysics often spark initial interest; however, students frequently become discouraged by the abstract theory and mathematical formalism before appreciating their broader significance. Research-inspired curricula present a compelling solution by inverting the traditional educational approach, using advanced topics as an entry point for introducing fundamental physics concepts and demonstrating their relevance to real-world scientific challenges. At Southern Connecticut State University, physics research spans multiple scales, from speckle interferometry of binary star systems to electron microscopy investigations of materials for sustainable energy applications. This study introduces a series of learning modules drawn from departmental and adjacent research areas, designed to introduce secondary and early college students to core physics and engineering principles through the lens of cutting-edge research. Integrating research early in a student's academic path fosters intellectual curiosity, builds transferable skills, and reinforces confidence in the foundational material necessary for long-term success. By embedding real-world applications into introductory courses, this approach not only strengthens STEM retention but also equips students with the technical and analytical skills essential for industry or postgraduate education. The modules were developed by pre-service and in-service educators while participating in a team based interdisciplinary research program and were subsequently piloted in a variety of settings.

S-12: High School Science Research: A Student Perspective on Benefits and Opportunities

Presenting Author: Armita Ahmed, Scarsdale High School

Providing high school students with authentic scientific research opportunities is crucial for STEM education. This abstract, from a student's perspective, explores the advantages of secondary-level science research, highlighting strengths of existing models and pathways for independent inquiry when formal structures are absent. Dedicated high school science research courses offer invaluable structured support. As a junior engaged in quantum computing research at Flatiron Labs, my personal experience with a three-year research course demonstrates its profound impact on my STEM career. Sophomore year requirements—journal article assignments, guidance on securing summer mentors via "cold-calling" professors, and a five-hour weekly research commitment—ensured my consistent progress and commitment towards my project. A mandatory four-week summer research period also provided essential focus. Now having finished my junior year of high school, the course continues to support me through competition preparation and fostering a collaborative environment among my fellow high school researcher peers. While still beneficial in the latter portion of my school experience, the courses's intense structure feels less necessary given the self-driven habits it had instilled in me earlier, suggesting that the course is most crucial earlier on in students's high school careers. However, many schools lack resources to run such programs. In these cases, it is necessary to promote independent research. Schools and educators should inform students about self-directed opportunities like prestigious high school contests (e.g., Regeneron ISEF, STS) that encourage research. Providing information on finding mentors, accessing resources, and understanding competition processes can significantly lower barriers when it comes to starting a scientific research project. Ultimately, whether formally facilitated or pursued independently, science research is transformative. It offers unparalleled intellectual growth, skill development, and cultivates an inquisitive mindset. Fostering an environment where all students are aware of and encouraged to pursue research, even independently, is essential for nurturing the next generation of scientific innovators.

S-13: The Role of Modern Physics in a Four-Year Sequence: Rationale and Implementation for a Modernized High School Curriculum

Presenting Author: Armita Ahmed, Student, Scarsdale High Schoola

The global impact of modern physics necessitates its earlier integration into high school curricula. The overlooking of modern physics within high school curricula deprives students of crucial insights into contemporary science and technology, hindering their understanding of the modern world. This abstract outlines the rationale and practical implementation for this paradigm shift. Introducing modern physics earlier provides a more accurate, engaging understanding of the universe. Traditional physics often presents a static view, while modern physics, providing the basis for new technologies (smartphones, medical imaging), makes the subject relevant and less abstract. Earlier exposure also enhances student belonging, particularly for underrepresented groups, fostering curiosity and critical thinking, thus cultivating a more diverse STEM pipeline. Effective implementation of this course requires thoughtful curricular design, which both implements and integrates classical physics. A dedicated modern physics course, ideally following a foundational physics course (e.g., AP Physics 1) would allow for such implementation. Its curriculum should prioritize rigorous, conceptual understanding of the course material rather than a purely mathematical understanding. Topics covered should include early quantum, quantum mechanics basics, special relativity, nuclear physics, and qualitative particle physics/cosmology, while emphasizing experimental evidence and societal implications. Successful integration demands robust professional development for teachers lacking modern physics backgrounds. Comprehensive training on content is crucial. Schools must also invest in resources: accessible textbooks, online simulations, virtual labs. In conclusion, modernizing high school physics is necessary. An structured introduction offers unparalleled intellectual growth rooted in contemporary science. By prioritizing relevance, fostering belonging, and addressing implementation, we empower the next generation of scientists with a more complete vision of the physical world, investing in future STEM literacy and progress.

S-14: Teaching Energy Generation As a Way to Teach Environmental Justice Issues in a High School Physics Classroom

Presenting Author: Nora Paul-Schultz, O'Bryant School Of Math & Science

Energy and electricity are major concerns for communities as well as being major topics in physics learning. My colleagues and I adopted our energy and electricity instruction and added a unit in order to help students connect their learning to local environmental justice issues. An important goal is to help students understand that science is implicated in ethical decision making that affects them and their communities. In this way, we hope to better prepare students to both understand social problems as scientists and address them as citizens. In this poster, I will provide an overview of the unit we created, example lessons and projects, examples of student work and a reflection on the experience. The unit that we developed started with a conceptual background into electromagnetism and then moved into students understanding how energy was generated. Students debated which energy sources Massachusetts should increase their use of and made posters about local environmental justice issues.An energy generation unit in a Boston high school physics classroom combines traditional topics in energy, electricity and electromagnetism with local environmental justice issues.

S-15: Pre-service Physics Teachers' Productive Beginnings in Learner-responsive Teaching

Presenting Author: Mark Akubo

Additional Authors | Jeffrey Woulfe, Nathan Todaro, Laura Francisco, Jacqueline Griffith

STeachers rank highest among influential factors for successfully supporting K-12 students' achievement of 21st century and quality learning experiences in classrooms. K-12 Teachers' development of proficiency in learner-responsive teaching is critical for supporting such students' experiences. In this research, we explored two pre-service physics teachers' productive beginnings developing proficiency in learner-responsive teaching. Their initial efforts consisted in developing and enacting learner-centered lesson plans as part of the requirements for successfully completing a science teaching methods course and student teaching experience. We gathered data in the forms of the pre-service secondary science teachers' lesson plans, their student teaching reflections, and an instructor or science teaching support specialist's observation feedback.

S-16: Student participation in Extended Research Projects and Science Fairs to Promote Higher Order Skills and Tertiary Opportunities in High Achieving High School Physics Students

Presenting Author: Kirsten Hogg, PhD (Physics), BSc(Hons), Grad Dip Ed., Queensland Academy for Science Mathematics and Technology

Additional Author | Nanako Takeda, Koichiro Hiromatsu

Extended research projects provide opportunities for students to develop problem solving, research, analysis and evaluation skills. Science fairs, student conferences and science competitions foster communication and collaboration - integral skills for tertiary study and workforce participation. Participation in this sort of extra-curricular activities, enhances tertiary and scholarship applications. Modern communications technology has broadened the scope and accessibility of both research collaboration and science fairs. This presentation provides suggestions for mentoring and facilitating these experiences, in person and online, for high achieving high school physics students. Our selective STEM high school offers students multiple opportunities to conduct extended research projects that lead to participation in local, national and international science fairs. Prior to 2020 the projects and fairs were conducted in-person with students travelling to host schools to present their results. The fair format is an invaluable opportunity for the students to hone their written and spoken communication skills and engage in cultural exchange with other fair attendees. From 2020 to 2022 many in-person fairs were cancelled and replaced with online fairs. While undoubtedly many benefits of in-person fairs were lost, the online fairs allowed teachers, mentors and students to develop online collaboration skills that have been maintained after the COVID pandemic passed. Work management and videotelephony tools like Slack, Teams and Zoom can be used to facilitate collaborative projects with local, national and international schools. Online fairs can be hosted with hundreds of participants. For example, in January 2025 Ritsumeikan High School Japan hosted an online fair with 32 collaborative projects from 20 schools from 8 different countries. Online research projects and science fairs provide additional and equitable opportunities for students and teachers. Beginning a student research and science fair program can be daunting. This presentation offers ideas and suggestions for starting small and local, utilising online options and then building connections towards an international network that offers your students unique and invaluable experiences.

S-17: Adelphi Lab For Kids: Amping up Physics Outreach for a Post-Pandemic World

Presenting Author: Matthew Wright, Adelphi University

Additional Authors | Carissa Giuliano, Patricia Mueller, Tracy Hogan

We will discuss our Lab-for-Kids outreach program, where college students are tasked to go out to high schools in our region to teach fun science outreach lessons with high school students. In the 2024-2025 school year, we will attend 15 different high schools and one museum to provide fun hands-on lessons for physics. Participating in this project are 8+ undergraduate students who have a career interest in teaching physics at the high school level. We will provide survey results from the high school teachers of participating schools and the result of an external focus group with the undergraduate-teaching focused students.

Introductory Physics

S-18: Force-vs-Position Diagrams to Distinguish Conservative and Non-conservative Forces

Presenting Author: Rob Salgado, St Catherine University

A force-vs-position diagram allows us to determine work done by calculating the area under the curve. This feature is commonly used to analyze spring forces and derive potential energy functions. In this poster, we extend this analysis to gravity and to sliding friction acting along closed paths in one dimension. Our analysis allows us to reveal a key distinction: mechanical cycles associated with conservative forces enclose zero area on these diagrams, while those associated with non-conservative forces enclose a nonzero area. This enclosed-area property provides a preview of the work done in thermodynamic cycles in pressure-vs-volume (PV) diagrams.

S-19: The New PICUP Project – Come to DICE and SLICE With Us!

Presenting Author: Larry Engelhardt, Francis Marion University

Join us in the Partnership for the Integration of Computation into Undergraduate Physics (PICUP). There are two new opportunities for you to get involved: (1) We are starting a series of workshops distributed across the country. These are the Distributed Institutes for Computational Education in Physics (DICE). (2) We are also hosting a week-long summer workshop, which is the Summer Leadership Institute for Computational Education in Physics (SLICE). This project is funded in part by the National Science Foundation under DUE IUSE grants 2337049, 2337050, 2337051, 2337052, 2337053, 2337054, 2337055, 2337056.to interact with the ideas we present.

S-20: How do Physics Identity and Perceived Recognition Predict Physics Grade for Women and Men

Presenting Author: Jaya Shivangani Kashyap, PhD, Graduate stduent, University of Pittsburgh

Additional Author| Chandralekha Singh

Perceptions of recognition and identity can be shaped by various forms of feedback and experience. Here we focus on the potential effects of course grades. We analyze statistical patterns in changes in identity and perceived recognition from pre to post course in three years of data of students enrolled in many sections of calculus-based Physics 1 (N=1034). In particular, regression models predicted post-semester survey means using pre-semester survey means and grade. Effects of gender and interactions of grade with gender were also included. All students showed declines in identity and perceived recognition after receiving lower grades. However, women showed larger declines, with a decline after receiving only a B grade that was similar to the declines men showed after receiving a C grade or a non-passing grade.

S-21: Using MATLAB in Introductory Physics Courses: Enhanced Understanding of a Model and Addressing its Limitations

Presenting Author: Soroush Khosravi, PhD Joshua Houseman, Penn State Univ

Additional Author| Joshua Houseman, Penn State Univ

Projectile motion is one of the first topics discussed in introductory physics courses as an example of two-dimensional motion. Understanding how the separation of components works to provide a mathematical model for the projectile's trajectory based on the one-dimensional kinematic equations can be challenging for students. We present a concise MATLAB script that can be readily developed by students to visualize this and also examine the effect of the initial parameters. However, this simplified projectile motion model is often inadequate for real-world applications because it disregards factors such as air resistance and flow, curvature and rotation of the Earth, and variations of the gravitational field strength, among others. We show how MATLAB can empower students to explore and address these limitations through computational modeling, rather than relying solely on cumbersome analytical approaches.

S-22: Applying Guided Inquiry as a Research Project in an Undergraduate Physics Laboratory

Presenting Author: Hannah Attard, Daemen Coll

The primary goal of this project is for students to take a deeper level of ownership over the laboratory experiments by applying the concepts from class to 'real world' situations. As such, the project is titled Waves in the Real World and occurred over a 3-week period in an algebra-based Physics 2 laboratory course. This project fully replaced three typical laboratory experiments and was implemented in 4 sections of the laboratory with three different instructors. Students worked in groups of 2-4. In week 1, students chose a topic from a predetermined list, developed their research question and hypothesis and began designing their experiment to test their hypothesis. In week 2, students conducted the experiment with oversight from the lab instructor. In week 3, students gave a 10-minute scientific presentation to the class. The assignment was scaffolded such that students received feedback consistently throughout their development and investigation. For example, after weeks 1 and 2, groups submitted a "Research Question" and "Experimental Design" document, respectively. They then received feedback within 24 h so they could make any suggested adjustments before continuing in the project. The process and documents used in the project are not specific to the topic and can be used for a myriad of subjects; this poster will provide more detail on how the project was structured, including providing examples of the materials utilized. The students reported that they gained a more thorough grasp of the material and the scientific process as a result of this project.

S-23: Taylor Series Derivations of 1-D Constant Acceleration Kinematic Equations

Presenting Author: Craig Looney, Merrimack Coll

In this poster I present the straightforward but not yet widely known Taylor series derivations of the familiar kinematic equations for uniformly accelerated one-dimensional motion, and provide links to student-accessible video resources for potentially interested instructors. The Taylor series approach provides an opportunity to introduce and discuss the jerk and higher-order kinematic derivatives, which emerge naturally in the course of the x(t) and v(t) derivations and which are important in a wide array of real-world applications.

S-24: UDL in Action: Enhancing Engagement and Assessment in Physics Education

Presenting Author: Chelsea Tiffany, Saint Paul College

Additional Authors | Matthew Cass, Joseph Martinez, Tamara G. Young

Universal Design for Learning (UDL) is an educational framework based on strategies to provide an opportunity to succeed to all students, including supporting student engagement, providing flexible and accessible learning experiences, and reducing barriers in assessment. Our group has implemented UDL techniques at various levels of physics, from conceptual to calculus based courses, in both the context of lectures and in labs. In this poster we provide case studies for the practical implementation of UDL principles in the classroom to help create a more equitable environment that fosters deeper learning by the students. We share examples of student instruction and assessments that provide multiple ways to grow and demonstrate mastery.

Labs and Apparatus

S-25: Comparing Sliding versus Rolling to Determine Moments of Inertia of 3D Printed Cylinders

Presenting Author: Rebecca Cree, Susquehanna University

Additional Authors | Robert Everly, Carl Faust

We present a laboratory activity aimed at having students combine several physics concepts to determine the moment of inertia of a custom 3D printed cylinder. Although the lab could be done without it, 3D printing was used to produce specific custom cylinders having the same outward appearance, size, shape, mass but different interior mass distributions. This serves to highlight for the students that mass distribution is the key factor when considering how an object will rotate. By racing a sliding block against one of the rolling cylinders down inclined ramp, the angle at which the objects tie can be used to determine information about the mass distribution if the friction coefficient is known. The exercise of deriving the angle at which the objects tie brings in concepts additional concepts other than rotation such as forces and torques or conservation of energy. The experimental method also leaves room for students to consider various assumptions in the model leading to a useful discussion of systematic error. We believe that these ideas, along with opportunity for discussion of error and measurements, will make for a compelling lab activity that could easily be incorporated into introductory classrooms with little or no need for purchase of additional equipment.

S-26: Demonstrating Geometric Phases with a Smarphone

Presenting Author: Iberto Rojo, Ph D, Oakland University

Additional Author | Jordan G. Dedene

Modern smartphones are versatile data collection devices that have become increasingly valuable in experimental physics. Equipped with micro-electromechanical system (MEMS) inertial sensors, they can measure accelerations, rotations, magnetic fields, pressure, and even sound and light levels. In this paper, we leverage the gyroscope functionality of a smartphone to design two experiments that demonstrate geometric phases in classical mechanics. The first experiment simulates the geometric phase of the Foucault pendulum by placing a smartphone on a turntable inclined at an angle. By measuring the integral of the angular velocity along an axis perpendicular to the smartphone, we obtain the angle of parallel transport on a sphere at latitude (heta), corresponding to the rotation of the pendulum's plane of oscillation. The second experiment models the rotation of light polarization in an optical fiber using a smartphone. Instead of propagating light through a coiled fiber, we slide a smartphone along a flexible helical track, analogous to an optical fiber winding around a cylinder. The gyroscope records the angular velocity along the smartphone's axis, allowing us to compute the Berry phase angle through integration. While this method introduces small experimental errors due to manual sliding, the measured phase remains consistent with theoretical predictions.

S-27: Exploring Near-field Optical Diffraction Using a Beamlet Approach: Theory and Experiment

Presenting Author: Shabbir Mian, PhD, McDaniel College

Additional Authors |Jeffrey Marx, Christopher Kulp

We introduce an engaging, hands-on approach for teaching near-field optical diffraction to undergraduate students taking optics or advanced laboratory courses. The approach involves passing a Gaussian laser beam (commonly from a HeNe laser) through a circular aperture and capturing the resulting diffraction pattern using a camera-based beam profiler. We model the truncated Gaussian beam as a sum of smaller Gaussian beamlets, propagate each one to the observation plane via the -parameter formalism, and then recombine the beamlets to construct the diffracted beam. This method allows students to visualize laser beam diffraction in a manner similar to how Huygen's wavelets are used in classical diffraction theory. Additionally, it offers a computationally simpler alternative to traditional diffraction integrals, such as Fresnel-Kirchhoff or Rayleigh-Sommerfeld. While the model provides excellent accuracy in the far-field and most near-field distances, some discrepancies arise at very near-field ranges (with F-numbers > 3). By combining both theory and experiment, we provide a dynamic and interactive way for students to explore Gaussian beam propagation, the -parameter formalism, and diffraction phenomena, enriching their understanding of optics in a laboratory setting.

S-28: Using AI-based Exercises to Enhance the Effectiveness of Pre-lab Preparation in Intro-physics Laboratories

Presenting Author: Mario Freamat, PhD, Penn State Scranton

Typical ancillary materials associated with introductory physics laboratories include pre-lab materials. These prepare the students for the respective lab by introducing them to the apparatus and the science behind the experiment, and integrate the lab unit into the general goals and outcomes of the course. At Penn State Scranton, students are expected to put significant work into the pre-lab preparation by reading extensively and solving quizzes. To modernize and improve the pedagogical effectiveness of pre-lab materials, we developed a series of exercises designed to pair the students with Artificial Intelligence (AI) tutors, illustrated here by a few examples to be implemented in a calculus-based intro course of classical mechanics. We show how one can avoid the problem-solving limitations of the machine by instructing the student to employ the AI as a generator of mockup versions of the lab apparatus and analytical idea. .

S-29: "Sound bulbs": Audible Light Bulb Replacements for Introductory Circuit Labs

Presenting Author: Karen M. Chinchihualpa Paredes, University of Cincinnati - Main Campus

Co-presenting Authors | Richard D. Chinchihualpa Paredes, Dean Stocker, PhD

In introductory circuit labs, students collect data based on visual observations of the brightness of incandescent light bulbs in various configurations, which presents a challenge for blind and visually impaired students. We aimed to develop the design and evaluate the efficacy of audible drop-in replacements for incandescent bulbs. We have found that a simple circuit based around a 555 timer can be used to create an audible sound whose pitch changes with voltage. The "sound bulbs" performance showed ohmic behavior in both positive and negative polarity with fitted curves indicating equivalent resistances of approximately 323 Ω, only about 1% different from the nominal value that would be expected from having a 100 Ω resistor (R3) in series with a 220 Ω resistor (R4). The frequency-vs-voltage curves for the sound bulbs show that around zero volts the audible pitch changes by a half step approximately every 0.3 V, and near the extremes of +/- 6 V the sensitivity increases, with pitch changing by a half step approximately every 0.2 V. When combined in series and/or parallel, the measured resistance behaves in the same way as resistors. Calculated values of equivalent resistances were within 1% of the expected values for series, parallel, and combination circuits. The frequency response is reasonably uniform across a typical voltage range used in introductory physics labs, showing a promising functionality. Sensitivity is such that changes of fractions of a volt create distinguishable sounds across the full input voltage range. While the motivation for this work is to improve accessibility for blind and visually impaired students, providing "sound bulbs" as an option is a step toward universal design that has the potential to benefit many more students

S-30: Cosmic Ray Cascades: Environmental Influences on High-Energy Cosmic Particles Studied in a University Physics Laboratory

Presenting Author: Elena G. Gregg, Oral Roberts University

Other Authors | Pavel Navitski, Wesley D. Klehm, Gabriel Pendell, Kolby E. Mostrom, Prem Thannickal

The Advanced Physics course at Oral Roberts University is strategically crafted to prepare students for professional engineering roles and academic research by embedding hands-on, adaptable laboratory projects specific to engineering fields. A pivotal element of this curriculum is a student-conducted study into cosmic ray cascades, focusing on the detection and analysis of muons—massive elementary particles like electrons, produced through cosmic ray interactions with atmospheric molecules. The current research phase extends an ongoing investigative series into cosmic ray cascades. Earlier phases of this study refined the detection process by calibrating steel plate thickness to enhance cascade visibility and detailing the muons' angular distribution in various observational setups. This latest phase pivots to examining the influences of environmental conditions on cosmic ray cascades. Students engaged in rigorous data collection and analysis, correlating the frequency and intensity of cascade events with variations in atmospheric temperature, pressure, and general weather conditions, utilizing an advanced detection setup optimized from previous findings (11 plates at a 70° angle relative to the northern horizon). Preliminary findings indicate that environmental factors significantly affect muon production in cosmic ray showers. Higher atmospheric temperatures reduce the amount of muon flux at ground level due to increased meson decay altitude, while lower atmospheric pressure allows more muons to reach the surface by reducing absorption. Additional factors such as humidity, solar activity, geomagnetic effects, and altitude also contribute to variations in muon detection. These insights not only broaden the scientific community's understanding of particle physics but also refine the experimental techniques used in this field, setting a solid foundation for future exploratory projects.

S-31: Measurement of Alpha Particle Energies and Half-lives in Air

Presenting Author: Randolph Peterson, University of the South

Other Authors | Sean Robinson, John Wilson

The physical explanation of alpha particle decay is derived from equation for quantum mechanical tunnelling and generally agrees with the Geiger-Nuttall empirical law relating the alpha particle kinetic energy to the half-life of the isotope from which the alpha particle is emitted. Measurements in the intermediate and advanced lab of a variety of half-lives and alpha particle energies can generate data for a Geiger-Nuttall empirical law can be made using a Passivated Implanted Planar Silicon (PIPS) detector in air. The isotopes from the radon decay from natural uranium and thorium are collected electrostatically on the front surface of the detector and the spectra of the emitted alpha particles can be measured as a function of energy and time, during the collection of the isotopes or after collection. Use of the Bateman equations helps to determine the half-lives of some of the decay products. Results from the measurements will be presented.

Two-Year Colleges

S-32: Who Do REUs Help? Results from Surveys of REU Students and Two-Year College Faculty

Presenting Author: Jonan-Rohi Plueger

Co-presenting Author | Bethany R. Wilcox

A major NSF goal in funding Research Experiences for Undergraduates (REUs) is reaching students with limited access to research, such as students from two-year colleges. Many such students have family and home circumstances that may impact their access to REUs. We surveyed (1) current REU students about their family and home circumstances and (2) two-year college faculty about whether they would recommend REUs to their students, and why. We present our results and their relevance to REU design and recruitment.

S-33: Impact of OPTYCs: Qualitative Data

Presenting Author: Kris Lui, OPTYCs/AAPT,

Co-presenting Authors | Dwain Desbien, Sherry Savrda, Rachel Ivie

The Organization for Physics at Two-Year Colleges(OPTYCs) is three years into its four-year grant (NSF-DUE-2212807). Part of OPTYCs' vision is that TYC physics and astronomy faculty are embraced within and empowered by an inclusive national physics education community. This poster will showcase feedback from our community on how well this vision is being achieved.

S-34: Impact of Physics in Two-Year Colleges

Presenting Author: Raymond Chu, American Institute of Physic

Additional Author | Susan White

New data hint impact of TYC faculty. OPTYCs funded the most recent TYC survey that AIP has conducted since 1995, a study that monitors the availability of physics classes, physics enrollments, and physics faculty counts in TYCs. Both organizations collaborated to collect data from web searches, a departmental questionnaire, and a faculty questionnaire. AIP has conducted the TYC surveys in roughly ten-year intervals. Overall trends are mixed, but data from other AIP surveys provide context and possible resolutions to the missing detail between the two most recent surveys. The web searches also provided the most accurate list of 1126 campuses offering physics. The physics faculty at TYCs is likely influencing students to pursue bachelor's degrees in physics. We look forward to sharing these data with you.

S-35: Reflections on My AAPT Leadership Institute Experience

Presenting Author: Keith P. Madden, Ivy Tech Community College, South Bend, IN

The goal of the TYC Leadership Institute is to empower its participants to advocate for and lead essential changes in STEM education. My project is based at the local level of my campus to work with college administration to improve our physics teaching laboratory physical plant. My goal is to make it consistent with the published AAPT TYC national standards to enhance student learning and safety. I will report on the initial steps taken, and the progress that has been made thus far.

S-36: TYC Tandem Meetings

Presenting Author: Thomas O'Kuma, Lee College

Additional Authors | Kris Lui, Paul Heafner

The TYC Tandem Meeting is an event that brings together faculty teaching physics, astronomy, and physical science at two-year colleges to share ideas, learn from each other, and build community. It is a productive day of activities to help all of us with new skills, ideas to enhance student success, and advancements in knowledge and tools. There have been five previous Tandem Meetings – July 2010, January 2012, July 2013, July 2015, and July 2023. This poster will have a brief look at the history of the TYC Tandem Meetings and information on the August 2, 2025 Tandem Meeting at Howard Community College. OPTYCs is supported by NSF-DUE-2212807.

S-37: Meeting Students Where They Are: HyFlex for Introductory Physics at a TYC

Presenting Author: Joseph Gallagher, University Of Cincinnati Blue Ash College

Co-presenting Author | Bogdan Leu

During the pandemic, restrictions led to an increased familiarity with online environments among the students in higher education. At the same time, these same restrictions led to the development of new, and the greater availability of existing, technologies and pedagogies beneficial to remote learning. The outcome has been a shift in the priorities of many institutions of higher education. In response, the University of Cincinnati Blue Ash College has charged some of its faculty with developing Hyflex STEM options to help meet the changing needs and learning styles of our students. Here we report on the designs, implementations, and lessons learned following three semester's worth of offerings of an algebra-based, introductory physics HyFlex course.

S-38: Research-Based Assessment Instruments: An OPTYCs-Sponsored Informational Series

Presenting Author: Sherry Savrda, Organization for Physics at Two-Year Colleges

Additional Authors | Sherry Savrda, Organization for Physics at Two-Year Colleges,

It is widely recognized that problem solving is a vital skill for physics students to learn. One element of expert-like problem solving is reflecting on one's solution A significant portion of students taking introductory physics courses do so at a two-year college (TYC), yet most PER studies on the introductory courses take place in R1 universities. Since the fall semester of 2022 the Organization for Physics at Two-Year Colleges (OPTYCs) has offered sessions on PER-related topics to interested TYC faculty. These sessions are designed to relate findings from PER and facilitate discussions on how to adapt innovations based on PER findings to the unique environment of the TYC classroom. In an effort to encourage more TYC faculty to use research-based assessment instruments (RBAIs) and share their findings, OPTYCs is planning an academic-year series on RBAIs. Developers and researchers will be invited to share their expertise, comparing the various instruments, providing advice on how to select the best instrument to meet specific needs, how to correctly administer the instruments and interpret the results, and how to share data with the broader physics education community. In this presentation we will review the planned series and provide information to interested faculty on how to be involved. This project is supported by the National Science Foundation under Grant No. 2212807. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Educational Technology

S-39: Project STEMinAR: Augmented Reality Physics Simulations

Presenting Author: David Rosengrant, University of South Florida St. Petersburg

Additional Authors | Karina Hensberry, Garrett Matthews, Nancy Sharfun Islam, Kelly Navas, Rachel Cacace, Gerald Woods

We have developed a new augmented reality app for mobile devices to be used in the classroom. The app is called STEMinAR. Within this app users will find simulations for Newton's Cannon, Newton's Laws, Rotational Motion, Thermodynamics, Optics, Lenses, and Electromagnetism. These simulations are available both on IOS and Android platforms. We will also be highlighting curriculum created which follows the Investigative Science Learning Environment framework. The simulations track a free, downloadable cube, allowing the user to interact directly within the virtual environment. A strength of these simulations is that users have access to multiple variables. Users are provided with real-time data representations, giving them the ability to observe the results from changing the input variables. In this presentation, we will demonstrate the simulations and share initial data from the simulations. Support for this work is provided by an IUSE grant from the National Science Foundation.

S-40: Communicating Beyond the Experiment: Revising the Intermediate Experimental Techniques Laboratory Course

Presenting Author: Duane Deardorff, PhD Addit

onal Author |Jennifer Weinberg-Wolf, Univ of North Carolina At Chapel Hill, , Shane Brogan

At UNC-CH we have revised our Experimental Techniques course that serves as a gateway for all our physics majors. We describe a novel approach focusing on communication both written and oral, including discussions about career development and opportunities, ethics, physics identity, mentorship models, and how to prepare for different types of interviews. Students communicate their results to different audiences (technical and mainstream), including individual and group lab reports, peer reviews, chalk talks, a letter home, multiple podcast style reflections, and a grant proposal as the final group presentation.

Beyond Intro

S-41: Developing Ultrafast Physics Tutorials for the AMOS Gateway

Presenting Author: Melissa L. Barru, BS, University of Colorado Denver

Additional Author | Kathryn R. Hamilton

The Atomic, Molecular, and Optical Science Gateway (AMOSGateway) [1] is a computational portal where researchers and educators can access a synergistic, full-scope platform for computational AMOS. The AMOS Gateway currently hosts ten state-of-the-art software suites for computing atomic spectra, transition probabilities, electron and positron collision and photoionization processes, including short-pulse intense-field laser-atom/molecule interactions. Software suites are accessed directly on the gateway, as are the required computing resources, providing novice users with a convenient way to perform calculations. The ease-of-use of the AMOS Gateway also presents an opportunity for involving research-grade software in classroom instruction. In this presentation we will demonstrate the use of Ultrafast Physics tutorials created for undergraduate instruction at the University of Colorado Denver. The tutorials are hosted on the AMOS Gateway and use several of the hosted software suites. We will comment on classroom implementation, student opinions of the tutorials, and future plans for tutorial development.
1] https://amosgateway.org/ Work supported by the NSF under OAC-2311928, ACCESS-PHY200012, and the Frontera Pathways Allocation PHY23020

S-42: Spacetime Continuum: A Novel Game to Build Science Literacy and Physics Identities

Presenting Author: Maria Mutz, MS

Exploring the expansive and diverse nature of physics history has the dual potential to increase science literacy among non-scientists and inspire future physicists by helping to build their physics identities[1]. My newly-developed card game, “Spacetime Continuum”, is a versatile tool for teaching physics history to all ages that taps into play and storytelling as natural pathways for learning. Within the game, players explore the story of physics as it unfolds throughout time with increasing detail and nuance. They learn the iterative and human natures of science: how scientists have tested theories, responded to new ideas and observations, and adapted to the world around them. The game includes opportunities to form hypotheses and reflect on assumptions players carry about physics and physicists. Most importantly, players learn about the accomplishments of physicists from a wide array of backgrounds whose names they may never have heard, but whose work they can’t imagine a world without. “Spacetime Continuum” decks can be used for several different activities, with length and style of play adaptable to grade level, class constraints, and educator needs. A prototype was launched at a large public event in 2024 and met with hundreds of enthusiastic participants and overwhelmingly positive feedback. The first official edition was distributed to requesting K-12 and college educators in May 2025. Learn more about the game and how to request your own deck!

S-43: PhysMath: Simulations for Upper-division Physics Topics with Interactive Equations

Presenting Author: Jared Arnell, Utah State University

Additional Authors | Hillary Swanson, Boyd Edwards, Joshua Knobloch, Sadra Jafari Ghalehkohneh, Rida Munir, Kaden Hart, John EdwardsAdditional Author | Aaron Titus, NC State University

Physics students often struggle to connect mathematical and conceptual ideas in physics contexts – even when they can demonstrate the prerequisite knowledge in other contexts. This is especially prevalent in upper-division courses, wherein physic students investigate a plethora of rich phenomena through advanced, rigorous, and complex mathematical lenses. Due to the disparity in enrollment, Introductory physics courses have received far more attention in educational research than the upper-division courses. As such, there exists a wealth of digital simulations covering introductory-level concepts – often with minimal to no mathematical aspects – and comparably few educational tools for advanced physics topics. To address these needs, the PhysMath research team has developed a suite of free-to-access digital simulations, which model upper-division physics phenomena and include explicit mathematical engagement through interactive equations.

S-44: Performance Evaluation Through Log Analysis for Interactive Simulations

Presenting Author: Jun Saito, Obihiro University of Agriculture and Veterinary Medicine

Additional Authors | Yasuyuki Nakamura, Fumiko Yasuno

This poster presents ideas for implementing computer-based performance evaluation through log data analysis obtained from students’ interactions with online simulations. We developed an interactive learning material that simulates a schematic experiment of the photoelectric effect using GeoGebra, a dynamic mathematics software, and STACK, an online assessment system, on Moodle LMS. Students can measure the photocurrent by adjusting the anode voltage and selecting appropriate wavelengths of the emitting light as well as the target cathode metals. These interactions produce time-series log data, which can be compared with an ideal experimental procedure and analyzed to evaluate the appropriateness of students’ performance. As our simplest option for the comparison mechanism, we use regular expressions to define the ideal operational sequences and conduct pattern matching to detect if such sequences appear in the students’ log data. More elaborate methods to better handle the time-series property of the log are also being developed. By focusing on not only the final states but also the process of interactions, the implementation provides rich information on the quality of learning, which is hard to obtain in ordinary assessments.

S-45: Clarifying Quantum Mechanics: The Importance of Formalization in Education

Presenting Author: Jeremiah Bass

The degree to which curricula can be understood depends on how they are defined and presented. If features of the content itself are not well-defined, or if the content is presented in a vague or misleading manner, then this places limitations on conceptual understanding. Such curricula lack a degree of formalization. Formalization is the process of translating an unclear idea into a precise, well-defined concept or mathematical structure. This has applications in physics and physics education. Quantum mechanics is notoriously difficult to understand, especially with its departure from classical intuition, but we argue that a lack of formalization in quantum models and curricula is a major source of that confusion. Formalization in this context is compared with other conceptual difficulties such as quantum indeterminacy and philosophical interpretations of quantum mechanics. Recommendations are offered for physics educators and future research.

S-46: Introducing the Quantum World via NMR: Modules and their Efficacy

Presenting Author: Dedra Demaree, PhD

Additional Authors | Merideth Frey, Physics, Colin Abernethy, David Gosser

Multiple lab-based modules have been developed as part of an NSF-IUSE grant to help make Nuclear Magnetic Resonance (NMR) more accessible and integrate NMR into the undergraduate science curriculum. Some of these modules can stand alone and be used in introductory and high school settings to introduce the quantum world. The activities are strongly influenced by the Investigative Science Learning Environment (ISLE) philosophy, including observation and testing experiments, and have been substantially assessed using techniques borrowed from ISLE publications. This poster will have two parts: introducing modules that can be used in physics or in chemistry classes with no prior knowledge of modern physics or NMR, and giving brief evidence for their efficacy.

S-47: Making Nuclear Magnetic Resonance Resonate with Students: Integrating NMR into the Undergraduate Curriculum

Presenting Author: Merideth Frey, PhD, Sarah Lawrence Coll

Additional Authors |Colin Abernethy, David Gosser

Nuclear magnetic resonance (NMR) is a quantum technology that serves as a crucial analytic and diagnostic tool in fundamental and applied science industries and promises to play an important role in the 21st-century STEM workforce. The recent development of inexpensive benchtop NMR spectrometers offers unique opportunities for undergraduate institutions to give their students relevant research skills with this essential technique and provide a more intuitive introduction to the quantum realm. Through the support of an NSF-IUSE grant, we have established an interdisciplinary and cross-institutional team to develop, assess, and disseminate curricular material that integrates NMR into all levels of the undergraduate science curriculum. These materials consist of interactive modules with associated instructional guides and online resources that introduce the topics without expectations of prior college-level science or math courses. Our research shows that students using our modules not only successfully master the NMR content, they also: (1) spend over four times as much time sense-making using our modules as in a traditional lecture course, (2) demonstrate positive scientific identity shifts, and (3) make statistically significant gains in learning attitudes about science and self-assessed research skills. If you or any faculty colleagues may be interested in implementing any of our materials, please scan the QR code on the poster for the contact form.

S-48: Bridging the Skills Gap for Future Quantum Workforce

Presenting Author: Mojgan M Haghanikar

The rapid advancement of quantum applications has led to an increasing demand for a streamlined workforce with specialized quantum-relevant skills tailored to various roles. Unfortunately, the traditional training method for quantum workers typically requires a doctoral degree, which is a prohibitively long turnaround to fill the hundreds of jobs open now and also leaves many skilled workers behind. To address this gap, the Quantum, Computing, Mathematics, and Physics program (QCaMP), initiated by Lawrence Berkeley National Laboratory and Sandia National Labs in 2022 under the Quantum Systems Accelerator and expanded in 2024 as a DOE Pathway Summer School, aims to introduce quantum information sciences to high school teachers and students. Since its launch, QCaMP has broadened its scope to provide more opportunities for engaging with fundamentalmathematics, physics, and computing concepts through hands-on experiments and independent projects. In the summer of 2024, I had the privilege of working as an external Quantum Curriculum developer alongside a diverse team of experts in quantum research and education from Sandia National Labs and Lawrence Berkeley National Laboratory. Deliverables were a week-long workshop for teachers with cohorts in 5 states and a 4-week-long camp for students in NM and CA, with accessible quantum-based hands-on activities designed for educators and high school students. These collaborative efforts focused on creating a well-structured and conceptually engaging curriculum.

Acknowledgements go to the funding agency, Department of Energy, Office of Science, Workforce Development for Teachers and Scientists, Pathway Summer Schools (DOE WDTS PSS) as well as Quantum Systems Accelerator, Lawrence Berkeley National Lab, and Sandia National Laboratories.

S-49: Building the Quantum Future: Visualizing an Associate's Degree in Quantum from a Student's Perspective

Presenting Author: Eyob Bulti, University of District of Columbia-Community College, Washington, DC

Additional Authors | Patrick Hall, Anil Pyakuryal, PhD

As quantum technologies approach real-world use, the need for foundational undergraduate education in quantum science is growing. Colleges are developing entry-level curricula under terms like Quantum Literacy, Quantum Readiness, and elementary Quantum Information Science Education (eQISE). These programs aim to provide accessible pathways for students with limited backgrounds in physics, math, or computer science. This poster offers a student-informed framework for a 60-credit associate-level eQISE program, grounded in direct experience with simulators (e.g., IBM Q, qBraid), conferences, and peer education. The proposed structure emphasizes early integration of qualitative quantum physics, linear algebra, computational thinking, digital circuit design, and Python-based simulation. To promote interdisciplinary fluency, the curriculum should also include ethics, applications in emerging technologies, public policy, and journal-based reviews. Experiential components like simulator-based labs and capstone projects are essential for developing practical quantum reasoning. Rather than producing specialists in two years, eQISE programs should empower new learners with the literacy needed to engage in the growing quantum ecosystem. This approach supports equitable access while aligning education with evolving workforce demands. In an era where quantum fluency increasingly defines technological agency, eQISE stands as a vital educational frontier.

S-50: From Memorization to Meaning: Helping Students See the Physics Behind the Constants: A Visual and Intuitive Method for Teaching Nondimensional P hysics

Presenting Author: David Humpherys, Adobe

Max Planck kickstarted the quantum revolution 125 years ago by introducing the constant of proportionality that bears his name. Planck showed that his constant and other universal constants contain natural units in their dimensions known as Planck units. Students learn dimensional analysis as a technique for manipulating natural correlations in physics formulae; setting universal constants equal to 1 gives proportionally meaningful results. While this method is mathematically convenient, without context, students may perceive it as a mathematical shortcut requiring memorization rather than deep understanding. Planck units offer a natural context for dimensional analysis by recasting equations in non-dimensional form, grounded in fundamental physical relationships. This approach gives students a better understanding of natural correlations that conserve physical quantities represented by universal constants. This poster is a visually engaging presentation of the article "Understanding the natural units and their hidden role in the law of physics" (Eur. J. Phys. 45 015805, 2024). Graphical elements will be available for teachers to use in the classroom.

Belonging and Access

S-51: Indonesian Students' Mental Models of Magnetism and Implications for Teaching

Presenting Author: Rika Mardiana, The Ohio State University

Additional Author | Lin Ding

Magnetism is a challenging topic for students due to its abstract nature. This study examines the type of mental models that Indonesian high school students used when completing tasks related to magnetic fields during clinical interviews. Results reveal that students engaged with different reasoning patterns through the use of various representations to illustrate their views of magnetic fields. Four distinct mental models of magnetism are identified from the students' responses: direction reinforcement, current-driven field orientation, field isolation and reinforcement, and comprehensive field interaction. These mental models represent students' understanding of the right-hand rule in the context of magnetic fields produced by current-carrying wires. These findings suggest that students rely on fragmented and incomplete knowledge when reasoning, highlighting the need for more targeted instructional strategies to help students refine their mental models of magnetism.

S-52: How an Online Gamified Physics Curriculum Affects Students' Physics Identity

Presenting Author: LaTeira Haynes Zavala, Ph. D., Los Angeles Unified School Dist

This research aimed to determine how a 'gamified' physics curriculum with immediate feedback affects students' perception of their ability to master physics as a discipline. Further, the study intended to determine how an online algebra-based physics curriculum that provides students with multiple levels of mastery in an interactive and responsive format affects students' physics identity and academic achievement. Multiple research studies (Hazari et al., 2017; Krakehl & Kelly, 2021) assert that access and participation of underrepresented urban youth in STEM fields, particularly in physics courses, is inequitable. Physics identity is particularly important for women and minorities who are underrepresented in physics. Pedagogical methods that focus heavily on math rather than concepts present a deterrent to many students in physics courses. This study examined the Los Angeles Unified School District's (LAUSD) strategic plan, which seeks to enrich academic experiences across all ages and disciplines, including math and science (LAUSD, 2022). Data was collected during the 2023-24 school year. The number of willing participants in the physics classroom determined the sample size. This sample included 24 high school physics students ranging between 14-19 years of age. The participants took three 10-minute attitudinal surveys on a computer during their physics class. The students' identities were coded, and data were viewed and analyzed at the end of the school year after students finished the physics course. All activities were done during class time as part of regular class activities. Survey data were analyzed via ANOVA and/or discriminant analysis to determine shifts in participants' attitudes about physics as the school year progressed. Preliminary findings indicated the student's self-assessed physics ability in the classroom increased. However, their assessment of their ability to do physics on a professional level decreased. This coincided with a reduction in their desire for physics. In addition, the students did not prefer one content delivery method over another. These data suggest that even as students' perceived ability to do physics increased, the increase in ability was confined to their current class. Funding: National Science Foundation Noyce Master Teacher Fellows Program.

S-53: Indonesian Teachers' Conceptual Understandings of Newtonian Mechanics and Classroom Teaching Practices

Presenting Author: Rika Mardiana, The Ohio State University, Lin Ding

Physics teachers play a crucial role in developing students' conceptual understanding of physics concepts. This study examines Indonesian physics teachers' understanding of Newtonian mechanics and its implications for teaching practices. We used the Force Concept Inventory (FCI) and semi-structured interviews to analyze participant responses to mechanics-related questions. The findings reveal that teachers with a strong grasp of Newtonian mechanics tend to implement guided-constructivist instructions (GCI) to foster students' engagement and deeper learning. In contrast, those with weak or non-Newtonian understandings rely on Content-Centered Instructions (CCI) and hesitate to adopt a student-centered approach, citing reasons such as time constraints, rigid instructional goals, and a lack of students' motivation. Our findings highlight the urgent need for targeted professional development programs that enhance teachers' conceptual understanding of Newtonian mechanics.

S-54: Fostering Student Success: Using the Underrepresentation Curriculum Across the USA

Presenting Author: Jennifer Parsons, Ph.D, Tyler Junior College

Additional Authors | Kristine Washburn, Tran Phung, Erik N. Christensen, SM, Mechanical Engineering, Tamara G. Young, Abigail R. Daaney

The Underrepresentation Curriculum (URC) is broadly applicable across all levels of physics, classroom settings, demographics, and state legislations. This poster will explore how to improve student success by incorporating the URC in different classroom contexts in four states: Florida, Texas, Utah, and Washington. We share the kinds of activities used, how to frame the lessons so that students will be engaged, the time frame allotted, the assessments used, student responses, and outcomes. .

S-55: Impacts of Funded Student-Driven Study Groups (an Access Network Site Activity)

Presenting Author: Red Lhota, Chicago State University

Other Authors | Dominique Moore, Meisha Daniels, Danyal Akbar, Kefira Fields

In a university environment where many students work part- or full-time, supporting students financially allows them to prioritize activities that contribute to their long-term success academically and professionally, which they may not normally be able to engage in. As an Access Network site (one of nine student-centered programs pursuing systemic change in STEM departments), students, faculty, and staff work together to create initiatives that support student agency. In this project, we funded 15 study group organizers over three terms so they could create peer-driven spaces where they shape their community and their learning. The student organizers chose the format, timing, and structure of their study sessions in collaboration with attendees, resulting in study groups that responded to the large range of needs of a primarily commuter student population. Organizers often chose to develop additional study materials with their peers or with course instructors to further enhance their collective learning. In this poster, organizers will share some of the strategies they used and the outcomes they observed. Like many STEM education grants through the NSF, the grant funding for this program has been prematurely terminated, and we are seeking ways to continue supporting peer-driven study groups. Funding Acknowledgement: NSF Grant #2011780 and #2309310, Alfred P. Sloan Foundation #2022-19555for us to carry out engineering education in K-12 teaching.

Physics Education Research (PER)

S-56: Analyzing Network Maps: A Cross-Comparison between Student Demographic Groups through Outreach Programs

Presenting Author: Jonathan Perry

Additional Authors | Kliya Ashtekar, University of Texas, Tatiana L. Erukhimova, Toni Sauncy

Recent research has shown the valuable impact on students between their facilitation of informal physics outreach programs and the development of their physics identity, sense of belonging, and development of essential 21st century career skills. Through a recent national survey sent to members of the Society of Physics Students responses were gathered to three open-ended questions sampling students' experiences through their engagement with outreach. To visualize statistically significant relationships between ideas expressed by students through the open-ended questions, we employed network analysis, drawing a web of interrelationships between connected ideas and themes. To evaluate the nuanced experiences of students based on differing background factors (e.g. gender, institution type) network maps were drawn for each subgroup to compare similarities and differences to their experiences. To analyze the various maps we conducted a broad search for systematic comparison methods across disciplines which employ mapping techniques. Here we will report on potential methods for systematic comparison of network maps, with particular attention to matrix difference calculations drawn from cognitive mapping techniques. Through this research, we expect to document how different identity groups are specifically impacted by informal learning methods, which themes stay consistent, and what ideas align more with different groups.

S-57: Implementing ISLE in Algebra-Based Physics: A Journey to Improve Student Learning and Beliefs about Learning Physics

Presenting Author: Amin Bayat Barooni, Georgia State Universityl

Since the Fall of 2023, I have redesigned the pedagogy of the studio class (Algebra-based physics) to implement the Investigative Science Learning Environment (ISLE) [1] approach. This change aims to improve students' beliefs about physics, enhance their experimental skills, and support concept learning through research-based pedagogy. In this approach, students construct physics concepts and develop specific scientific process abilities.
I emphasize the following steps:

1) Presenting students with intriguing physical phenomena.
2) Encouraging students to collect data about the phenomena, identify patterns, and generate multiple explanations for why or how the phenomena occur.
3) Testing these explanations through one or more experimental trials.
4) Developing problem-solving skills with an emphasis on evaluation and reasoning.
5) Applying the established ideas to solve real-world problems.

This process is time-consuming, so I must be selective about the topics covered during the semester. Since most studio class students are life science majors, the second semester focuses on Energy, Vibration, Wave, Optics, Wave Optics, and Electricity. During the Spring Semester, I use the pre-post Wave Diagnostic Test (WDT) [2] to assess students' understanding of basic wave concepts. Additionally, I use the pre-post Colorado Learning Attitudes about Science Survey (CLASS) [3] to measure students' beliefs about physics and how these align with expert beliefs. I also invite experts to observe my class and gather student feedback to improve the course continuously. I analyze the data to determine if there are any improvements in their beliefs about learning physics and specific learning concepts.

S-58: Physics Instructors' Perspective on the Use of Team-based Learning (TBL) in Physics Courses*

Presenting Author: Edgar Corpuz, University of Texas-Rio Grande

Additional Authors | Natalia D. Guevara, Pamela Kelley

At least seven (7) physics faculty members at the University of Texas-Rio Grande Valley (UTRGV) have been pilot-testing the use of team-based learning (TBL) in their physics courses Faculty interviews were conducted to generate feedback regarding the use of TBL. Interview participants were recruited using a convenience sampling approach in which an invitation email was sent to the faculty members who have implemented TBL, of whom five agreed to participate in an interview. The five interview participants included three Full Professors and two Lecturers. Participants reported positive impacts from implementing TBL, with themes that included gaining a better sense of their students' abilities and an enhanced instructional perspective with more focus on helping students work as a team. Participants also reported positive impacts for their students, including course enjoyment; increased learning and engagement; being more open to asking questions; and improved attitudes about learning physics. In this presentation, we will document other issues associated with the implementation of TBL including the challenges faced by instructors, suggestions for instructors wanting to adopt the approach, and how TBL can be leveraged for promoting culturally responsive teaching.

S-59: AI as a Research Partner: Enhancing PER Literature Analysisl

Presenting Author: Michael Mingyar, Montana State University

Additional Author | Shannon Willoughby

Understanding the evolution of a field of study is important for engaging with that field, yet tracking trends in Physics Education Research (PER) is increasingly challenging due to the expanding amount of relevant literature. Traditional literature reviews provide valuable insight but are slow and labor-intensive, limiting researchers' ability to track how concepts develop over time. To explore this challenge, we develop an automated approach for large-scale literature analysis using modern language models. By applying natural language processing techniques like sentiment analysis, we investigate the potential of machine learning to extract insights from PER publications. We focus on publications from The Physics Teacher, PER Conference Proceedings, American Journal of Physics, and Physical Review PER. While not a replacement for human analysis, this approach may help identify patterns in how ideas emerge, spread, or fade within PER literature.

S-60: An Investigative Study of Retention Rates in Physics Graduate Programs

Presenting Author: Christopher Overton, University of Georgia

Additional Authors | Bill Bridges, James T. Laverty, Nicholas You

Graduate students and degree holders play a central role in the growth of science and technology for both institutions and the country. Historically, STEM graduate programs have had a stable retention rate of around 60%, potentially causing a high cost for those leaving the programs and for society. We aim to identify programs with greater trends of retention to learn which should be emulated to achieve the greatest number of PhDs awarded. We use 23 years of data from the Integrated Postsecondary Education System (IPEDS) and the Survey of Graduate Students and Postdoctorates in Science and Engineering (GSS) to examine retention rates for physics graduate students and compare these trends to current literature. By observing the trends, we can make general observations about the current state of physics graduate education in the United States. We find that retention rates vary between different physics graduate programs..

S-61: Examining the Motivations of STEM Graduate Teaching Assistants Through Expectancy Value Theory

Presenting Author: David Seiden, University of Georgia

Additional Authors | Nicholas Young, Nandana Weliweriya, Sarah Jane Bork

Teaching assistantships are the primary funding mechanism for many STEM graduate students. These roles are known to have a large impact in undergraduate courses; undergraduates often spend as much face time with graduate teaching assistants (GTAs) as faculty members. At the same time, the experiences of GTAs in these positions are equally formative and potentially important for retention, yet are often de-prioritized. This presentation will discuss analyses of two focus groups of GTAs previously collected as part of a photovoice study. We will analyze focus group transcripts using expectancy value theory (EVT). EVT theorizes motivation for a goal is influenced by a person's expectancies to succeed, the associated cost, and three types of value: intrinsic, utility, and attainment. We will code the focus group transcripts for each of these constructs. Preliminary findings show individual GTA experiences are each consistent with one or more EVT constructs. If many experiences point towards GTAs lacking one aspect of motivation, educators and graduate program leaders may be able to identify larger systemic issues in GTA motivation. These institutional issues can then be addressed rather than only targeting the resultant symptoms GTAs experience while ignoring the underlying causes. Without motivation, GTAs are in danger of falling behind in their work, declining mental health, and even leaving the program. Support for GTA motivation is vital for the health of a graduate program and scientific discipline.

S-62: Multi-semester Investigation of Introductory Student Difficulties Interpreting Electric Field Diagrams

Presenting Author: Raymond Zich, Illinois State University

The effects of visually modifying traditional electric field diagrams on student interpretation were studied over nine semesters. Electric field diagrams were modified with variations in line thickness, line continuity, and arrow shape to indicate the magnitude and direction of the electric field and the results on student correctness were compared with traditional diagrams drawn with a uniform line thickness and color. The modifications were consistent with theories of visual attention and grounded cognition, to communicate the electric field strength and direction using the students' ability to perceive line variations and arrow styles. Students were randomly assigned traditional or modified diagrams and asked to rank electric field strength and direction. Results show correctness gains ranking magnitude of 12.3% and gains direction 7% for using the modified diagrams. Modified diagrams yielded overall correctness gains of 10% over the traditional diagrams. Results from randomizing presentation order diagrams and question modifications will be presented.

S-63: Understanding Student Sensemaking while Solving Physics Problems

Presenting Author: Jaya Shivangani Kashyap, PhD, Graduate student, University of Pittsburgh

Additional Author | Chandralekha Singh

Instructors and researchers who focus on student sense-making try to understand 'how' students navigate the problem-solving process. Understanding these mechanisms plays an important role in helping students become good problem solvers. In particular, investigating student sense-making in the context of physics problem-solving can be useful for developing curricula and pedagogies to help students learn. We used individual interviews to investigate student sense-making in upper-level E&M in the context of problems that can be efficiently solved using the method of images as part of the development and validation of a research-based tutorial. Some of the valuable findings using the epistemic game framework proposed by Tuminaro and Redish are presented.

S-64: Longitudinal Development of Learning Assistants' Approaches to Teaching and Learning

Presenting Author: Benjamin Dreyfus, George Mason Univ

Additional Authors | Tina Bell, Rebecca M. Jones

We present longitudinal data from a Learning Assistant (LA) program that includes LAs in physics, astronomy, and 7 other STEM fields. All first-time LAs write reflection assignments about their interactions with students, and all returning LAs write about their goals for the semester and how they have achieved these goals. In this study, we look at data from students who were LAs for multiple semesters, and trace the development over time of how they think about teaching and learning.

S-65: Undergraduate Research for Two-Year College Students has Major Benefits: Enhanced Skills, Confidence, and Sense of Belonging

Presenting Author: Mia K. Longen, South Seattle CollegeAdditional Author | Daniel Sharkey, University of Central Florida

Additional Authors | Larissa Carter, Abigail R. Daane, Vashti Sawtelle

The merits of undergraduate research are well-established at four year institutions, but its impact at two-year colleges remains underexplored. During this study we investigated a Pacific Northwest two-year college physics education research program to identify possible impacts of undergraduate research on the academic journey of two-year college students. We interviewed current and former students, using a protocol we designed, specifically asking open-ended questions about how research experiences shaped them personally and academically. Through qualitative analysis, we identified key themes in students' responses, including: increased sense of belonging, enhanced self-confidence, stronger community building, and readiness for university transfer. These findings suggest that undergraduate research may contribute to better student retention, completion, and transfer rates. This presentation highlights the valuable work already occurring at the two-year college level and advocates for expanding research opportunities to further support these students in their academic and professional paths.

S-66: Using Bayesian Networks to Predict Student Performance

Presenting Author: John Pace, West Virginia University

Additional Authors | John Pace, West Virginia University

Bayesian networks trained on students' core physics course performance data were used to analyze student progression through the curriculum and predict student performance in a set of upper-level undergraduate courses. An expert-elicited method of developing conditional dependency structures is explored and compared to standard Bayesian network structure learning algorithms. The course grade classification performance of a set of Bayesian network models is examined for modern physics, electricity and magnetism, and quantum mechanics courses. Adjustments to modeling procedures are explored in consideration of low record counts in the course performance datasets. Benefits of Bayesian networks, such as ease of interpretation and conditional probability querying, are discussed.

S-67: Building a More Transfer Receptive Culture through Relationship Centered Research

Presenting Author: Vashti Sawtelle, Michigan State University

How do we make physics and STEM a place where students thrive instead of simply survive? For the past decade I have been a part of a team of researchers who has been interrogating this question from multiple angles. We have explored how to better design introductory physics courses for students who are fearful (e.g. Sawtelle & Turpen, 2016), how to develop curricula that center students' identities as part of learning physics (e.g. Nair & Sawtelle, 2019), and most recently how to support two-year college (also known as community or technical college) through transfer to bachelor's degree programs (e.g. Wood & Sawtelle, 2022). Throughout all of that work we have continually put relationships and partnerships at the center of our research program. In this posterI will share an overview of this work, and how relationships have played a central role in pushing our research forward. Then I will describe a project that aims to build relationships in order to make institutional change. This project addresses the need to support two-year college transfer students of color in STEM fields by transforming the receiving baccalaureate granting institutions. This NSF-funded project is a collaboration of two institutions, San Jose State University and Michigan State University. We have created Transfer Advocacy Groups (TAGs) which are collaborations of faculty, students, and advisors working to implement interventions to support transfer students of color in STEM and promote a transfer receptive culture at the receiving baccalaureate granting institutions.

S-68: Introduction to a Physics Curriculum Structure Based on the Anatomy of Disciplinary Discernment

Presenting Author: Dennis Gilbert, PhD, Lane Community College

TIn "Introducing the anatomy of disciplinary discernment: an example from astronomy", Erickson et al* introduced a structure of disciplinary discernment. This discernment is built a disciplinary understanding of what is noticed and how sense is made of it (noticing and reflecting). To this general framework was added results of an empirical study of modes of sense making in order of their extent of learning. These modes are: (1) Non-disciplinary Discernment; (2) Disciplinary Identification; (3) Disciplinary Explanation through representations; (4) Disciplinary Appreciation of representations; (5) Disciplinary Evaluation of collections of representations and their affordances). Preliminary suggested directions for curriculum structure are made particularly involving the use of a curricular curriculum and making use of transparency of student learning that the discernment process provides. Through text and diagrams, this poster introduces additional curriculum structure that makes use of the above anatomy of discernment.

* European Journal of Science and Mathematics Education Vol. 2, No. 3, 2014, 167-182 Urban Eriksson 1,2 , Cedric Linder 1,3 , John Airey 1,4 , Andreas Redfors 2

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Physics Education Research: Assessment

S-69: Discovering Various Non-Newtonian Misconceptions with a Hierarchical Bayesian IRT Model

Presenting Author: Aaron Adair, MIT

Additional Authors| Martin Segado, Elaine Christman, David Pritchard, John Stewart

We analyze FCI data at the level of individual distractors using our exploratory IRT-based methodology(1) and discover 15 coherent, non-orthogonal student misconceptions, including some not previously identified in the PER literature. These misconceptions range from the expected (i.e., motion implies force) to the surprising (i.e., circular and linear impetus are distinct; accelerated masses travel on straight paths). All appear robust to sampling variability within our multi-school dataset, and most are present in both pre- and post-instruction data. We are also developing simple spreadsheet-based methods to analyze new FCI responses with the aims of (a) empowering physics teachers to monitor and adapt to the amount of each misconception harbored by their classes and (b) facilitating pre-post assessment of the effectiveness of instruction. Our code will be available on GitHub in the coming months.

S-70: Developing a Comprehensive Survey of Physics Computational Literacy

Presenting Author: Marcos Caballero, Michigan State University

Additional Authors| Rachel Roca, Alex Reynolds

Computing is quickly becoming a critical component of the modern physics curriculum; students learn to develop computational models and write programs that represent physical systems, analyze data, and operate laboratory equipment. Physics Computational Literacy (PCL) is an emerging theory that models how different knowledge, practices, and beliefs are drawn on by students in computing-enabled physics learning environments. As part of a new national effort to support integrating computing into physics courses, we aim to design a survey of instructional activities and student perspectives that can illuminate what strategies and approaches might lead to certain forms of PCL development. To do so, we have begun to interview students and faculty to ground our development efforts. In this poster, we report on the overall project to develop the survey, the work to contextualize PCL for the purposes of classroom use, and the preliminary results from interviews with students and faculty.

S-71: Modeling Response Times Along with Scores in IRT models – Usefulness in Item and Assessment Design

Presenting Author: Harish Moni Prakash, The Ohio State University,

Additional Author | Andrew F. Heckler

Item Response Theory (IRT) models are widely used in psychometrics and education research to model student latent ability(ies) and item and test characteristics. This is commonly done by fitting individual student scores on items to estimate student 'ability' and item 'difficulty' and 'discrimination' parameters. However, a class of IRT models analogously model student response times (RT) on items typically using lognormal fits to estimate student and item 'slowness' parameters. These 'slowness' parameters suggest how time-consuming an item is or how comparatively slow a student is. We apply these models to student data on conceptual tests of 1-D kinematics and Newton's laws to understand the relevance of the 'slowness' parameters in gauging physics conceptual learning. We find broad ranges for these parameters suggesting varying strategies or behavior by student and item. Interestingly, the item slowness parameter is positively correlated with the score-based item 'discrimination' parameter, and surface-level item features like length, number of response choices, and the presence of figure(s). Based on our findings, we discuss how such RT models can reveal important features useful in designing and selecting items for a test and determining appropriate time limits.

S-72: Introducing New Terminology: Standardized Conceptual Learning Assessments (SCLAs)

Presenting Author: Rebecca S. Lindell, Tiliadal Solutions

To clarify distinctions among research-based, conceptual learning, and general assessments, we introduce the term Standardized Conceptual Learning Assessments (SCLAs). This term represents any assessments that meet the following standardized criteria: 1) measure conceptual understanding, 2) follow established psychometric development procedures, 3) be field-tested on a large, diverse, and nationally representative population to ensure broad applicability, and 4) provide evidence of each item's fairness, reliability, and validity for that population. Assessments will not be considered fair, reliable, and valid without these criteria. In addition it may introduce bias and fail to measure knowledge accurately across diverse populations. This poster provides an overview of the development of The Fluids Conceptual Evaluation (FCE) along with its justification classifying it as a SCLA. Evaluating the effectiveness of these sampling and validation efforts will inform the design of future standardized assessments. Supported by NSF Award # 2021273.

S-73: PE-CAP: Redesigning Legacy Conceptual Inventories: Qualitative Validity Evidence from Student Reasoning in Cognitive Interviews

Presenting Author: Heather Mei, The Ohio State University

Additional Authors | Elaine Christman, John Stewart

The Physics Evidence-Centered Assessment Project (PE-CAP) seeks to redesign conceptual assessment instruments to better reflect contemporary frameworks of physics understanding and assessment design. This poster presents the development and refinement of items through cognitive interviews with students at multiple universities. These interviews examined how students interpreted question prompts, visual representations, and response formats. Insights from these interviews guided iterative revisions to item wording, diagrams, and response structures, as well as informed the creation of new items based on unexpected student reasoning, all aimed at improving alignment with intended constructs. The resulting instrument, a one-dimensional kinematics assessment, was subsequently administered as a pre- and post-test across multiple institutions to validate its effectiveness. This material is based upon work supported by the National Science Foundation under Grant No. 2235518.

S-74: Developing an Assessment Task to Elicit Blended Mathematical Sensemaking in Science for Students in Introductory E&M

Presenting Author: Jessica Randolph, Michigan State University

To understand how students approach complex problems, we can utilize a framework of blended mathematical sensemaking in science ("Sci-Math sensemaking"). While directly assessing students' Sci-Math sensemaking can be difficult, it is an important area of work, especially within the understudied context of introductory electricity and magnetism (E&M). Situated within a larger multi-institutional and cross-disciplinary NSF award (DUE-2235487, DUE- 2235413, DUE-2235641, and DUE-2235311), we aim to develop a physics task that can be used on an exam to elicit students' Sci-Math sensemaking in an introductory E&M course. Using a modified version of Evidence Centered Design and the Three-Dimensional Learning Assessment Protocol, we will create a physics task to examine the core physics idea that interactions are mediated by fields. During this process, we intend to investigate the specificity of the published core idea and consider how other cross-cutting concepts & scientific practices in E&M relate to the core idea. This poster will focus on the physics task creation and development process.

Physics Education Research: Belonging and Access

S-75: The C2C Design Team: Insights from the Experiences of Disabled Physics Students

Presenting Author: Theodore Bott, Michigan State University

Additional Authors | Daryl McPadden, Matt Guthrie, Erin M. Scanlon, Xian Wu, Tanya Adams

We present a study stemming from the Courses to Careers (C2C) project, aimed at creating a mutually beneficial professional development experience for physics faculty and disabled students. A central component of the C2C project is to build partnerships, including in the design of the workshop. To that end, we recruited the C2C design team, comprised of six disabled physics students with different disability identities and academic trajectories. The design team and primary investigators meet virtually for one hour every week to discuss their experiences as disabled students in postsecondary physics, what they wish instructors knew or considered about their experiences, and the challenges they've faced in their own career preparation. Prior to the meetings, the design team members answer a couple questions in an asynchronous working document that prompt ideas for that week's meeting. From the working documents and recordings of the design team meetings, we utilize frameworks such as community cultural wealth, critical disability theory, and critical discourse analysis to identify emergent themes. In this poster, we present the analysis and emergent themes elucidated from the design team's experiences. This work is supported in part by NSF Grant Nos. DUE 2336367 and DUE 2336368.

S-76: Doing the Work: How to Keep Moving When Grants Are Cancelled

Presenting Author: Vashti Sawtelle, Michigan State University

Executive orders from the Whitehouse in early 2025 banned any work advancing issues of diversity, equity, or inclusion. As a result of these Executive Orders, institutions that have historically supported research investigating inclusive teaching and supporting diverse groups to succeed in STEM majors have been canceling and terminating existing grant projects. At Michigan State University, I have had two such projects terminated in the Spring of 2025. These projects were both in the middle of 5 year timelines and our teams were actively working on both programming and research. In this poster presentation I will share what I learned about resisting cancellations, and continuing the work in spite of funding cancellations. I will share lessons learned and invite folks to engage in discussion about how to continue our important work in physics education research.

Physics Education Research: Intro

S-77: Practitioner Inquiry for Iterative Introductory Lab and Course Improvement

Presenting Author: Hallie Trauger, North Carolina A&T State University

Practitioner inquiry is an approach for continuous improvement in education that centers teachers' analysis and reflections about day-to-day observations and classroom data. While more commonly applied in K-12 contexts, this approach also has much to offer for university pedagogy, providing a framework for course revisions that are iterative and responsive to student input. The Physics Department at North Carolina A&T State University, the largest of the Historically Black Colleges and Universities in the U.S., has identified an urgent need to improve students' success rates and conceptual understanding in large algebra-based and calculus-based introductory courses. One initial step in this process has been redesigning labs to more effectively reinforce lecture content and teach problem-solving and data analysis skills. This transformation has been approached through a practitioner inquiry framework, gathering data and feedback from students and laboratory teaching assistants on a semester and weekly basis as a basis for critical reflection and iterative redesign of laboratory activities. This poster presents this framework, data about lab transformation progress so far, and next steps in applying this approach toward broader curricular improvement.

S-78: Course Grades and Self-efficacy Before and During the Pandemic: A Comparison of Women and Men in Introductory Physics Courses Who Typically Worked Alone or in Groups

Presenting Author: Apekshya Ghimire, PhD in Physics, University of Pittsburgh

Additional Author | Chandralekha Singh

Meaningful collaboration with peers inside and outside the classroom can be an invaluable tool for helping students learn physics. We examined the characteristics of women and men who typically worked alone versus those who worked with peers in their algebra-based introductory physics course. We compared periods before the COVID-19 pandemic, when classes were conducted traditionally, and during the pandemic, when classes were conducted via Zoom. We find that on average, those who typically worked with peers had higher grades and reported greater peer influence on their physics self-efficacy during the COVID pandemic than before it. We discuss these findings in relation to students' prior academic preparation, physics grade and self-efficacy as well as student perception of the effectiveness of working with peers on their physics self-efficacy.

S-79: Enhancing Student Learning of Introductory Physics Through Funds of Knowledge

Presenting Author: Guang Zeng, Texas A&M University-Corpus Christi

Co-presenting Author | Liang Zeng

Previous research has established the pedagogical approach of Funds of Knowledge (FK) as effective in engaging minority students in learning. However, there is a lack of studies connecting FK to the teaching of college-level introductory physics or physical science courses. This study addresses that gap by incorporating the lived experiences of regional Mexican-American communities as examples in physics instruction at a Hispanic-serving institution located along the recently politicized U.S.-Mexico border. The findings provide evidence of how physics educators can use FK to engage students in learning introductory physics concepts.

S-80: Life Science Students' Conceptions about Fluid Statics

Presenting Author: DJ Wagner, Grove City College

Additional Authors | Rebecca S. Lindell, James Vesenka, Dan Young, Dawn Meredith

This work is part of a multi-institution collaboration developing the Fluids Conceptual Evaluation (FCE), a fair, valid, and reliable research-based standardized conceptual learning assessment (SCLA) on fluids (both statics and dynamics) for Introductory Physics for Life Science (IPLS) courses. In 2021-2023 our group conducted 73 structured interviews at 10 diverse institutions, asking students to answer a subset of our questions and to explain their reasoning. When coding those interviews, we identified several difficulties IPLS students have with fluids topics. This poster will highlight a few of the difficulties identified involving fluid statics topics such as hydrostatic pressure and Archimedes' Principle. IPLS instructors interested in serving as a pilot test site for the FCE assessment should contact DJ Wagner (wagnerdj@gcc.edu). Project supported by NSF 2021273, 2021059, 2021261, and 2021224.

Physics Education Research: Beyond Intro

S-81: A Taylor Series Expansion Tutorial for Upper-division Physics Contexts

Presenting Author: Idris Malik, North Dakota State University

Additional Authors | Jessica Searl, Warren M. Christensen

Undergraduate physics students are often taught mathematical methods across multiple courses, but may still not be prepared to transfer those methods to physics contexts. Here, we sought to develop a tutorial for students to learn how physicists approach the strategy of "Taylor Series Expansions" to effectively model complicated physics situationss. After piloting our materials in one-on-one student interview settings and getting feedback from Physics and Math experts, we recorded small groups of students working on the tutorial during a standard period of their E&M class and Junior Mechanics class. We provided examples of a potential graph, classical pendulum, and charged disk with a gradual reduction of scaffolding between sections. We intend that this tutorial can be used in a Math Methods course, or an upper-division E&M or Quantum Mechanics course. We aim to include a focused amount of physics content without requiring extensive background knowledge, in contrast to some existing tutorial/explanation sections of textbooks. We hope that this tutorial and research will help us better support students who will use Taylor Series Expansions in physics courses, as we continue to find sources of student confusion to revise our tutorial and the respective instructor guide with this feedback. Material based on work supported by NSF PHY 1912152 and 2336911. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of NSF..

Society of Physics Students

S-82: Modeling Diffusion in a Slab

Presenting Author: Ryan M. Biddle, Fisk University

Additional Author | Peter H. Nelson

We investigated diffusion in a one-dimensional slab with various initial conditions (ICs) and boundary conditions (BCs) using finite difference (FD) methods in Excel. The slab was divided into 5 boxes. The BCs were maintained by setting the left-hand edge of box 1 and the right-hand edge of box 5 to constant concentrations. The ICs were implemented by setting the concentration of each of the 5 boxes to the desired values. The concentrations in each of the boxes were determined using FD methods and plotted at selected times. We discovered that the concentration profiles always tend towards a linear steady-state profile that depends only on the BCs and not the ICs. When the slab starts out with a constant initial concentration profile and zero-concentration BCs, the diffusing molecules are eliminated from the edges of the slab, and the initial rectangular profile is smoothed out by the diffusion process. After an initial transition period, the profiles appear to approach a sinusoidal shape that decays exponentially with time. That intuition was confirmed by the long-time linear behavior of a semi-log plot of the concentrations with time. Using separation of variables, we were able to show that an exponentially decaying sine wave is a characteristic solution to the diffusion equation. We confirmed that hypothesis by making the initial profile sinusoidal and then observed an exponential decay in all boxes, demonstrating that our 5-box FD model successfully solves the diffusion problem.

S-83: To Study the Outcome of Intensity-Modulated Radiation Therapy (IMRT) Treatment in Prostate Cancer

Presenting Author: Yanlong Li, University of District of Columbia Community College

Additional Authors | Ahmecia Williams, Sung-Woo Lee, Anil Pyakuryal, PhD

Prostate cancer, the most frequently diagnosed cancer in men, is a second-leading cause of cancer death after lung cancer in the United States. Intensity-Modulated Radiation Therapy (IMRT) is a standard approach for delivering high-precision radiation to the target while minimizing the damage to surrounding healthy tissues or Organs at Risk (OAR). This study utilized open-source radiotherapy computational systems--CERR (Computational Environment for Radiotherapy Research), matRad, and the Histogram Analysis in Radiation Therapy (HART) to design and evaluate IMRT treatment plan for prostate cancer. Using images from anonymized prostate cancer patients, treatment plans were generated in both CERR and matRad under standardized constraints and dose objectives. Target coverage, radiation dosage to OAR, plan conformity and indices, and does-volume histogram (DVH) were analyzed to compare the performance of each platform. Results show that these platforms can generate clinically viable IMRT plans with advanced visualization, evaluation tools, and optimization strategies. This study demonstrates the application of open-source software for research and education in IMRT radiation therapy and highlights the potential to integrate artificial intelligence guided treatment analysis into adaptive and automated treatment planning workflows for prostate cancer.

S-84: What Does Inequity Look Like in Our Physics Labs?

Presenting Author: Rosie Durland, The University of Utah

We have recently reformed an introductory physics lab course for life science majors to promote physics learning in a biology context. In this lab course, students work together in groups of four to design and execute their own investigations. It is vital to us as educators that all students are able to engage in scientific practices, yet group interactions can surface power dynamics that may inhibit equitable access for some students. In an effort to improve equity in this lab, we designed a study to explore students' access to group discussions and lab equipment (e.g., computer monitors, microscopes, etc.). We qualitatively analyzed video data of students working in five different lab groups across two sections of our Summer 2024 course. In this poster, we focus on two contrasting case studies: a group that showcased equitable group dynamics, and a group where one member was consistently excluded. We found that group conversation can be characterized as inclusive when group members turn to face each other, ask each other for input, and ensure everyone has access to the conversation through open positioning. Furthermore, equitable access to equipment includes the rotation of equipment usage, the ability for all students to see the equipment, and the ability for all students to approach the space surrounding the equipment. In characterizing group-based inequity, we discovered that teaching assistants (TAs) and learning assistants (LAs) play a vital role in group dynamics. In particular, TAs and LAs can reinforce or disrupt inequitable dynamics through their body positioning when supporting a group during a troubleshooting episode. Future work involves using short examples of these inclusive and exclusive dynamics to create a series of training videos. These videos will be used to support TAs and LAs in recognizing inequitable dynamics, and help them leverage their physical position to disrupt these dynamics.

Session A01: Bio Focused Advanced Labs

Location: Declaration A **Time:** 9–10 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Nancy Beverly

A01-1: 9–9:24 a.m. Incorporating Biophysics Experiments into Your Advanced Lab

Invited – Ashley Carter, Amherst College

Biophysics experiments in the undergraduate advanced lab course are a great way to broaden students' perspectives on physics and prepare students for real-world problem solving. However, what biophysics experiments should an advanced lab instructor select, particularly if their own background is limited to physics? Here I will present on four cornerstone biophysics experiments: 1) tracking motion, 2) building an optical microscope, 3) taking spectroscopic data, and 4) measuring the Brownian motion of microscopic particles. These labs are simple, affordable, versatile, and have a lot of great interdisciplinary science.

A01-2: 9:24–9:48 a.m. Cell Biology in the Advanced Lab: Diffusion, Flow, and Molecular Machines

Invited – Douglas Martin, Lawrence Univ

Physics experiments with living cells can be an attractive addition to the advanced lab. Passive and active force generation, by diffusion, fluid flow, and mechano-chemical energy transduction via motor proteins, can each be quantitatively studied using microscopy on live cells. In this talk, I present three exemplar experiments suitable for the advanced lab: (i) tracking particles in live onion cells and quantifying diffusive and ballistic (flow) components of the trajectories; (ii) tracking the motor protein kinesin and examining its velocity as a function of energy use; (iii) imaging mitosis in RPE cells and tracking the velocity of chromosome movement during cell division. Each of these experiments is done on a home-built, open-source microscope that is useful for teaching optics in the advanced lab as well. Finally, challenges for implementation will be discussed as well – in particular, the need for partnership with biochemists or cell biologists for materials and supplies – and I will present a bio-inspired alternative of purely diffusive, non-cellular, experiments.

Session A02: Effective Practices in Teaching Astronomy and Astrophysics

Location: Declaration B **Time:** 9–10 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Jeffrey Marx

A02-1: 9:00–9:12 a.m. Using the Kerbal Space Program Rocketry Video Game to Teach Orbital Dynamics in Introductory Astronomy

Brian Zanger, Juniata College

It is often difficult for introductory astronomy students to develop an intuitive understanding of Kepler's laws because celestial mechanics are so far removed from the typical human experience. To make orbits more tactile, I use the rocketry simulation video game Kerbal Space Program, which accurately portrays the physics behind rockets and orbits. I start by using the game to review rocket construction, then I do a live launch to demonstrate the Newton's Cannonball thought experiment and reach orbit. In orbit, I demonstrate Kepler's laws and the interplay between kinetic energy and orbit shape, speed, and period in a real-time reactive environment, asking students to predict the outcome of firing the rocket's engines at different times and orientations. For students interested in going further with rocketry, I offer an optional project to send a rocket to the moon and back, allowing students to learn about more advanced topics in orbital mechnics, rocket design, and the history of space exploration. This active approach leads to greater student engagement and participation in an otherwise abstract topic usually disconnected from everyday human life.

A02-2: 9:12–9:24 a.m. Course Correction and Attitude Adjustment

Jillian Bornak, University of Toledo

I examine six years of changes in student learning in response to tweaking course material in a large-enrollment non-major introductory astronomy class. These results are based on long term data collection using an informal pre/post-test. I will share wins and losses on individual questions as well as broad trends in the course.

A02-3: 9:24–9:36 a.m. Exploring Accuracy of Self-evaluation About Introductory Astronomy Topics: Gender and Cross-age Differences

Silvia Galano, University of Naples Federico II, Department of Physics, Italo Testa, Physics

Accuracy of self-evaluation – namely students' assessment of their own ability - is at the basis of important cognitive processes, such as decision making, and is positively correlated with academic achievement in science, persistence in science tasks, and motivation towards science. In this cross-sectional study, we investigated how gender differences in accuracy of self-evaluation vary across school grades, from primary to secondary school. We chose introductory astronomy as the subject area because astronomy is taught at all school levels and is often considered a "gateway science", as students may be inspired to choose a scientific career after being exposed to astronomy content in different contexts. Moreover, astronomy is a scientific area where the gender gap is less pronounced, as girls are usually interested in astronomy topics as much as boys. A total of N=3,287 students (mean age:14.7,SD=2.4 years, girls=50.4%) participated in the study. The research instrument used was a multiple-choice test developed from previous studies. T-tests and factorial ANOVA were used to analyse the collected data. The results show that, on average, boys are more confident than girls on all questions and that the differences increase with school grade. Overall, our results suggest that astronomy education practice in secondary schools should go beyond teaching astronomy as a collection of facts and aim to better calibrate students' assessment of their performance.

A02-4: 9:36–9:48 a.m. Integration of Projects in Astrophysics Courses

Rudra Kafle, Ph.D., Worcester Polytechnic Institute

Project-based learning is the hallmark of WPI's undergraduate curriculum. WPI students complete multiple projects both on and off campus throughout their undergraduate studies. Some projects are closely tied to their majors, while others apply their WPI education to benefit communities around the world. As WPI celebrates the 50th anniversary of its global project programs, faculty continue to incorporate project-based learning into their courses, making student learning more engaging, effective, and rewarding. In this presentation, I will introduce WPI's two major project types: the Major Qualifying Project (MQP) and Interactive Qualifying Project (IQP), and share my experiences with integrating projects into my astrophysics courses, along with student reflections on these projects.

Session A03: From Atoms to Wave Functions: Quantum in 4 Levels: Part I

Location: Franklin/McPherson **Time:** 9–10 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Mike Florek

A03-1: 9–9:24 a.m. The Scientific Thinking Method: A Guided Process

Invited – Jose Soto, Fermilab

In order for students to develop the necessary skills to gain a fundamental understanding of physics in elementary grades, science classes must be enriched with multiple opportunities for students to experience physics in the real world. This includes firsthand experience in class demonstrations to help develop conceptual understanding of how the world works. In an elementary setting, students can gain these abilities when they are guided on how to think like a scientist, reason like a mathematician, and design like an engineer. Students can utilize this guided approach to help them think creatively when faced with novel situations. This guided thinking method becomes an instrument that students can draw upon in early grades that can assist them in the problem solving process in an individualized way. The Scientific Thinking Method begins with key focused concepts like Evaluate, Explain, Predict, and Summarize as multiple entry points that students can choose to begin to problem solve with and multiple channels that work their way to the next key concept. This guided roadmap works dynamically in order to connect student thinking to related approaches that they can learn to use across multiple content areas. As students begin the process of learning how to think about a topic and reason in different ways, they begin to also build a foundational understanding of physics, and of the building blocks of nature, in a challenging and logical way. This manner of thinking allows students to approach every situation with an open mind, but also teaches resilience when faced with difficulties along the way.In a classroom that seeks to create an environment conducive to the natural acquisition of critical thinking skills, guided roadmaps are an essential component of this effort. This presentation seeks to highlight the different ways that instruction can help to facilitate this manner of thinking utilizing interactive activities, demonstrations, authentic assessments and multifaceted project based units. Ultimately, the end goal becomes, in part, the preparation of students to enter the next grade level as resilient, innovative and confident problem solvers.

A03-2: 9:24–9:36 a.m. Unlocking the Quantum World for Middle School Students

Invited – Meghan DiBacco, Cinco Ranch High School- Katy ISD, Jan Mader

Quantum physics offers endless opportunities to captivate and inspire young learners. This session equips middle school teachers with strategies for introducing its intriguing concepts in a way that engages young learners. By focusing on creativity, curiosity, and exploration, educators will receive lesson plans and tools to inspire curiosity and connect quantum to their futures. By fostering inquiry-based learning, teachers can bring quantum physics into their classrooms, sparking a love for science in their students. Materials provided are developed by the Quantum for All Project a program funded by the National Science Foundation.

Session A04: Science Research in High Schools: Part I

Location: Wilson/Roosevelt **Time:** 9–10 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Nina Morley Daye

A04-1: 9–9:24 a.m. Research at the High School Level Using Radio Telescopes

Invited – John Makous, Doctorate, Concord University

The advancement of modern technology has enabled more sophisticated investigations at the high school level. The observation of radio signals from our galaxy that once required state-of-the-art experimental equipment can now be routinely carried out using an antenna and a laptop computer. In 2017 the RET program "Digital Signal Processing in Radio Astronomy (DSPIRA)" provided training to high school teachers for building, operating, and implementing affordable horn radio telescopes into their curricula. This presentation will describe some of the results of this program, including student projects that have been done as well as some possible investigations that can be done by high school students using horn radio telescopes.

A04-2: 9:24–9:36 a.m. Creating Interesting and Innovative Physics Research Opportunities in the High School Physics Lab with Accessible Materials and Inspiration from AAPT Publications

Kirsten Hogg, PhD (Physics), BSc(Hons), Grad Dip Ed., Queensland Academy for Science Mathematics and Technology

A selective STEM high school has no shortage of physics students, many are talented and extremely driven. However, the class enrolments are predominantly male and most are not contemplating tertiary physics study. To foster participation from a more diverse group and promote tertiary study, multiple opportunities to complete physics research projects are offered. A classroom magazine rack that includes The Physics Teacher and the American Journal of Physics is used to stimulate interest and excitement in short and longer physics research projects in the high school physics lab. Students in grades 10, 11 and 12 are encouraged to research and design individual or group projects both curricular and extra-curricular. Students work with a mentor on projects that span astronomy, astrophysics, particle physics, optics, general relativity, quantum physics, nuclear physics, acoustics, mechanics and electromagnetism. The projects are developed using the AAPT publications, advice from university academics, teachers and technical support staff. Projects utilise equipment common in Australian high school laboratories supplemented with adapted materials from hardware stores, electronics stores or manufactured in the school's maker space. In addition, students make use of smart phones, video, audio, coding and school-based robotics. Students conduct experimental investigations utilizing primary and secondary data. They present their results as either written reports, conference posters or oral presentations depending on curriculum assessment or extra-curricular requirements. A primary aim of the physics research projects is to increase the number of women and gender minorities participating and promote tertiary physics study. Under-represented students tended to flourish in the small group mentored environment. Women and gender minorities now account for 50% of project participants after 10 years with many enrolling in astronomy, physics, mathematics, engineering and radiology majors.

Session A05: Innovations in Quantum Curriculum: Part 1

Location: Cabin John/Arlington **Time:** 9–10 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Tatiana Allen

A05-1: 9–9:12 a.m. Quantum Knowledge Needed for the Quantum Information Science and Engineering Workforce: Findings from Interviews with Industry Professionals

Andi Pina, Rochester Institute of Technology, Shams El-Adawy, Heather J. Lewandowski, Benjamin M. Zwickl

Quantum Information Science and Engineering (QISE) is a top priority at the national level in the US. This has included a push for academia to support the development of programs that will prepare students to enter the QISE workforce. As QISE has grown rapidly in academia and industry, there is a need to better understand what quantum knowledge is needed for students to be ready for the workforce. This talk presents findings on the level of quantum expertise and the specific quantum knowledge utilized across different roles in the QISE industry. Qualitative analysis of semi-structured interviews with industry professionals elucidates these aspects of the vital work functions related to the ongoing development of quantum technologies in industry. This work will provide insight into QISE curriculum development and changes needed to better support students transitioning into this growing industry.

A05-2: 9:12–9:24 a.m. Job Profiles in the Quantum Information Science and Engineering Workforce: Insights from Industry

Shams El-Adawy, University of Colorado Boulder/JILA,

Andi Pina, Benjamin M. Zwickl, Heather J. Lewandowski

As the quantum industry continues to grow, understanding its workforce dynamics is critical for aligning education and training with emerging needs. This talk presents findings from interviews with quantum industry professionals, focusing on the current landscape of Quantum Information Science Engineering (QISE) jobs and projections of workforce needs. Through a qualitative analysis of interviews with managers and employees in various quantum companies, we identify key factors in workforce development of the quantum industry, including required degrees, disciplines, quantum awareness levels, as well as necessary scientific, quantum, and professional skills needed for various job roles. By analyzing current QISE job profiles to projected knowledge, skills, and abilities needed for various positions, we provide insights for physics educators seeking to align curriculum and career guidance with the evolving quantum industry. Ultimately, these insights help bridge the gap between academia and industry, ensuring that students are prepared for various career opportunities in the quantum ecosystem.

A05-3: 9:24–9:36 a.m. Interactive Data on Programs and Courses in Quantum Information Science and Engineering Across the United States

Benjamin M. Zwickl, Rochester Institute of Technology,

Andi Pina, Michael Verostek, Shams El-Adawy, Heather J. Lewandowski

Quantum Information Science and Engineering (QISE) is an emerging technology area that has seen rapid growth in research and education. Our team has developed the most comprehensive publicly-shared data set on QISE education across all disciplines, which includes 1456 institutions, 89 programs, and over 8000 quantum-related courses. We use our interactive data set to examine programs based on the primary discipline, level (BS, MS, PhD), type (concentration, degree, etc), and location. We find that interdisciplinary programs are the most common, with physics departments also hosting many programs. We also examine the disciplinary distribution of quantum-related courses, including the 944 that mention QISE topics and the 514 that have QISE as their primary focus. Physics and Chemistry offer the most quantum-related courses, but Physics, Electrical and Computer Engineering, and Computer Science offer the most QISE courses. Finally, an analysis of the prerequisites for undergraduate QISE courses taught in physics departments shows how educators are grappling with math requirements (is linear algebra needed?) and physics requirements (is prior exposure to quantum needed?). In addition to sharing these results, we will highlight how you can use our interactive data set for your own purposes at quantumlandscape.streamlit.app/. This work was supported by NSF Awards 2333073, 2333074, and REU-2149957.

A05-4: 9:36–9:48 a.m. Designing and Developing Quantum Information Science Education Programs and Courses

Heather J. Lewandowski, University of Colorado,

Shams El-Adawy, Andi Pina, Benjamin M. Zwickl

As the demand for a quantum-ready workforce grows, educators in Quantum Information Science and Engineering (QISE) face the challenge of aligning their programs and courses with rapidly evolving industry needs. Through a series of interviews with program directors and faculty across 15 different institutions, we identified the factors that educators are concerned with as they design and develop their various courses and programs. Grounded in a curriculum and program design framework, we conducted a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis, which revealed key factors about program context, curriculum development, collaboration, program data collection and evaluation, and connections across stakeholders in the quantum ecosystem that educators should consider when developing their QISE efforts. Applying a systematic approach to efforts of QISE curricula design and development can provide overarching perspectives that enable educators to have a better understanding of factors to consider as they align students' academic preparation with the quantum workforce.

A05-5: 9:48–9:69 a.m. Effectiveness of Mini-Tutorials on Quantum Mechanics Concepts for a Smooth Transition to Quantum Computing

Jianlan Wang, Texas Tech University, Beth Thacker, Yuanlin Zhang, Emmanuel Ebom, Mahamadu Duut

Quantum computing (QC) is an emerging field that underpins many cutting-edge technologies and is increasingly integrated into physics curricula. Despite its significance, there remains a lack of empirical research on effective instructional strategies for QC. To bridge this gap, we investigate the impact of research-based mini-tutorials on students' understanding of key QC concepts, specifically, the Stern-Gerlach experiment, quantum entanglement, and single-qubit gates, as connections between Quantum mechanics and QC. We conducted this study in an upper-level undergraduate introductory QC course, where we video-recorded class interactions during the mini-tutorials. Additionally, we administered pre- and post-tests to assess the students' knowledge growth in these target areas as leveraged by the mini-tutorials and conducted post-interviews to capture their feedback on this approach. The findings provide insights into the effectiveness of mini-tutorials as an instructional strategy for QC education and offer recommendations for optimizing quantum mechanics instruction to facilitate a smooth transition to QC learning.

Session A06: Exploring New Frontiers in K-12 Physics Education

Location: Bulfinch/Renwick **Time:** 9–10 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Gary White

A06-1: 9–9:12 a.m. Integrating Sources of Knowledge in the K-12 Physics Classroom

Elissa Levy, Thomas Jefferson HS for Sci-Tech

When we teach physics, students glean knowledge from authoritative sources and hands-on experience, in ways both qualitative and quantitative. In this talk I will present a way of thinking about the various modes of knowledge acquistion in physics and how to integrate them in a coherent storyline that is responsive to students and deepens their learning. It's not enough to just use multiple modalities; we need to sequence and integrate them deliberately. The goal is to increase access to and persistence in physics. My talk will be based on this essay: https://elissa-dunn-levy.medium.com/hands-on-and-textbooks-and-sims-oh-my-fe9753c98f26

A06-2: 9:12–9:24 a.m. PhET Simulations to Promote Data Fluency: New In-Sim Uncertainty Features and CODAP Integration

Matthew Blackman, PhET Interactive Simulations, University of Colorado Boulder,

Catherine Carter, Katherine Perkins, Heather J. Lewandowski, Qiaoyi Liu, William Finzer

Longing for "imperfect" data in PhET simulations? It's here! In 2023, PhET Interactive Simulations at University of Colorado Boulder launched a new Data Fluency initiative, aiming to support learning goals that span physics, statistics, and data science. To address these goals, the PhET team has engaged in a co-design process to innovate new designs and technical approaches for adding adjustable noise, measurement uncertainty, and systematic errors into PhET simulations. In addition, PhET has partnered with the Concord Consortium to integrate PhET simulations with CODAP, an open-source tool for graphing and statistical analysis. This powerful integrated environment allows students to collect, visualize, and analyze data directly from simulations, offering a rich context for exploring uncertainty and variability. In this talk, we will present several new and enhanced PhET simulations—including Circuit Constructions Kit, Gas Properties, and Projectile Data Lab—and their integration with CODAP, as well as modeling how these tools can be used to address experimental design and data analysis learning goals. Open access resources and freely available links will be shared, as well as the roadmap for future work. This talk will be of interest to physics educators looking to engage students with the concepts of uncertainty and variability in data and to build data fluency while maintaining subject-specific alignment.

A06-3: 9:24–9:36 a.m. Building Community Through Student Empowerment

Amee Johnson, Bachelor of Science in Mechanical Engineering, Virginia Beach City Public Schools

This session will help you foster and gain techniques to empower students' voices to cultivate mentorship and leadership skills in your physics students and your school community. The Everyday Actions Guide, a pedagogy handbook for teachers, is part of the STEP UP curriculum. Recently updated, the Everyday Actions Guide is the foundation of a new NSF grant supporting teachers' professional learning through the incorporation of inclusive practices in physics. Creating an inclusive and thriving high school physics program starts in the classroom with smaller, daily actions and can soar to unprecedented heights by building community outside the classroom. Come learn how to utilize multiple avenues of communication that identify underrepresented students for physics courses and how you and your school community can celebrate their successes and capabilities. Discover untapped partnerships that exist in your community and how you can support your students' elective events. Teachers of all levels and amounts of experience are encouraged to come to this discussion.

A06-4: 9:36–9:48 a.m. Launching Minds: Bringing Real-World Space Missions into Your Classroom with the StellarXplorers Space Design Competition

Rebecca Dalton, StellarXplorers Director

Inspiring the next generation of physicists and engineers starts with hands-on learning, and the StellarXplorers National Space Design Competition offers a platform to do just that. This presentation highlights how the StellarXplorers program can transform the way middle and high school students engage with physics by incorporating real-world applications in space exploration and design. Through a series of online, team-based challenges, students apply principles of physics, math, and engineering to solve problems related to space missions (orbit planning, satellite design, and launch operations), fostering critical thinking, collaboration, and problem-solving skills. The program offers teachers a structured yet flexible framework to bring these concepts into the classroom in an exciting and interactive way. By participating, students not only gain a deeper understanding of physics but also develop teamwork and communication skills that are essential for success in any field. This session will explore how educators can bring StellarXplorers into their classrooms and inspire students to pursue careers in STEM fields, all while making physics come to life in a way that is both fun and educational.

Session A07: Culturally Responsive Teaching: Part 1

Location: Penn Quarter AB **Time:** 9–10 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Clausell Mathis

A07-1: 9–9:24 a.m. Enhancing Physics Understanding by Leveraging Cultural Resources in NGSS-Aligned Assessments

Invited – Mathilda Smith, Michigan State University, Clausell Mathis, Ozlem Akcil Okan, Ph.D., Lucky Nonyelum

This paper presents a framework for designing Next Generation Science Standards (NGSS) aligned assessments, using the six-stage Crafting Engaging Science Environments (CESE) project-based learning (PBL) system (He, et al., 2024), that leverage students' cultural resources to engage them in physics concepts. Synthesizing CESE with Culturally Relevant Teaching (CRT) and Culturally Responsive Pedagogy (CRP), we develop innovative assessment methods that allow students to demonstrate their understanding of physics phenomena in meaningful ways - emphasizing local relevance, student identity, and science engagement. By integrating cultural relevance into assessment design, we aim to broaden the pool of students who can effectively showcase both their comprehension and application of physics ideas by recognizing the varied backgrounds and experiences students bring into the classroom. This framework emphasizes the importance of CRP and its role in fostering deeper connections between students and the subject matter, ultimately leading to improved educational outcomes in physics.

A07-2: 9:24–9:48 a.m. Transforming First-Year Education: Integrating Physics, Math, and Engineering in a Studio Model

nvited – Hiba Assi, University of Detroit Mercy, Prasad Venugopal, Shuvra Das, Dawn Archey

Structural and systemic barriers have long existed in physics and engineering education, especially for students from underserved and historically marginalized communities. Inspired by the American Society for Engineering Education (ASEE) Inclusive Mindset Report that summarizes the challenges and recommendations for engineering education, a multidisciplinary team at the University of Detroit Mercy is introducing a first-year pilot program that integrates physics, math, and engineering into a studio-style curriculum. Our approach, designed to cultivate and support a diverse student population, aims to remove rigid prerequisites and gatekeeping practices while emphasizing student agency in a holistic learning environment. Our pedagogical framework embeds physics instruction within culturally responsive real-world engineering challenges. This presentation will provide details of our pilot program and integrated studio-style curriculum that seeks to shift engineering education from a "college-ready student" model to a "student-ready college" one. Examples of culturally-informed case studies that highlight diverse experiences will be presented.

A07-3: 9:48–10 a.m. The Impact of Learning Assistants Establishing Trust in an Active Learning Classroom

Stefania Cantisani, Florida International University, Emely Lopez Calderon, Idaykis Rodriguez

Having instructors adopt to a new active learning curriculum and pedagogy has its challenges, where many new instructors resort to same style of teaching as they were taught in (Nguyen, K. et al, 2021). At FIU, the introductory modeling physics course is a student-centered active learning classroom with little to no lecture time. The course is facilitated by a lead instructor and several learning assistants (LAs). We present a study that focuses on the personal experiences of new LAs as proxies of "new instructor". We investigate all the challenges and critical aspects of adopting an active learning pedagogy and managing social dynamics of the class. We are particularly focused on the ways in which new instructors develop a sense of trust with the students while teaching students content in a social learning environment. We collected data through focus groups interviews with 5 LAs that are teaching a new curriculum for the algebra-based introductory physics course. Initial findings suggest that creating a personal connection or showing interest in the student's lives can establish trust in the learning dynamic. Trust is also experienced through the dynamic, where the new instructors establish trust through teaching strategies. We hope to characterize ways in which instructors feel comfortable adopting active learning pedagogy for a wider range of adopters.

Nguyen, Kevin A., et al. "Instructor strategies to aid implementation of active learning: a systematic literature review." International Journal of STEM Education 8 (2021): 1-18.

Session A08: PER: Graduate and Beyond

Location: Constitution DE **Time:** 9–10 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Molly Griston

A08-1: 9–9:12 a.m. Social Mediation a Critical Component of Quantitative Ethnography

Stella Nelson, Sabrina Henige, Geraldine Cochran

Quantitative ethnography provides us with a unique ability to apply quantitative research methods to qualitative data for the purpose of making stronger claims about people's experiences. However, findings in a quantitative ethnography are only as valid as the process used to code the qualitative data. In physics education research, qualitative studies help reveal how students construct conceptual understanding in peer discussions, instructor-led activities, and technology-enhanced environments. An important aspect of this research process is validating the findings that we draw from our participants' experiences. Taking positionality statements a step further, social mediation rather than interrater reliability, allows researchers to analyze their own role in the coding process, recognizing how their interactions and experiences influence their interpretation of qualitative data. This approach provides a deeper understanding of how the researchers determine codes, rather than merely ensuring coding consistency.

A08-2: 9:12–9:24 a.m. Examining the Motivations of STEM Graduate Teaching Assistants through Expectancy Value Theory

David Seiden, University of Georgia, Nicholas Young, Nandana Weliweriya, Sarah Jane Bork

Teaching assistantships are the primary funding mechanism for many STEM graduate students. These roles are known to have a large impact in undergraduate courses; undergraduates often spend as much face time with graduate teaching assistants (GTAs) as faculty members. At the same time, the experiences of GTAs in these positions are equally formative and potentially important for retention, yet are often de-prioritized. This presentation will discuss analyses of two focus groups of GTAs previously collected as part of a photovoice study. We will analyze focus group transcripts using expectancy value theory (EVT). EVT theorizes motivation for a goal is influenced by a person's expectancies to succeed, the associated cost, and three types of value: intrinsic, utility, and attainment. We will code the focus group transcripts for each of these constructs. Preliminary findings show individual GTA experiences are each consistent with one or more EVT constructs. If many experiences point towards GTAs lacking one aspect of motivation, educators and graduate program leaders may be able to identify larger systemic issues in GTA motivation. These institutional issues can then be addressed rather than only targeting the resultant symptoms GTAs experience while ignoring the underlying causes. Without motivation, GTAs are in danger of falling behind in their work, declining mental health, and even leaving the program. Support for GTA motivation is vital for the health of a graduate program and scientific discipline.

A08-3: 9:24–9:36 a.m. An Investigative Study of Retention Rates in Physics Graduate Programs

Christopher Overton, University of Georgia, Bill Bridges, James T. Laverty, Nicholas Young

Graduate students and degree holders play a central role in the growth of science and technology for both institutions and the country. Historically, STEM graduate programs have had a stable retention rate of around 60%, potentially causing a high cost for those leaving the programs and for society. We aim to identify programs with greater trends of retention to learn which should be emulated to achieve the greatest number of PhDs awarded. We use 23 years of data from the Integrated Postsecondary Education System (IPEDS) and the Survey of Graduate Students and Postdoctorates in Science and Engineering (GSS) to examine retention rates for physics graduate students and compare these trends to current literature. By observing the trends, we can make general observations about the current state of physics graduate education in the United States. We find that retention rates vary between different physics graduate programs.

A08-4: 9:36–9:48 a.m. Evaluating Scientific Impact: A Control Group Study at the Gordon and Betty Moore Foundation

Ian Olivant, Drexel University, Eric Brewe, Meagan Sundstrom, Theodore Hodapp, Catherine Mader, Manolis Antonoyiannakis, Heidi Williams, Sheen Levine

Measuring scientific impact is at the heart of the question, 'Do people who receive grant funding have more scientific impact than their equal-potential counterparts who do not get funded?' In partnership with the Gordon and Betty Moore Foundation Experimental Physics Investigator (EPI) Initiative, we present a method and preliminary results for measuring the scientific impact of funded vs. unfunded applicants. The method draws on the network normalized citation index, Ĉ. This citation index addresses concerns common to other citation indices, particularly that different fields have different publication practices and that citation counts increase over time. The citation index, Ĉ, compares papers to others in the same subdiscipline not by determining a priori the subdiscipline, but instead by creating a citation network and then using the average yearly citations of nearest neighbors to normalize. Because Ĉ uses average yearly citations, it also accounts for the cumulative nature of citations. We present a preliminary analysis of the 2022 cohort of the EPI Initiative, as we intend to follow a similar analysis pattern for other cohorts in a pre-registered study of scientific impact. In that study, we will not include the 2022 cohort, but use this to demonstrate proof of the viability of the data collection and analysis. The 2022 cohort included 16 funded EPI investigators and 8 members of a comparison group (i.e., equal-potential, unfunded applicants). This analysis is based on the set of papers from the 2022 cohort of EPI investigators (N = 734) and comparison group members (N = 434). These papers were drawn from the OpenAlex database on 22 October 2024.

Session A09: Innovations for Introductory Physics

Location: Lafayette Park **Time:** 9–10 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Dawson T. Nodurft

A09-1: 9–9:12 a.m. Teaching Introductory College Physics Course Online: Successes and Challenges

Philomena Agu, Houston Community College

This course is taught synchronously online, followed by asynchronous homework activities. The instructor uses lectures, discussions, demonstrations, and laboratory investigations to teach the course. At the beginning of each semester, the college requires each student enrolled in the course to pick up lab kit materials packaged by the physics department and return the lab kit at the end of the semester. No student takes the course without a lab kit or earns a final grade without returning the borrowed lab bit to the college. Although the lab kit requirements limit enrollment to students who can drive to the campus to pick up their lab kit, the department saw an increase in enrollment. Students from other two- and four-year colleges across the state and neighboring states take the class. In a whole group section, the instructor introduces topics with solved example problems, shows students how to set up lab materials and collect data, and then assigns students to breakout rooms to solve practice problems or complete laboratory investigations. One noticeable advantage of this small group section is that students who would not usually talk in the whole group or turn on their cameras are very comfortable in small group sections sharing ideas with their cameras on. The instructor requires in-class assignments on most contact days to increase engagement and attendance, and this strategy has proved successful. Most students attend classes and complete their work. Protecting the integrity of a test has remained a considerable challenge. Exams are timed; students see one question at a time and cannot return to previous questions, and tests with The Respondus LockDown Browser + Webcam; all practices are to minimize cheating.

A092: 9:12–9:24 a.m. Enhancing the Introductory Laboratory Learning Experience with Smartphones

Jennifer Klay, PhD, Physics, California Polytechnic State University - San Luis Obispo

In Fall 2024 we introduced a new curriculum in our mechanics laboratory class for pre-health and pre-vet majors at Cal Poly that utilizes smartphone sensors to collect and analyze motion data. Labs were based on the Physics with Phones curriculum developed by David Rakestraw at LLNL. Students used the phyphox app to collect data and analyzed the results in spreadsheets with Excel. Each week the activities connected their experiments to life science applications that resonated with them. The two final experiments were explicit examples of physics applications to health disciplines, with an experiment examining walking gait and another that incorporated AI tools to analyze physiological tremor data. The latter is described in a paper in the April 2025 issue of The Physics Teacher. In this talk we will present our experience with the course and offer insights and guidance for others interested in innovating the lab curriculum for introductory physics.

A093: a.m. 9:24–9:36 Water Leaking out of a Tank

Carl Mungan, Ph.D., US Naval Academy

The Bernoulli equation predicts the speed at which water exits a small hole in the bottom of a cylindrical tank, a result known as the Torricelli theorem. If the hole is not small, one can use the equation of continuity to correct the prediction for the nonzero rate of decrease of the surface height of water in the tank. However, the corrected result diverges if the cross-sectional area of the hole equals that of the tank (i.e., the water is freely falling down a vertical pipe open at both ends). The issue is that the flow is unsteady and so the standard form of the Bernoulli equation presented in introductory physics courses is not applicable. I will present a simple derivation of the unsteady form of the Bernoulli equation and show that it gives the correct answer for any size hole. Next I will discuss the force that must be applied to the tank to hold it in place while water is escaping from the tank. This is a variable-mass problem and thus care must be taken in applying Newton's second law. I will end with some comments about other shapes of tanks such as a funnel.

reference: J. Otto and C.E. Mungan, "Flow of water out of a funnel," Eur. J. Phys. 45, 055007 (2024)

Session A10: Professional Impact of OPTYCs: Part 1

Location: Farragut Square **Time:** 9–10 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Kris Lui

A10-1: 9–10 a.m. OPTYCs: Nourishing Bold, Brilliant Teaching

PANEL–Raeghan Graessle, MS, MEd, Harper College

Before I found OPTYCs, I was stuck in the rut of traditional lecturing. I knew my students deserved more, but I wasn't sure how to break free from the cycle of covering material, assigning problem sets, and hoping something stuck. When I did try something different, I worried it wasn't "rigorous" enough. My colleagues (mostly non-physicists), though supportive, didn't fully understand the unique challenges of teaching physics at a two-year college. I was filled with self-doubt, unsure how to make my classroom a place of community, engagement and learning. Then I found OPTYCs. OPTYCs gave me something I had been missing: permission—permission to be bold, to be creative, and to fully embrace the kind of educator I wanted to be. More than that, it provided me with a community that values both innovation and student-centered teaching. OPTYCs gave me the critical combination of inspiration, support, and shared expertise that gave me succor but also challenged me to be better. Through OPTYCs, I found a network of like-minded educators who understand the realities of teaching physics at a two-year college. They share my passion for making physics relevant and accessible to all students. This community has given me a space to develop, refine, and test my ideas without fear of failure.With OPTYCs, I don't just teach. I experiment. I imagine. I push boundaries. I know that if something doesn't work, I have a caring network of educators ready to help me troubleshoot, refine, and try again. Teaching physics at a two-year college comes with unique challenges—students with diverse backgrounds, varying levels of preparation, and often a fear of physics. OPTYCs has given me the tools and confidence to meet these challenges and to create an inclusive classroom where students feel seen, valued, and capable. OPTYCs has fundamentally shaped the way I approach my classroom. I no longer hesitate to bring imagination into my teaching. I no longer second-guess whether a creative new idea belongs in a physics course. Instead, I embrace the boldness, innovation, and student-centered approach that OPTYCs fosters. I am the educator I am today because of OPTYCs.

A10-2: 9–10 a.m. How OPTYCs Connects Me to the Physics Teaching Community

PANEL–Brian Lee, Santa Fe College

Having participated in the OPTYCs Leadership Institute, the TYC Physics Program Guidelines Revision team, and the Continuing Professional Development Workshops, I report on how OPTYCs has impacted me as a mid-career faculty member. I describe the OPTYCs-sponsored activities I have attended and the projects I have undertaken as a result. Furthermore, I present a before-and-after-OPTYCs comparison of the quality and quantity of my interactions with other educators to illustrate how OPTYCs has increased my opportunities for faculty growth via avenues such as community of practice meetings and professional development workshops. OPTYCs is supported by NSF-DUE-2212807.

A10-3: 9–10 a.m. Positive Impacts of OPTYCs on My Teaching and My Professional Development

PANEL–Dean Stocker, PhD, University of Cincinnati Blue Ash College

The Organization for Physics at Two-Year Colleges (OPTYCs) has had a profound influence on my teaching and my professional development. In fact, my CV mentions OPTYCs twelve times, mostly related to workshops and seminars that I have either attended or helped to facilitate. I will share some of the ways that OPTYCs has had a positive influence on my career: the experience of collaborating with others in writing a grant proposal, some ways that the teaching environment in my classroom has been transformed, support that our local section of AAPT has received, and presentations supported or inspired through OPTYCs that I have given online, nationally, and even international.

Session A11: P/A SEA Change – An All Hands on Deck for Inclusivity and Excellence

Location: Salon E (Washington at Metro Center) **Time:** 9–10 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Alexis Knaub

This session will be a discussion panel featuring different individuals who have been part of the Physics and Astronomy (P/A) STEMM Equity Achievement (SEA) Change program. We will have someone from AAAS SEA Change, one reviewer, 1-2 awardees, and someone from the P/A SEA Change Committee.

SPEAKERS:
Arlene Modeste Knowles
Travis York
Daniel Borrero

Session A12: Building Stronger Together: Transforming AAPT Area Committees into Thriving Communities

Location: Salon A/B (Washington at Metro Center) **Time:** 9–10 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Bree Barnett Dreyfuss

This roundtable discussion will bring together key stakeholders leading the re-envisioning of AAPT's Area Committees into vibrant communities. Through open dialogue and shared experiences, we will share innovative approaches to: (1) Create opportunities for increased member engagement and leadership, (2) Strategize building inclusive and equitable Communities across the organization, and (3) Address the evolving needs of physics educators in diverse regions. Join us for a thought-provoking discussion on the future of AAPT's Communities.

Session A13: Funds for Your Class – What We Did with Bauder Fund $ & How YOU Can Too

Location: Salon C/D (Washington at Metro Center) **Time:** 9–10 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Susan Allison

Learn about how the AAPT Bauder Fund (https://aapt.org/Programs/grants/Projects-Supported-by-the-Bauder-Fund.cfm) can lead your school or educational group to brand new equipment that can spark fresh engagement. The session leader has earned funds to be used through one of the state's Educational Cooperative and will share the process to apply all the way down to how to spend the money. The funds awarded went to 8 PocketLab (https://www.thepocketlab.com/) Voyager 2 Sensors and 2 Thermal Sensors. The equipment will be demonstrated in collecting data for linear acceleration, rotational motion, temperature and magnetic field. There will be several links to investigations and standards that use this type of data collection.

Session B01: Beyond Intro

Location: Declaration A **Time:** 10–11 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Elizabeth Gire

B01-1: 10–10:12 a.m. Defining Success in Science Multimedia Communication Courses

Steven W. Tarr, Georgia Institute of Technology, Emily Alicea-Munoz

Despite widespread agreement that communication and presentation skills are vital for students in the sciences, few universities have implemented dedicated science communication courses and fewer include sufficient opportunities for student improvement through repeated practice. We previously reported that student presentation quality in a physics senior seminar course was unaffected by observation and reflection on peer presentations, and that student takeaways from peer presentations were primarily affected by prior exposure to presentation content rather than any immediate course content. Inspired by student testimonials, we investigate the content, structure, and outcomes of an analogous chemistry senior seminar course at our institution. Across multiple multimedia presentations, chemistry students significantly improved their presentation skills as measured by the Cognitive Theory of Multimedia Learning and reported noticeably higher course satisfaction in semi-structured interviews. Here, we discuss trends in interview responses between both physics and chemistry students and the results of consequent classroom reforms in the physics course.

B01-2: 10:12–10:24 a.m. A Sketch of the Undergraduate Physics Curriculum

Juan Burciaga, PhD, Colorado College

The Undergraduate Physics Curriculum tends to be both ubiquitous and equivocal. Though normally defined at the level of courses there is ambiguity in the content and coverage of course work from institution to institution, and frequently within the same institution, even though identical or similar textbooks are used. The talk focuses on a sketch of a representative Undergraduate Physics Curriculum using an inventory that focuses on the learning objectives, key concepts, content, and iconic problems of a model physics major.

B01-3: 10:24–10:36 a.m. Integrating Nanoscience into the Classroom: An Introductory Course on Nanomaterials

F Fatima, Roanoke College

Nanoscience is a rapidly evolving field that is transforming various disciplines, from materials science to electronics and medicine. Effectively integrating nanoscience into undergraduate education is essential for preparing students for advancements in nanoscale research and technology. Here, a teaching outline of an undergraduate nanoscience course, "Introduction to Nanomaterials," is described. The course introduces key concepts of the collective behavior of atoms and molecules, crystal structure, mechanical, electrical, electronic properties of nanostructures emphasizing the importance of material characterization techniques. Students gained hands-on experience with Scanning Tunneling Microscopy/Spectroscopy (STM/STS) and Atomic Force Microscopy (AFM), enabling them to analyze materials at the atomic level and explore their structural and electronic behaviors. Through laboratory experiments and interactive learning modules, the course bridges theoretical knowledge with practical applications. The curriculum serves as a model for integrating nanoscience into undergraduate education.

B01-4: 10:36–10:48 a.m. Are the Kids Alright (with delta functions)? How Students Navigate Cultural Difference Between Math and Physics

Andrew Meyertholen, UC San Diego, Jeffrey Rabin, Brian Shotwell

Students' use of mathematics in physics classes has been widely studied in physics education research, including the role of specific mathematical methods in physics contexts. Beyond these technical aspects, broader "cultural" differences between the disciplines of mathematics and physics have also been explored. However, little attention has been given to students' own awareness and interpretation of these differences. In this talk, we present findings from a qualitative study investigating how undergraduate students perceive and navigate these disciplinary contrasts. Through surveys and interviews, we examine students' experiences with distinct pedagogical approaches, mathematical justifications, and conceptual organization in their mathematics versus physics courses. Our results indicate that students are indeed aware of these differences and develop specific coping strategies to bridge the gap. We identify key themes from our data and discuss their implications for learning and problem-solving. Finally, we suggest ways in which greater faculty and student awareness of these disciplinary differences could enhance knowledge transfer and improve interdisciplinary learning.

Session B02: The Role of Peer Instruction and Collaborative Learning Environments

Location: Declaration B **Time:** 10–11 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Jaya Shivangani Kashyap, PhD

B02-1: 10–10:24 a.m. The Role of Peer Collaboration in Physics Education: Conceptual Understanding, Academic Performance and Self-efficacy

Apekshya Ghimire, PhD in Physics, University of Pittsburgh, Chandralekha Singh

Peer collaboration can play a crucial role in physics education by fostering deeper conceptual understanding, improving academic performance, and enhancing self-efficacy. In this talk, I present findings from three research studies that examine unguided peer collaboration at different levels of physics learning. First, I discuss results from graduate-level students who completed the Conceptual Survey of Electricity and Magnetism (CSEM) and the Magnetism Conceptual Survey (MCS) individually and then collaboratively. The results highlight the effectiveness of peer interactions in refining conceptual understanding. Second, I explore the relationship between peer collaboration, academic performance, and self-efficacy among introductory physics students. Together, these studies emphasize the power of peer collaboration as a learning tool across different levels of physics education. By providing opportunities for students to articulate their reasoning and learn from each other, collaborative learning can enhance and reinforce both cognitive and psychosocial aspects of learning. The findings underscore the need for physics educators to actively promote peer collaboration both inside and outside the classroom to support students' academic and personal growth.

B02-2: 10:24–10:36 a.m. Surveying SCALE-UP Students Ten Years into Implementation

Jennifer Blue, Miami University, Allie Rolph

Miami University was able to start teaching introductory physics with SCALE-UP pedagogy when we moved to a new building in 2014. At the time, we gave the students many surveys, including the expectancy violation survey (Gaffney, Gaffney, and Beichner, PRPER 6, 2010). This survey asks one series of questions about how often students expect / experience several things in class including working with others, discussing their work with peers and instructors, and even how the room will be shaped. There is also a series of questions addressing how students feel about the way the classroom is set up, ranging from "Courses in other departments should use this classroom environment" to "This classroom environment is inappropriate for college physics." Now that it has been ten years, we gave this survey again during the 2024-2025 school year to compare the results.

B02-3: 10:36–10:48 a.m. The Implementation of Team-based Learning (TBL) Approach in Introductory Physics Courses*

Edgar Corpuz, University of Texas-Rio Grande

This presentation will document the perceptions of students on the use of team-based learning (TBL) in their introductory physics courses. In TBL classes, students are engaged in their learning through pre-class preparation, readiness assurance testing (with immediate feedback), and concept application via group-problem solving. Carefully formed permanent teams of students work on a task that has direct application of physics concepts learned. Students reported that TBL made the class more enjoyable, made them more engaged with the course materials, improved their learning and performance in the course, TBL helped sustain their interest in the course, increased their motivation to learn and helped foster a sense of belonging and community. In this presentation, details of the implementation of the TBL approach in algebra-based and calculus-based introductory physics courses will be provided.

B02-4: 10:48–11 a.m. The Integrated Peer Leader Program: Empowering Students as In-Class Leaders*

Brianna Santangelo, The College of New Jersey,

Eliza Morris, Mikkel H. Jensen, Bita Rivas, Daria Eiteneer, Brenda Weiss, Kay Zora

Active learning pedagogies are known to lead to better student outcomes on exams, formative assessments, and course grades compared to traditional lectures. Despite the benefits, many instructors hesitate to embrace active learning, relying primarily on lecturing, with active learning used only as a supplement. This can be due to implementation challenges such as limited resources, lack of support, and large class sizes. The Integrated Peer Leadership Program (IPLP), inspired by peer-led team learning models, provides a structured approach where students in the course assume leadership roles within the class. IPLP is an active team-based format where enrolled students act as Peer Leaders for 1 week out of the semester. This talk will present the IPLP format and compare learning outcomes from the program with a Learning Assistant (LA) program. Data from multiple semesters in an introductory physics course reveal that IPLP can yield student outcomes comparable to or exceeding those of the LA model, while decreasing associated costs and instructor support.

Session B03: From Atoms to Wave Functions: Quantum in 4 Levels: Part 2

Location: Franklin/McPherson **Time:** 10–11 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Mike Florek

B03-1: 10–10:24 a.m. K-12 Teacher PD on Constructing a Wave-Particle Model of Light in a Quantum Famework

Invited–Maajida Murdock, Morgan State University, Erin R. Sohr, Emiiy R. Mercurio

The growth of the quantum industry has prompted essential efforts to prepare the next generation of the quantum workforce. The Institute for Robust Quantum Simulation (RQS) has developed a three-polarizer demo, a hands-on experiment that illustrates a key concept in quantum mechanics. This demonstration inspires scientific inquiry among middle and high school students in informal and formal learning environments. Through a partnership between RQS and the Morgan State Physics Department, we have created a professional development workshop for K-12 STEM teachers. This collaborative workshop, designed to enhance their teaching skills, aims to use the driving phenomenon to support constructing a wave-particle model of light, followed by some thought experiments that guide the selective application of features from classical models to an emerging quantum framework. This presentation shares preliminary insights into the experiences of participating teachers, focusing on how a physics-centered approach supported their understanding of quantum concepts and technologies. We conclude by discussing planned changes to our activities based on our evaluation and broader implications for encouraging more learners to take the leap from classical to quantum physics.
Supported by NSF # 2417664

B03-2: 10:24–10:48 a.m. Clarifying Quantum Mechanics: The Importance of Formalization in Education

Invited – Jeremiah Bass

The degree to which curricula can be understood depends on how they are defined and presented. If features of the content itself are not well-defined, or if the content is presented in a vague or misleading manner, then this places limitations on conceptual understanding. Such curricula lack a degree of formalization. Formalization is the process of translating an unclear idea into a precise, well-defined concept or mathematical structure. This has applications in physics and physics education. Quantum mechanics is notoriously difficult to understand, especially with its departure from classical intuition, but we argue that a lack of formalization in quantum models and curricula is a major source of that confusion. Formalization in this context is compared with other conceptual difficulties such as quantum indeterminacy and philosophical interpretations of quantum mechanics. Recommendations are offered for physics educators and future research.

Session B04: Science Research in High Schools: Part 2

Location: Wilson/Roosevelt **Time:** 10–11 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Jan Mader

B04-1: 10–10:24 a.m. Astronomy Research with Archival Satellite Data and JS9

Invited–Pamela Perry, M.Ed, Lewiston High School

How can we provide an authentic research experience to students who want to find out what science is REALLY about? We couple JS9, a fun to use, web-based image display environment, with archival satellite data to allow students to perform astronomical analysis remotely using their browser. Energy spectra, light curves, periodic phenomena, and much more can be explored, using FITS files from thousands of deep sky objects, spanning the gamut of observed energies, from infra-red emission to gamma rays. Since this system is platform independent, it is especially useful in the classroom, as well as in distance learning environments. Pre-written investigations with step-by-step instructions stand alone or can be used to introduce analysis tools to students in preparations for their own, independent research.

B04-2: 10:24–10:48 a.m. High-Altitude Ballooning as a Platform for Engineering and Astrophysics Research

Invited–Alissa Sperling

High-altitude ballooning provides students with an engaging platform for engineering design and authentic scientific research. Students are tasked with formulating scientific questions, conducting literature reviews, designing data collection devices, meeting design specifications and government regulations, planning and carrying out a launch mission and recovery, and then analyzing data and presenting scientific findings. Most importantly, however, high-altitude ballooning provides students opportunities for repeated failure and the skills to work through it. This talk will explore the pedagogical benefits of high-altitude balloon programs, including its ability to teach systems engineering, sensor integration, coding, and data analysis, while fostering problem-solving and teamwork skills. I will also highlight the High-altitude Engineering for Research in Astrophysics (HERA) program, a joint high school-undergraduate initiative that enables students to develop and launch payloads for cosmic ray and atmospheric studies.

Session B05: Innovations in Quantum Curriculum: Part 2

Location: Cabin John/Arlington **Time:** 10–11 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** TBA

B05-1 10–10:12 a.m. Effectiveness of Research-based Mini-tutorials on Quantum Computing Protocols and Algorithms

Beth Thacker, Texas Tech University, Jianlan Wang, Yuanlin Zhang, Emmanuel Ebom, Mahamadu Duut

As the revolutionary new field of Quantum Computing (QC) continues to gain attention, it is crucial to introduce research-based materials and pedagogical approaches to effectively teach quantum computing concepts and skills to students across multiple disciplines. We present an empirical investigation into the use of a set of mini-tutorials developed to enhance the learning of core QC concepts and skills. We videotaped the in-class group discussions during the mini-tutorials, pre- and post-tested the students before and after the mini-tutorials and interviewed students a semester after they took the course. We report on the effectiveness of the mini-tutorials, the students' in-class use of the mini-tutorials and their gains/losses in content and skills after using the mini-tutorials. We also discuss the implications of our research on the pedagogy and materials used for teaching more complex protocols and algorithms in an Introductory Quantum Computing course for upper-level undergraduate students.

B05-2 10:12–10:24 a.m. Hands-On Quantum: Teaching Core Quantum Concepts with Bloch Cubes

Dan Luo,

Jeremy Levy, Chandralekha Singh

The quantum information revolution demands innovative approaches to teaching foundational quantum concepts. We introduce the Bloch cube, a hands-on educational tool that demonstrates abstract quantum phenomena without requiring mathematical formalism. Through accompanying instructional videos, we illustrate how Bloch cubes effectively teach quantum measurement, dynamics, pure versus mixed states, decoherence, and other concepts. This approach bridges the accessibility gap for pre-college and introductory college students, preparing a new generation for participation in quantum science and technology. Our research-based learning materials are being developed to maximize educational impact. This work is supported by the National Science Foundation through grants PHY-1913034 and DMR-2225888.

B05-3 10:26–10:36 a.m. Advancing Quantum Information Education: Research-Based Tutorials and Assessment Tools

Steven J. Pollock, University of Colorado,

Gina Passante, Bethany R. Wilcox

Quantum information science (QIS) is a rapidly evolving field, and in recent years, many universities have introduced undergraduate courses covering its fundamentals. These courses often focus on quantum computing and communication, attracting a diverse, interdisciplinary student population and faculty. This early stage of QIS education presents a unique opportunity for Physics Education Research (PER) to shape and inform effective pedagogical models. In this talk, I will share our group's recent work on developing research-based tutorials—both in-class and online—as well as an assessment tool designed to evaluate student learning. Additionally, I will present our new PhysPort resource (physport.org/curricula/ACEQIS) aimed at supporting faculty in teaching QIS effectively. (Work supported by NSF-DUE-2012147)

B05-4 10:36–10:48 a.m. Implementation of Quantum Mechanics into Traditional Introductory Physics Courses

D. Baker, William Jewell College

Knowledge of quantum mechanics is essential for employment in many technical fields today. To introduce students to quantum mechanics earlier in their undergraduate careers, we have expanded several introductory physics activities to include quantum-mechanical concepts and computations. Examples include incorporation of boundary conditions to develop quantized wavefunctions and introduction of energy bands to determine wavelengths of light emitted from quantum dots. This talk will focus on how to implement these activities into traditional introductory physics courses and details of the assignments.

Session B06: Innovations in K-12 Teaching

Location: Bulfinch/Renwick **Time:** 10–11 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** TBA

Session B07: Culturally Responsive Teaching: Part 2

Location: Penn Quarter AB **Time:** 10–11 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Darsa Donelan

B07-1 10–10:24 a.m. Beyond the Formula: Exploring Cultural Epistemologies in Physics Learning

Invited –Clausell Mathis, Michigan State University,

Hiba Assi, John Kelly, Ian Neuhart, Hassaan Azam

Physics education has historically faced challenges in engaging students from culturally and linguistically diverse backgrounds. Traditional approaches often emphasize abstract mathematics and decontextualized problem-solving, disconnecting student's experiences from the curriculum. In contrast, research on culturally based pedagogies (CBP) underscores the value of incorporating students' cultural knowledge, ways of knowing, and sensemaking practices to foster more inclusive and resonant learning environments. Our study explores how students in introductory physics courses draw on their cultural resources and epistemologies to make sense of core physics ideas. We designed and piloted culturally based assessments across three universities to better understand this process. In this presentation, we will share the curriculum materials, qualitative coding frameworks, as well as preliminary findings from students' responses. By examining how cultural backgrounds influence students' engagement with physics, our work offers insights into how the discipline can evolve to reflect and respect diverse lived experiences and knowledge systems.

B07-2 10:24–10:48 a.m. Framing towards Epistemic Decolonization

Lucky Nonyelum, Michigan State University, Clausell Mathis

The struggle for epistemic freedom in African education is central to the ongoing efforts to decolonize the curriculum and empower students to center knowledge within their contexts. The presentation presents how framing could be a powerful tool for Nigerian high school teachers in advancing epistemic decolonization in physics teaching and learning by challenging entrenched colonial narratives and centering knowledge production. I define framing as the deliberate act of shaping how knowledge is presented.Historically, physics has been taught to students in a way that encourages them to think, theorize, and interpret the world through a Eurocentric lens, which often alienates them from their own cultural and intellectual traditions. This imposition of Western ways of knowing has contributed to marginalizing indigenous knowledge systems in science. Reclaiming epistemic freedom, therefore, is a crucial step towards fostering a more inclusive and culturally relevant approach to teaching science, one that acknowledges and celebrates alternative ways of knowing and thinking. Through interviews with eight Nigerian physics teachers, this study investigates how teachers frame canonical physics knowledge in their teaching and how they can develop alternative strategies that leverage students' cultural ways of learning. By deliberately reframing science education, teachers can highlight the interconnectedness of indigenous knowledge systems and modern scientific principles, showing their relevance to students' lived experiences amidst the ongoing coloniality happening in Nigeria.

Session B08: Connecting Learning Assistants and Graduate Students to Departments

Location: Constitution DE **Time:** 10–11 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Paul DeStefano

B08-1 10–10:12 a.m. Leveraging Learning Assistant (LA) Voice and Perspectives to Impact Instructional Delivery

Mel Sabella, Chicago State University,

Jacquelyn Benchik-Osborne, Andrea Van Duzor, Vivian Cox, Trinity Thomas, Kefira Fields, Kimberly Hollings-Johnson

The Learning Assistant (LA) Model, developed at the University of Colorado - Boulder, leverages undergraduate students (LAs) as facilitators of learning in active engagement classes. Often, LA roles go beyond the classroom as LAs are involved in instructional changes across the institution and in the broader learning community. LAs also provide support through their expertise and experience in both local contexts and LA Program implementation across multiple campuses. We suggest a developing framework for identifying LA leadership and provide examples, with a specific focus on LA roles as advisors and supporters of effective teaching frameworks. Funded by the Department of Education (CSER, RECESS), the National Science Foundation DUE#1911341 & 2412938, and the Illinois Space Grant Consortium.

B08-2 10:12–10:24 a.m. Enhancing STEM Graduate Student Teaching: The Cultivation of Teaching Skills and Identity among Graduate Students

Nishchal Thapa Magar, George Mason Univ,

Jessica L. Rosenberg, Jill K. Nelson

This study examines the development of Graduate Teaching Assistants' (GTAs') teaching identity through professional development (PD) and hands-on teaching experiences. While prior research highlights how PD improves teaching practices, less attention has been paid to their impact on the formation of a cohesive teaching identity. Understanding GTA identity evolution is essential for designing PD programs that enhance teaching effectiveness. This study explores how structured PD, including pre-semester workshops and classroom experience, influences GTAs' instructional roles and student engagement. Data were collected from seven focus groups (33 GTAs) following a two-day pre-semester workshop in August 2023, along with one-on-one interviews with 20 GTAs throughout the academic year and 10 follow-ups in summer 2024. Using open and axial coding methods, the analysis identified key themes related to the development of teaching identity, and the difficulties GTAs encounter as they grow into their instructional roles. Findings reveal that GTAs initially held a limited view of their roles but, through PD and experience, developed a deeper, student-centered approach. They integrated insights from PD, personal skills, and prior learning to refine their instructional methods. This study underscores the need for PD programs that not only provide teaching strategies but also support GTAs in shaping their evolving teaching identities.

B08-3 10:24–10:36 a.m. DELTA-P: A Decade of Efforts to Improve Graduate TA Teaching Preparation

Charles Ruggieri, Rutgers State University - Piscataway

In this talk, I summarize the 15-year history of graduate student pedagogical preparation in our physics and astronomy PhD program, as well as lessons learned for better engagement in and perceptions of pedagogical preparation among graduate students in our program. These experiences may help inform other institutions' graduate program pedagogical preparation offerings, and may help open up new pathways towards more desirable graduate programs in physics and astronomy. Starting from its inception in 2010, I walk through the history of our department's program, DELTA-P (Developing Education Leaders Among TAs in Physics), as a mandatory one-hour weekly seminar series with invited speakers (mostly local to the institution) to its current form of targeted pedagogically oriented workshops within the same time constraints. Content and activities of these workshops will be shared, and include a mixture of general education principles borrowed from our institutions Learning Assistant Program training, as well as physics-specific pedagogy tailored to the typical graduate teaching roles in our department. Survey data over several years reveals the topics that our graduate students preferred, and topics they didn't prefer, as well as their perceptions of the DELTA-P program as part of their overall graduate experience in our institution. Lessons learned and the next phases of the program will be discussed, including institutional-level steps taken towards improving the standards of graduate student pedagogical preparation across all departments, which will shape the future evolution of DELTA-P as a department-specific pedagogical training effort.

B08-4 10:36–10:48 a.m. Leveraging Education Research and Partnerships in Launching Learning Assistant Program

Rob Dalka, University of Detroit Mercy, Eleni Geragosian

At the University of Detroit Mercy, the Physics Program is investigating how a Learning Assistant (LA) program may be developed in alignment with the active learning initiatives throughout the College of Engineering & Science (CES). In leading the investigation of current Undergraduate Teaching Assistant (UTA) practices across different STEM disciplines, we see an opportunity for the Physics Program to explore how an LA program would best fit into our own institutional context. We aim to gather data and develop important partners throughout CES to design research-informed program updates. The focus of this project is to investigate current Teaching Assistant (TA) roles, faculty attitudes toward the LA model, and the LA model's alignment with existing practices across Detroit Mercy. This presentation will share the research design and our future plans to partner with other programs and administration in implementing an LA program.

Session B09: PER: Courses, Curriculum, and Programs

Location: Lafayette Park **Time:** 10–11 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Julian D. Gifford, Ph.D.

B09-1 10–10:12 a.m. "I don't know, Sir": Indonesian Pre-Service Physics Teachers' Views on the Nature of Science (NOS)

Aula Al Balad, The Ohio State University, Zhenis Kenzhekey, Lin Ding, Ph.D.

This study explores Indonesian pre-service physics teachers' views on the Nature of Science (NOS) regarding the local socio-scientific issues (SSI). Through semi-structured interviews with two male and one female pre-service teachers from Kendari, Southeast Sulawesi of Indonesia, we examined the participants' understandings of NOS concepts within the context of physical and environmental challenges. The findings revealed participants' significant misconceptions about fundamental NOS. The results highlight the critical gaps in NOS understanding among future Indonesian physics teachers, emphasizing an urgent need for reforms in teacher education to address these misconceptions and better prepare teachers for integrating NOS into science curricula.

B09-2 10:12–10:24 a.m. EP3 Guide: Implementing Research-Based Teaching Practices in Your Classroom

Sarah McKagan, American Physical Society, Michael Wittmann

The Effective Practices for Physics Programs (EP3) initiative (EP3guide.org) is a collaborative effort between APS and AAPT designed to support physics departments in improving all aspects of their programs through continued self-reflection. One focus area identified early on for EP3 was providing guidance on teaching practices. Several of the most recently published sections include strategies for how instructional staff can apply research-based teaching in their classrooms. In this talk, we describe the EP3 Guide, summarize the process of writing the Guide, and provide details about the section "Implementing Research-Based Teaching in Your Classroom."

B09-3 10:24–10:36 a.m. EP3 Guide: Supporting Research-Based Teaching in Your Department

Michael Wittmann, American Physical Society, Sarah McKagan

Implementing research-based teaching throughout a department comes with challenges that are different from implementing research-based teaching in a single classroom. The Effective Practices for Physics Programs (EP3) Guide (EP3guide.org) has a newly released section, "Supporting Research-Based Teaching in Your Department" which describes how departments can create cultural structures to support instructional staff in both in-person and online modalities. Several sections of the guide offer suggestions for how to incorporate research-based teaching in specific types of physics courses, such as introductory and upper-level courses. We describe these sections of the EP3 Guide as well as others that help create the cultural and structural changes needed to support student learning using research-based teaching.

B09-4 10:36–10:48 a.m. A CSU Online Particle Physics Course with Summer Research at CERN: Assessing Student Identity, Interest, and Learning in Particle Physics

Qing Ryan, California State Polytechnic University Pomona, Shohreh Abdolrahimi, Yongsheng Gao

As part of a National Science Foundation-funded initiative to expand career pathways for physics majors at 14 Hispanic-Serving Institutions, we developed an online particle physics course through the CSU Fully Online program, collaborative between CSU Fresno and Cal Poly Pomona. This course provides students with opportunities for summer research experiences at CERN, U.S. national labs, and R1 universities, aiming to bridge the gap between undergraduate studies and advanced research in physics. The course integrates active learning strategies, including pre-lecture videos, weekly assessments, structured office hours with think-pair- share activities, guided discussion forums, and term papers on frontier topics in particle physics. This project contains a physics education research component, where we collect data on student attitudes such as self-efficacy, physics identity and physics interest; assessment performance on pre and post assessment questions, as well as their career goals. We report first year's preliminary findings from these efforts.

B09-5 10:48–11 a.m. Enhancing Physics Education with an Effective Personalized Assessment Model

Neel Haldolaarachchige, Ph.D., Bergen Community College, Kalani Hettiarachchilage, Dr., PhD

The recent development of physics education leads educators to explore new teaching and learning methodologies and restructure classes and assignments to bring students' knowledge to the highest level of education by allowing learners to gain various skills that will be beneficial in their future. We discuss developing and delivering effective introductory level physics courses by personalizing the class and individualizing the assignments in all teaching modalities (in-person, hybrid, and online). Various teaching and learning activities are aimed at effective learning and interaction to enhance student learning. Student registration and retention are well preserved by providing learners freedom of education, a sense of belonging, mindset-growing encouragements, effective feedback, problem-solving strategies, and one-to-one communications. Academic integrity is well-balanced by individualizing the assignments, personalizing class materials, breaking down problems, and investigating AI usage. The students' performances are analyzed by evaluating class performance in total grade distribution, missing assignments, and choice-based learning. Student progress is investigated by analyzing their commitment, respect, willingness to improve, and time management toward education.

Overall, the class model demonstrates great performance, progress, and achievements that indicate a positive learning environment for all students throughout the semester. Hence, the effective model with personalized assignments and other strategies that we share will be highly beneficial for physics education.

Session B10: Professional Impact of OPTYCs: Part 2

Location: Farragut Square **Time:** 10–11 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Kris Lui.

B10-1: 10–11 a.m. A Firsthand Account of Transformative Growth Through the New Faculty Development Series

PANEL– Angela McClure, Estrella Mountain Comm Coll

Join me as I share my experience navigating the faculty life of a two-college physics instructor. The New Faculty Development Series wasn't just a program; it was a game-changer. Learn how it helped me grow as an educator and build a supportive community. We'll talk about the impact it had on my teaching and how mentoring helped me to continue to evolve. Let's explore how mentoring can benefit you too!

B10-2: 10–11 a.m. New Submission

PANEL–Anthony Musumba, Riverside City College

The Organization for Physics at Two-Year Colleges (OPTYCS) is a gamechanger in professional development for the TYC professor. In the last 4 years I have benefited immensely from the OPTYCs community and its resources. My contributions to the physics community are inextricably tied to OPTYCs. I highlight some of the great collaborations that I have been involved in through OPTYCs with AAPT affinity groups: PICUP (Partnership for Integration of Computation in Undergraduate Physics), STEP-UP (Supporting Teachers to Encourage the Pursuit of Undergraduate Physics), NASA HEAT (Heliophysics Education Activation Team) and NEXT Gen PET (Next Generation Physical Science for Everyday Thinking). Through OPTYCs, I have participated in mentoring relationships with professors that are starting off their physics careers, mid-career faculty and some very resourceful retired faculty that are still doing the work. Finally, involvement with OPTYCs webinars and online communications keeps the community in the Community College.

B10-3: 10–11 a.m. A Reflection on Things I Have Learned Over a Decade as a Participant and Mentor for the New Faculty Experience/ Development Series

PANEL–Elizabeth Schoene, South Seattle Coll

Over the last 13 years, I transitioned from a novice teacher to a seasoned practitioner of Physics Education Research with the New Faculty Experience/Development Series serving as my backdrop, both as a participant and a mentor. I discovered that working with students and fellow faculty have some striking similarities, and my experiences in one realm strengthened my work in the other. In this talk, I will reflect on what I have learned through teaching, mentorship and the New Faculty Experience/Development Series that bolstered my professional growth and resilience as a teacher and colleague. The New Faculty Development Series, based on the earlier New Faculty Experience program, is offered by The Organization for Physics at Two-Year Colleges (OPTYCs) and funded by NSF-DUE-2212807.

Session B11: Interactive: Award Winning Physics Lessons

Location: Salon E **Time:** 10–11 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Richard Gelderman

B11-1: 10–11 a.m. A Baffling Brain Behavior: Lessons on Inertia

PANEL– Dylan Fedell, Palisades High School

In this interactive presentation, I will share a unique series of lessons centered around the question, "In which direction will the brain move in a collision?" Participants will explore this question and the concept of inertia from a student's perspective, using cork and pendulum accelerometers to predict the direction of motion for themselves. Additional resources will be made available, including student activity sheets, lesson plans, and teacher notes.

Session B12: Apparatus Competition Showcase

Location: Salon A/B **Time:** 10–11 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Paul Noel

This session is the return of the beloved Apparatus Competition. Individuals will showcase the apparatus that they entered in the competition during the session. Come and learn about new ways to teach with apparatus from innovative teachers and students.

Session B13: QuarkNet at 25+1: Data Activities – Panel

Location: Salon C/D **Time:** 10–11 a.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Kenneth Cecire

The QuarkNet program turned 25 last year! In that time, we have collected, developed, and refined interactive activities that enable teachers and students to experience cutting edge science in the classroom. We will try out a few activities together, from our classics to the latest, and teachers will share how the activities fit the curriculum. We'll intersperse our work with discussion of ways the program has grown over the past quarter-century and how you can get involved. It's a good idea to bring a laptop and an active mind.

Session C01: From Vision to Reality: Implementing the STEP UP Curriculum – Panel

Location: Declaration A **Time:** 2–3 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Amee Johnson

Three high school teachers (Elissa Levy, Amee Johnson, and Bree Barnett Dreyfuss) share how they have used the STEP UP curriculum in their classrooms. From lesson modifications to strategies that they use to grow their classroom community as inspired by STEP UP's Everyday Actions Guide, come here more about how to make it fit your space. Panelists offer different perspectives, having taught in different school settings on both coasts.

Session C02: Demos in a Box

Location: Declaration B **Time:** 2–3 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** George Trammell

C02-1: 2–2:12 p.m. Science Sorcery: How to Use Magic to Enhance Physics Classroom Experiences

Joshua Buchman, Fayetteville-Manlius HS

Participants will learn to incorporate several principles of magic that can enhance physics demonstrations and increase student engagement. The incorporation of magic into your program can help make your class even more fun and memorable than it was before.

C02-2: 2:12–2:24 p.m. A Simple Model for Teaching Special Relativity

Robert Close, PhD, Clark College

Mathematical analysis of the Dirac equation indicates that mass is associated with rotation of wave velocity. Hence, we can expect that a wave propagating in a circle would exhibit some properties of elementary particles. Such a stationary wave-like particle can be modeled by drawing lines of constant phase (i.e. wave crests) on a transparency sheet, then rolling up the sheet along an axis parallel to the wave crests to represent waves propagating in circles around a cylinder. Moving particles are then represented by rotating the orientation of each wave crest so that the propagation direction has an axial component, forming helical paths. Comparison of the stationary and moving wave packets offers a good demonstration of special relativity because the wave equation (and any solution) is Lorentz covariant. Time dilation results from assuming that the particle "clock" ticks once each time the wave traverses 360 degrees around the cylinder. Rotation of the wave crests reduces the length of the wave packet along the axis. The relativistic frequency shift results from the fact that rotating the individual wave crests decreases the wavelength. The deBroglie wavelength is simply the spacing between wave crests along the axis of the cylinder.

C02-3: 2:24–2:36 p.m. How Thick is Your Hair? An Interactive Physics Demo for the General Public

Eugene Torigoe, PhD, Thiel College

This talk will describe a demo-in-box that can be setup on a standard table and requires a pen laser, a mount, a ruler, and a box (if it's sunny). Participants are invited to pluck a hair, and tape it onto a cardboard mount. The diffraction pattern is observed on a screen and the width of the central bright band is measured. To speed up the process we use a data table to convert the measurement in mm to the hair thickness in micrometers. The participants help update a histogram of all of the hair thickness measurements made during that day. This demo can be used to talk about a variety of different topics depending on the age and sophistication of the audience. We can discuss the meaning of a micrometer, what a histogram shows, the normal distribution, how laser light is different from other light, the shadow of the hair vs the diffraction pattern, Huygens wavelets, and Babinet's principle.

C02-4: 2:36–2:48 p.m. Density Lab: Determining the Density of the Glass in a Snapple Bottle by Non-Destructive Methods

Joe Wyatt, Bayonne HS

Density is an important concept in Physics especially at the High School Level. Most students cannot explain how a steel ship of thousands of tons can float in water. The basic concept is that an object can float if its density is less than the density of the liquid it is in. Conversley, an object sinks if its density is greater than the density of the liquid it is in. As density is an average property, this lab is designed to help students develop a thorough understanding of density through a hands-on experience. They must determine the density of the glass in a Snapple bottle by non-destructive means. This involves measuring various masses and volumes, solving sophisticated equations, and developing detailed lab procedures. The Lab uses a minimum of equipment: A Snapple bottle, three glass cylinders, 100 ml and 10 ml graduated cylinders, scales (1 g accuracy), beam balances (0 .1 g accuracy), water, salt water, and alcohol. By the end of the lab, students have a thorough understanding of the concept of density and its uses.

Session C03: Alternative Assessment

Location: Franklin/McPherson **Time:** 2–3 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** David Brookes

C03-1: 2–2:12 p.m. Rediscovering Oral Examinations in the Age of AI: An Alternative Assessment Approach

Tatiana Stantcheva, Ph.D., USNCC

Oral examinations have long been a cornerstone of assessment in European higher education, yet they remain uncommon in US academic institutions. While American education has traditionally favored standardized testing for reasons of efficiency, perceived objectivity, and practicality, these methods are increasingly challenged by a combination of two modern developments: the rise of online course delivery and the advancement of AI technologies that can compromise test integrity. As educators seek assessment methods that remain effective in this changing landscape, oral examinations offer a compelling alternative worthy of reconsideration. This presentation explores how oral examinations—a time-tested assessment method that continues to be the standard in professional contexts such as job interviews and apprenticeships—can be effectively reimagined for contemporary educational settings. The session will present both the benefits and challenges of integrating oral examinations into course assessment, along with practical, low-cost strategies for piloting and gradual implementation that are accessible to educators across the STEM disciplines.

C03-2: 2:12–2:24 p.m. The Use of Collegewide Common Exams in Calculus-Based Physics Classes at Montgomery College

Richard Szwerc, PhD, Montgomery College, Maryam Hosseini

The Montgomery College (MC) Physics program has used common mid-semester and final exams across three campuses and multiple instructors for more than ten years. These common exams and the associated single grader for each problem provide a uniform assessment that offers multiple advantages to the students, the faculty, and the administration. Our common exams ensure that the grades are equitably assigned regardless of the instructor or campus. They also identify teachers whose instruction methods are more effective than others, so that best practices can be shared. And they provide data so that administrators are assured that all students are receiving the same education. These benefits are not achieved easily, as communication, negotiation, and compromise among the faculty are a constant need. We will discuss the process that we use to develop and grade the exams. And will expand on some of the advantages and challenges of having common exams across three campuses and with an ever-changing roster of instructors.

C03-3: 2:24–2:36 p.m. Using D2L to Create Tests for both Online and Face-to-Face Courses

PEI Xiong-Skiba, Ph.D., Austin Peay State University,

William Longhurst, Spencer Buckner, Andriy Kovalskiy

Online courses have grown increasingly popular in recent years. At Austin Peay State University, approximately 50% of our introductory physics courses have been offered online over the past four years, largely driven by student demand. This highlights the need for consistent standards across both in-person and online modalities. A key aspect of maintaining the standards is designing comparable online tests, used in both modalities. The primary guidelines include:

Minimizing the online searchability of solutions.

Utilizing proctoring tools like Honorlock to deter academic dishonesty.

Structuring exams to mirror traditional paper tests, including organized problem sets and partial credit opportunities.

Austin Peay State University uses Desire2Learn (D2L) as its learning management system. In this presentation, we will discuss how we utilize D2L features—such as Sections, Multiple-Selection, Double Submission, and Honorlock— to help create more effective assessments that better align grades with students' understanding of the subject.

C03-4: 2:36–2:48 p.m. Qualitative Student Feedback Regarding Alterative Grading System in Introductory, Calculus-based Physics Courses

Richard Pearson, Embry-Riddle Aeronautical University, Caitlin Martin

Adjusting to any change is a difficult task. Asking undergraduate students to adapt to an unfamiliar, alternative grading system for their introductory physics course in their first or second year fits that bill. To assist in assessing the transition process, recurrent reflections are asked of the students, as well as pre- and post-semester surveys regarding their experiences. This presentation provides some of the descriptive and qualitative comments, suggestions, and observations made by engineering and engineering physics undergraduate students in a classroom constructed with various aspects of alternative grading methods; the conglomerate included facets of mastery-based, labor-based, and specifications grading systems. The hope is to build-up further discussion as educators, instructors, and teachers around these student-focused insights.

Session C04: Engaging Students with Educational Technology

Location: Wilson/Roosevelt **Time:** 2–3 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Michael Galllis

C04-1: 2–2:24 p.m. Enhancing Student Engagement in the Era of Digital Fluency

Invited–Beth Lindsey, Pennsylvania State University - Greater Allegheny

As educators, we are all familiar with some variation on the adage, "Tell me and I'll forget, teach me and I may remember, involve me and I'll understand." This adage underscores the importance of active learning in education. In today's digital landscape, students are immersed in technology that can both enhance and hinder their engagement with physics. While digital tools offer innovative ways to involve students in learning, they can also present distractions and exacerbate the "digital divide" based on disparities in access to resources. At Penn State Greater Allegheny, where more than 40% of students receive Pell Grants, minimizing course costs is essential for student success. Through the campus's "Digital Fluency" initiative, for the last several years every incoming student has been provided with an iPad. Having access to this shared technology has fostered new avenues for student collaboration and engagement. This talk will explore how open-source and widely licensed institutional software can be leveraged to transform physics instruction, making learning more interactive while maintaining an inclusive and cost-effective educational environment.

C04-2: 2:24–2:36 p.m. Engaging Students with Augmented Reality to Learn Abstract and 3D Physics Concepts

Michele McColgan, Siena College

The MARVLS Augmented Reality (AR) Apps are designed to allow students to visualize abstract 3D physics concepts, link 2D representations to 3D models, and link variables in equations to physical objects in the 3D models. The MARVLS Apps use the camera on the phone or tablet to place the digital model visually onto the Merge cube and then change the orientation of the AR model in response to the user rotating the Merge cube. Many of the AR scenes in the Apps reflect common abstract and 3D concepts that students have difficulty visualizing. Five Apps are available on the App Store and Google Play Store and include Physics I, Physics II, Plasma Physics, Quantum Computing, and Chemistry. Lessons are available for most of the AR scenes. NSF funded work on the effectiveness of the magnetism AR models and corresponding lessons. We use the mathematical sensemaking framework to evaluate the apps and lessons and make improvements to both.

C04-3: 2:36–2:48 p.m. Worksheets to Accompany HTML5 Physics Simulations

Andrew Duffy, Boston University

There is a nice collection of over 200 HTML5 physics simulations available, at https://physics.bu.edu/~duffy/sims.html In this talk, I will discuss our project of writing worksheets to accompany the simulations, and show several examples. Much of that work has been done by people attending our AAPT workshops, so this effort is a great example of some members of our Physics community coming together to create something collectively for the benefit of the entire community.

C04-4: 2:48–3:00 p.m. Our Journey to Reviving Physics Java Applets

Muhammad Syed, Ph.D., Mount Royal University, Ralph Acusar Acusar, Stefan K. Morano

COVID-19 posed various economic, health, social, and academic challenges but created unique opportunities for some academic projects that might otherwise not have been pursued. In the context of this study, the shift to remote teaching due to COVID-19 enhanced the importance of computer simulations in learning physics, providing a catalyst for reviving a collection of high-quality Java applets of physics simulations at the first/second-year level that had become obsolete due to security concerns and the associated changes in the internet and browser landscape since their creation around the early 2000s by Alberta physicists. COVID-19 limited the work-term opportunities for our computer information systems students in the industry. Serendipitously, the availability of some of these students for this project was also a significant factor in realizing this project. In this presentation, we will share our journey of bringing these applets back to life using browser-dependent, browser-independent, and internet-independent approaches. The revival of these applets holds great promise for the future of physics education as it preserves the collective expertise and experience of many physicists.

Session C05: Innovations in Quantum Curriculum: Part 3

Location: Cabin John/Arlington **Time:** 2–3 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** D. Baker

C05-1 2–2:12 p.m. Effectiveness of Research-based Mini-tutorials on Quantum Computing Protocols and Algorithms

Beth Thacker, Texas Tech University, Jianlan Wang, Yuanlin Zhang, Emmanuel Ebom, Mahamadu Duut

As the revolutionary new field of Quantum Computing (QC) continues to gain attention, it is crucial to introduce research-based materials and pedagogical approaches to effectively teach quantum computing concepts and skills to students across multiple disciplines. We present an empirical investigation into the use of a set of mini-tutorials developed to enhance the learning of core QC concepts and skills. We videotaped the in-class group discussions during the mini-tutorials, pre- and post-tested the students before and after the mini-tutorials and interviewed students a semester after they took the course. We report on the effectiveness of the mini-tutorials, the students' in-class use of the mini-tutorials and their gains/losses in content and skills after using the mini-tutorials. We also discuss the implications of our research on the pedagogy and materials used for teaching more complex protocols and algorithms in an Introductory Quantum Computing course for upper-level undergraduate students.

C05-2 2:12–2:24 p.m. Hands-On Quantum: Teaching Core Quantum Concepts with Bloch Cubes

Dan Luo,

Jeremy Levy, Chandralekha Singh

The quantum information revolution demands innovative approaches to teaching foundational quantum concepts. We introduce the Bloch cube, a hands-on educational tool that demonstrates abstract quantum phenomena without requiring mathematical formalism. Through accompanying instructional videos, we illustrate how Bloch cubes effectively teach quantum measurement, dynamics, pure versus mixed states, decoherence, and other concepts. This approach bridges the accessibility gap for pre-college and introductory college students, preparing a new generation for participation in quantum science and technology. Our research-based learning materials are being developed to maximize educational impact. This work is supported by the National Science Foundation through grants PHY-1913034 and DMR-2225888.

C05-3: 2:26–2:36 p.m. Advancing Quantum Information Education: Research-Based Tutorials and Assessment Tools

Steven J. Pollock, University of Colorado,

Gina Passante, Bethany R. Wilcox

Quantum information science (QIS) is a rapidly evolving field, and in recent years, many universities have introduced undergraduate courses covering its fundamentals. These courses often focus on quantum computing and communication, attracting a diverse, interdisciplinary student population and faculty. This early stage of QIS education presents a unique opportunity for Physics Education Research (PER) to shape and inform effective pedagogical models. In this talk, I will share our group's recent work on developing research-based tutorials—both in-class and online—as well as an assessment tool designed to evaluate student learning. Additionally, I will present our new PhysPort resource (physport.org/curricula/ACEQIS) aimed at supporting faculty in teaching QIS effectively. (Work supported by NSF-DUE-2012147)

C05-4: 2:36–2:48 p.m. Implementation of Quantum Mechanics into Traditional Introductory Physics Courses

D. Baker, William Jewell College

Knowledge of quantum mechanics is essential for employment in many technical fields today. To introduce students to quantum mechanics earlier in their undergraduate careers, we have expanded several introductory physics activities to include quantum-mechanical concepts and computations. Examples include incorporation of boundary conditions to develop quantized wavefunctions and introduction of energy bands to determine wavelengths of light emitted from quantum dots. This talk will focus on how to implement these activities into traditional introductory physics courses and details of the assignments.

Session C06: Building a Classroom Culture: Part 1

Location: Bulfinch/Renwick **Time:** 2–3 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Yaren Ulu, PhD student

C06-1: 2:00–2:24 p.m. Cultivating Curiosity and Confidence: Daily Practices for an Engaged and Connected High School Physics Classroom

Invited–Justine Harren

Creating a positive and engaging classroom culture is essential for student success in high school physics. This session explores effective daily routines that create a safe space for failure, success, and active student participation. Key strategies include incorporating a Question of the Day, the High School Physics Photo Contest, and utilizing Involuntary Response techniques to encourage broad student participation. Attendees will gain practical insights and adaptable strategies to implement these routines in their own classrooms.

C06-2: 2:24–2:36 p.m. Ten Tips for a Cheerful Physics Classroom

Liz Schiefer, Master's in Chemistry, Jessieville High School

We've all dealt with students who don't really want to be in our physics class or students who have given up before they've even started. I believe intrinsic motivation can be built when students first feel welcome and appreciated, and then when they have opportunities to see their potential and their growth. I want to share 10 tips for how I create a classroom environment that is cheerful, challenging, and rewarding. From greeting students at the door to student-driven labs to tests with a little bit of humor, I want to share simple changes I made to my classroom that had a profound impact on student engagement.

C06-3: 2:36–2:48 p.m. Building Belonging: "Fast Friends," Collaborative Quizzing, and Multimedia Group Projects

Andrea Goering, University of Oregon

Student motivation varies widely amongst physics learners, especially in large-enrollment general education settings. Motivation to learn is impacted by many factors, including the perceived usefulness or value of content and tasks, a student's expectation to succeed, feelings of autonomy in their learning experience, and a sense of belonging. One major path toward supporting motivation is therefore to encourage a sense of belonging in the classroom and social connectedness between peers, and between students and instructors. Inspired by the results of several years worth of affective outcomes (including self-efficacy and social connectedness) in my 100-level physics and astronomy courses, I have experimented with various practices that help build student-student connections and encourage a growth mindset and spirit of collaboration. These include "fast friends" icebreaker questions, collaborative quizzing, and multimedia group projects. In this presentation, I will explain why I selected these practices, including the resources and materials I referenced when planning my own implementation. I will describe how I have customized practices to best suit my class context, how they have impacted student perceptions and outcomes, and how my approach has evolved over time.

Session C07: Culturally Responsive Teaching: Part 3

Location: Penn Quarter AB **Time:** 2–3 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Brianna Santangelo

C07-1: 2:00–2:12 p.m. Inclusive STEM Teaching Strategies in Rural Communities: Experiences in Tamazunchale and Puebla, Mexico

Carmen P. Suarez Rodriguez, Autonomous University of San Luis Potosi,

Patricia Mendoza Mendez, Vicente Espinosa Solis

This project, implemented in rural communities in Tamazunchale, San Luis Potosí, and Puebla, Mexico, engaged elementary students, families, and teachers in inclusive, culturally relevant STEM learning through hands-on workshops, mentorship programs, and community science fairs. Activities included crafting handmade soaps, textiles, and Mexican candies and geometric and astronomical explorations, among others. Recent efforts have focused on students with physical disabilities and neurodivergent children, adapting multisensory and collaborative approaches for 65 students aged 9–14 in formal and informal settings. Strategies included hands-on experiments with accessible materials, artistic integration, community-based learning, and university mentorships, fostering confidence, independence, and STEM engagement. Results showed increased motivation, problem-solving, and teamwork skills, alongside notable self-esteem improvements, as students gained confidence in learning and experimenting. Parents reported higher engagement, emphasizing STEM's transformative impact. This initiative highlights the importance of inclusive STEM environments, ensuring accessibility for all students. Plans include expanding technological integration and documenting student experiences in an interactive guidebook. STEM education is a robust academic, social, and emotional transformation tool fostering future innovators and problem-solvers.

C07-2: 2:12–2:24 p.m. Transforming Physics Teaching and Learning through Cultural-Based NGSS-Aligned PBL\

Ozlem Akcil Okan, Ph.D.,

Clausell Mathis, Lucky Nonyelum, Mathilda Smith

This study introduces a culturally grounded physics curriculum developed using the six-stage CESE (Crafting Engaging Science Environments) design framework—an NGSS-aligned, project-based learning (PBL) system (He et al., 2024). CESE integrates four design principles: Three-Dimensional Learning, Project-Based Learning, Student-Situated Engagement, and Learning Progressions and Coherence. A multi-state randomized controlled trial showed that CESE supports science learning and increases students' college ambitions. This work synthesizes CESE with principles from Culturally Relevant Teaching (CRT) and Culturally Responsive Pedagogy (CRP) to develop a physics curriculum emphasizing local relevance, student identity, and meaningful science engagement. Participants will explore the main stages of curriculum development and features of the exemplary units developed via the framework. These session supports educators in applying these frameworks to inform their curriculum design efforts, including how to draw on students' community knowledge and lived experiences to inform the selection of phenomena and project tasks.

C07-3: 2:24–2:24 p.m. Connecting Culture and Curriculum: Climate Change and Energy in Introductory Physics Classes

Larissa Jalloul Guimaraes, South Seattle College, Al

K. Snow, Hanan Mohamed, Abigail R. Daane

Although much has been explored regarding introductory physics students' everyday ideas about energy, it is often still taught in much the same way as it was 30 years ago (e.g., cannons, roller coasters, skateboarding). During this period, the climate crisis and society's energy consumption has become a culturally important topic, largely neglected in physics courses. Three instructors at a Pacific NW community college introduced activities designed to explicitly tie physics energy topics to climate change issues (Levy et al., 2023). We collected post-lesson student written reflections, stating their views of the connection between energy topics in physics and climate change, from these classes and another class that did not implement this lesson. We coded responses using a phenomenographic qualitative analysis and found that students who engaged with this lesson identified more climate-change connections. We make recommendations for a more robust, culturally-relevant integration of climate change into physics education.

Session C08: PER: Student Reasoning and Active Engagement: Part 1

Location: Constitution DE **Time:** 2–3 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Qing Ryan

C08-1: 2:00–2:12 p.m. Questioning Your Own Brilliance: How Shifts in Physics Ability Mindset Differ Across Students and Grades

Fargol Seifollahi, University of Pittsburgh,
Christian Schunn, Chandralekha Singh

Students' domain-specific ability mindsets play a significant role in shaping their experiences and persistence in STEM fields. Physics is often viewed as a domain requiring innate brilliance, which can reinforce fixed mindset views, particularly after early setbacks in introductory courses. Our study examines shifts in physics ability mindsets, as well as gender differences in these shifts in an introductory calculus-based physics course. Our findings indicated the presence of three mindset categories—Hesitant, Hopeful, and Confident—with gender differences in representation at the high and low ends. We found an overall decline in students' physics ability mindsets, with women being significantly more likely than men to shift away from the Confident category, especially those earning Bs or Cs (the most commonly awarded grades in this course). Our findings provide empirical evidence for the dynamic, grade-sensitive nature of students' mindsets in introductory physics courses and highlight the need for instructional strategies that mitigate shifts toward fixed mindsets, as well as targeted interventions to support students at higher risk of adopting a fixed mindset.

C08-2: 2:12–2:24 p.m. Investigating Development of Covariational Reasoning in Students enrolled in Transformed Calculus-based Physics Course

Kazi Aatish Imroz, The Ohio State University,
Geraldine Cochran

Improving Quantitative literacy, the skill of an individual to utilize mathematical instruments to make sense of physical quantities, has been identified as a major goal for students enrolled in introductory physics courses. Still, previous works suggest that traditional introductory courses rarely support the development of quantitative literacy skills. Recently, instructors involved in the Transforming Introductory Physics Sequence to Support all Students network are restructuring introductory physics courses to better support students' development of quantitative literacy skills. To assess the success of these efforts, we administered the Physics Inventory of Quantitative Literacy, developed by Dr. Suzanne White Brahmia and colleagues. This inventory evaluates students' quantitative literacy skills in physics contexts. In this presentation, we will share the results of our study conducted at three universities across the U.S. This work is supported in part by National Science Foundation Award# 2403512. The findings and opinions present are that of the authors and do not necessarily reflect the views of the National Science Foundation.

C08-3: 2:24–2:36 p.m. Can Students Solve for x: Introductory Physics Students' Approaches to Problem Solving

Abigail Creyts, Physics Bachelor's, Georgia Institute of Technology,
Steven W. Tarr, Emily Alicea-Munoz

Research has shown that novice physics students perform better in exams when the problems have numerical values as opposed to only symbols. For example, Torigoe and Gladding (2011) found that students in algebra-based introductory mechanics scored consistently lower on multiple-choice symbolic problems regardless of overall course grade. We investigate whether this pattern also holds for students solving free-response problems in a calculus-based intro physics course by randomly assigning students with numerical and symbolic versions of the same exam problems. Additionally, we use semi-structured interviews and survey instruments to probe the problem-solving approaches of instructors and students, respectively. In this talk, we present the preliminary results of our investigations.

C08-4: 2:36–2:48 p.m. Exploring Differences in Introductory Mechanics Courses Using Conceptual Growth Curves

Paul Miller, PhD, West Virginia University,
Elaine Christman, John Stewart

Conceptual Growth Curves allow us to visualize how effectively courses serve the full range of students and use natural variation in student preparation to make meaningful comparisons between classes, instructors, or instructional models. In this study, Conceptual Growth Curves were used to examine student outcomes on the Force Concept Inventory from introductory algebra-based and calculus-based mechanics courses at a variety of two-year and four-year colleges and universities. This work explores variation in these curves within and across types of institutions and compares the range of outcomes among students with similar incoming conceptual knowledge at different institutions.

Session C09: Teaching the Introductory Physics for the Life Sciences (IPLS) Course: Part 1

Location: Lafayette Park **Time:** 2–3 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Juan Burciaga, PhD

C09-1: 2–2:24 p.m. Using Nuclear Magnetic Resonance Applications to Resonate with Life Science Students

INVITED – Merideth Frey, PhD, Sarah Lawrence College,
Colin Abernethy, David Gosser

Nuclear magnetic resonance (NMR) is a quantum technology that is a crucial analytic and diagnostic tool in scientific and biomedical fields and promises to play an important role in the 21st-century STEM workforce. The recent development of inexpensive benchtop NMR spectrometers offers unique opportunities for undergraduate institutions to give their students valuable research skills with this essential technique. Furthermore, focusing on the applications of NMR (e.g., NMR spectroscopy and MRI) can provide much-needed real-world relevance to students' physics studies. Students studying the life sciences often feel a disconnect to the physics they learn in the standard introductory physics classroom. We hypothesize that incorporating class sessions dedicated to NMR applications in standard introductory physics courses can provide valuable research skills and real-world relevance to all students but may have the largest impact on those studying the life sciences. Through the support of an NSF-IUSE grant, we have established an interdisciplinary and cross-institutional team to develop, assess, and disseminate curricular material that integrates NMR throughout all levels of the undergraduate science curriculum. These materials consist of interactive modules with associated

instructional guides and online resources that introduce the topics without expectations of prior college-level science or math courses. Our research shows that students using our modules not only successfully master the NMR content, they also: (1) spend over four times as much time sense-making using our modules as in a traditional lecture course, (2) demonstrate positive scientific identity shifts, and (3) make statistically significant gains in learning attitudes about science and self-assessed research skills. Future studies will explore how these positive impacts differ across different populations of students and how these materials can best be implemented at other institutions.

C09-2: 2:24–2:48 p.m. Model Building for Life Sciences in the Two-Semester Introductory Physics Course

Invited – Mark Reeves, George Washington University

Building mathematical models for living systems has enabled novel insights into our understanding of biology. This is one of the major shifts of modern science, yet for most biology undergraduates, there is little opportunity in the standard curriculum to develop the skills for model building. We have adapted the year-long calculus-based course to address this gap by teaching fundamental, mostly two-body interaction models of the traditional physics curriculum to students, while extending the usual problems solved in the University Physics course to apply to biological systems. Much attention has been paid to biological relevance and to defining how much biology a successful instructor should know, but we have found that the most important aspect of student success (defined by confidence to use physics to build models for living systems) is to carefully scaffold problems to allow the physics being taught to meet the biology. As mentioned, biological relevance is essential for making this real, but an encyclopedic knowledge of biology is not important here. Where we have found success is to stick to a modest selection of biological ideas, that can be revisited and layered upwards with additional physical concepts rather than increasingly diverse of sophisticated biological ideas. I will outine the comfortable-and-familiar-to-us core of physical concepts that we have used to build models. And I will present a few examples of macroscopic and microscopic biological systems that recur throughout the year-long course, and will discuss some of the important mathematical tripping points faced by our beginning students. I will also discuss briefly how we have developed resources and made them available to the colleagues for use in their courses.

Session C10: What We Have Learned from JWST: Part 1

Location: Farragut Square **Time:** 2–3 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Thomas Herring

C10-1: 2–2:24 p.m. What We Have Learned from JWST

Invited– William Dittrich, MS Physics Univ of Colorado, MS Aero Eng U of W, Portland Community College

A classroom tool has been created which is a twenty minute recorded Powerpoint which is designed to excite and attract your students into learning of the discoveries produced by the James Webb Space Telescope. There is an accompanying Reference List for each discovery slide so that after presenting this Powerpoint to your students, they can pursue further research and study on any of the discoveries. The goal is to attract students into the field of physics and astronomy by exciting them with the amazing new discoveries that the JWST has brought to us. The following three very accomplished speakers in this session are referenced in the Powerpoint for their pioneering research in astrophysics using data from the JWST.

C10-2: 2:24–2:48 p.m. What JWST Reveals about the Hubble Tension

Invited – Adam Riess, Johns Hopkins Krieger School of Arts and Sciences

Discussion

Session C11: Life After PAEMST: Opportunities and Doors

Location: Salon E **Time:** 2–3 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Marianna Ruggerio

This session will explore the exciting pathways and opportunities available to Presidential Awards for Excellence in Mathematics and Science Teaching (PAEMST) recipients. Hear from past awardees about their experiences after receiving this prestigious honor, including professional growth, leadership roles, and the impact of their awards on their careers. Discover how PAEMST can open doors to new collaborations, research opportunities, and lasting contributions to the field of education.

PANELISTS: Rebecca Vieyra, Marianna Ruggerio

Session C12: Reaching Every Student: Strategies for Success in an Evolving Academic Landscape

Location: Salon A/B **Time:** 2–3 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Kris Lui

The current political climate has made the work of supporting all students even more challenging. In this panel, three participants in The Organization for Physics at Two-Year Colleges (OPTYCs) program 'Creating Environments that Reach Every Student' (CERES) share their insights on doing this work while living in States with limiting legislation.

PANELISTS: Erik Christensen, Jennifer Parsons, Tamara Young

Session C13: Physics with Phones

Location: Salon C/D **Time:** 2–3 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Dan Burns

LLNL scientist Dave Rakestraw has developed an extensive and detailed curriculum centered on the use of smart phones and low-cost materials. Dan Burns has teamed with Dave to conduct Physics with Phones workshops for teachers (both in-person and online). This session will introduce participants to the Physics with Phones curriculum using several hands-on lab activities. The activities will focus on measuring acceleration using the phone's 3-axis accelerometer. Experiments will include the investigation of gravity, biomechanical movement, and seismic activity. The activities are appropriate for high school and introductory college physics classes. Materials will be provided and there will be phones to borrow. The Physics with Phones curriculum can be accessed at this website: https://st.llnl.gov/sci-ed/Physics-with-Phones.

Session D01: Reframing How We Teach Physics for Engagement: Activites

Location: Declaration A **Time:** 3–4 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Vitalina Bialiauskaya

D01-1: 3:00–3:24 p.m. Head in the Game: Using Sports-Related Concussions to Drive Student Engagement

INVITED – Dylan Fedell, Palisades High School

How can we improve student engagement in physics? Physics concepts become more engaging and meaningful when students connect them to real-world issues impacting their lives and communities. One such issue—sports-related concussions—provides a compelling socioscientific context for exploring physics principles such as force, impulse, and momentum. In this session, we will examine how integrating the issue of student concussions into the physics curriculum provides a coherent and relevant learning context for students while fostering deeper engagement, scientific inquiry, and critical thinking. Participants will be guided through the entire unit, exploring hands-on activities, data-driven investigations, and discussions that challenge students to analyze real-world data, consider protective technologies, and evaluate the societal implications of sports-related brain injuries on student-athletes. By reframing physics instruction around socioscientific issues (SSI) like concussions, physics teachers can create dynamic, student-centered learning experiences that promote engagement, conceptual understanding, and social awareness. This material is based upon work supported by the National Science Foundation under Grant No. 2101395. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

D01-2: 3:24–3:36 p.m. That's the Way the Cookie Crumbles: High School Students Engineer Earthquake Proof Gingerbread Houses

Patrick Englehardt, BScH Environmental Geoscience, The Winchendon School

Can a gingerbread house survive an earthquake? This sweet lab challenged students to design and test structures that could withstand the shake of a DIY earthquake simulator. Along the way, students explored stress, strain and fracture points, discovering how ingredient choices like flour, sugar, and molasses influence material strength. Students made predictions about engineering stresses, tested their designs, and shared findings through engaging poster presentations. From testing recipes to witnessing shake-table failures, students were glued to their seats, proving that food and Physics make an irresistible combination. Join this talk for tips on blending waves, forces, and creative experimental design into your classroom – no baking required.

D01-3: 3:36–3:48 p.m. More "There Are Two Types" Activities as Examples of NGSS Based Practices

Richard Slesinski, Syosset High School

Inspired by Professor Richard Gelderman's interactive classification activity at the 2025 AAPT Winter Meeting, this workshop will engage participants in a hands-on approach to exploring NGSS-based science practices. Gelderman's original activity challenged participants to classify vials of liquid based on an unknown rule and then determine the classification criteria of another group. In this workshop, we will adapt this engaging strategy using laminated diagrams of physics phenomena. Participants will collaboratively classify diagrams of either electric circuits, waves, or moving cars into two distinct categories based on observable patterns. After initial classification, groups will rotate and attempt to deduce the classification rule established by another group, fostering scientific argumentation and pattern recognition. This activity encourages deeper conceptual understanding, models the NGSS Science and Engineering Practices, and provides a low-barrier, high-engagement strategy for physics classrooms. Teachers will leave with ready-to-use materials and insights on implementing this activity to promote inquiry-based learning. My students have found this approach just as engaging as the original liquid vials activity, and I am excited to share its impact with fellow educators.

Session D02: Quantum Labs

Location: Declaration B **Time:** 3–4 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Heather J. Lewandowski

D02-1: 3–3:24 p.m. From Quantum Labs to Quantum Computing

Invited –Catherine Herne, SUNY At New Paltz

With a conceptual shift, quantum labs become an introduction to quantum computing. A single photon is the implementation of a qubit, which carries information such as polarization or path as a superposition of states. In this talk I will describe the instructional elements, highlighting quantum labs, that we have used to introduce STEM majors to quantum computing. We use the Deutsch-Jozsa algorithm, which involves a black-box "oracle" to find the output of an unknown function, as a simple model of quantum computing. While classically this can only be determined with a very large number of executions of the function, the algorithm utilizes superposition and interference to make this determination with only one measurement. Its implementation involves a small modification to a single-photon interference experiment where half-wave plates in the arms of a Mach-Zehnder interferometer serve as the "oracle." When our students come to this material without prior knowledge of quantum mechanics, the emphasis needs to be instead on the essential elements of quantum computing, such as quantum phenomena including superposition and entanglement, mathematical skills, quantum gates, and optics. The student learning outcomes of our instruction are to develop skills used in quantum professions while building hands-on optics experience. In addition to describing the components of instruction I will share qualitative student outcomes of two five-week summer sessions.

D02-2: 3:24–3:36 p.m. A Look at Interdisciplinary Collaboration in a Quantum Lab Class

Matthew Bravo, University of Maryland, College Park,

Erin Sohr

Right now, Quantum Information Science and Engineering programs are popping up across the country. At the University of Maryland, this includes a quantum science and engineering minor with a hardware lab, open to all majors. Each student brings aspects of their respective discipline for the others to learn from, such as physics students' knowledge of quantum physics and engineering students' knowledge of design constraints. This creates an interdisciplinary, collaborative learning environment similar to the professional environments of quantum labs in industry and academia. In practice, these students can enact different framings on how to approach the lab, which can be mutually enriching or potentially disruptive to their learning. To better understand how to facilitate interdisciplinary groups working on quantum lab activities, we invited undergraduates to participate in video-recorded lab testing sessions, from which we will show cases of students working together productively and cases where their approaches are in tension. This work informs theory and practice, helping the field understand potential connections between disciplinary background and framing, and the implications for group facilitation.

D02-3: 3:36–3:48 p.m. Calibration of Quantum Computing Software

Patrick Hall, University of District of Columbia-Community College, Washington, DC 20017
Eyob Bulti, Anil Pyakuryal, PhD

Quantum computation is an integral component of Quantum Information Science and Technology (QIST). Now a days, experimental quantum computational resources such as IBM Quantum processors, have limited accessibility to support real-time educational activities in Quantum due to its overwhelming applications around the globe. Therefore various types of quantum computational simulators are generally being used as an alternative in order to address such problems. However such tools need to be well calibrated using standard techniques, prior to its applications in QIST and other corresponding activities in Quantum. We have employed simple statistical methods to determine the reliability, reproducibility, efficiency, and precision of various types of quantum computational tools.

D02-4: 3:48–4:00 p.m. Analyzing Graduate Student Views on the Challenges of Self-guided Leadership and Team Structure in a Laboratory Setting

Aaron Price, Undergraduate in Physics, University of Colorado - Boulder, Kristin Oliver, Victoria Borish, Carrie Weidner, Bethany R. Wilcox, Heather J. Lewandowski

The Quantum Engineering Centre for Doctoral Training (QE-CDT) at the University of Bristol prepares PhD students to enter a dynamic quantum workforce. The QE-CDT familiarizes first-year students with quantum engineering through a series of theory and team-based lab courses; a large focus of the labs being teamwork. We analyzed student views of leadership and team structure with a codebook based on the Adaptive Instrument for Regulation of Emotions survey to understand how programs like the QE-CDT can better train PhD students for future research and careers. We found that developing leadership and team organization skills were primary goals for students, but that they were often concerned that there would not be enough opportunities to attain these goals. Furthermore, the lack of designated leadership roles and team structure led to specific challenges that students had to overcome. This work can provide guidance to institutions and instructors in developing more effective teamwork structures in graduate lab courses.

Session D03: Supporting Transfer Students and Other Lessons Learned from TYCs

Location: Franklin/McPherson **Time:** 3–4 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Elizabeth Schoene

D03-1: 3–3:12 p.m. Aligning Transfer Sense of Belonging with Transfer Student Experiences

Frank Dachille, Michigan State University, Vicky Phun, Vashti Sawtelle

Students who begin their higher education trajectories at community college (or TYC) have complex and unique pathways (Dachille & Quan, 2024). Researchers in higher education often use sense of belonging as a metric for understanding the success of students on their journeys (Goplan & Brady, 2020). In this presentation, I will discuss the need to move to a construct that invites transfer students to be part of changing the culture of higher education to be welcoming of transfer students. To this end, I introduce the construct of Transfer Sense of Belonging (TSB), which empowers transfer students to meaningfully engage with change processes while putting the responsibility on the broader system to change to meet the needs of transfer students. I am studying TSB in the context of the newly formed Transfer Experience Mentoring Program (TEMPO). TEMPO is designed to provide opportunities for transfer students to develop TSB. I will be using a series of case studies with TEMPO mentors, explored with a transfer grid, to align the construct of TSB with the experiences of these TEMPO mentors.This work was also generously supported by the IMPACT STEM Transfer Network and Michigan State University.

D03-2: 3:12–3:24 p.m. The Transfer Advocacy Group Experience and the Future of Transfers

Mariana Rojas-Montoya, San Jose State University,
Annie Chase, Vashti Sawtelle, Camila Monsalve Avendaño, Missy D. Cosby, Angela Little, Fatima Abdurrahman, Gina Quan

Community colleges have long served as a starting point for many students of color who later go on to transfer into bachelor's granting institutions. Despite the success of reaching such a milestone, transfer students still face obstacles at their new institution such as: not knowing about inherent order to upper division courses based on discipline; delayed graduation timelines, and feeling alone at their institution. Transfer Advocacy Groups (TAG) are groups of faculty, staff, and students that work together through facilitated meetings to create institutional change to support transfer students of color at two bachelor's granting institutions: San Jose State University (SJSU) and Michigan State University. This presentation will share experiences as a participant on a TAG within the physics and astronomy department at SJSU. These experiences include what it feels like to collaborate with faculty, be asked opinions about the department, and have student ideas be valued. I'll also give an update on the current TAG's goals and where it's at with respect to achieving them. By sharing about my TAG experience, I hope to inspire more institutions to show care for their own transfer students by providing support and agency for students to create change.

D03-3: 3:24–3:36 p.m. A Wonder: A Student and Faculty/Staff Talk about an Idea to Address Systemic Discrimination Experienced by Transfer Students of Color

Camila Monsalve, Michigan State University,

Vashti Sawtelle

Research shows that the path towards a bachelor's degree for transfer students of color in Science, Technology, Engineering and Math (TSOC-STEM) has barriers which may be mediated by individuals at the receiving institution. In this presentation I will share a snippet about trust between students and faculty/staff to support changes within a bachelor-degree granting institution (BDGI). The Transfer Advocacy Group (TAG) is a project to facilitate discussion with TSOC-STEM and faculty/staff members to address the effects of institutional discrimination by the BDGI. The faculty/staff are institutional advocates who support transfer students of color to obtain a bachelors in STEM while being aware of the students' needs and the demands of the institutions. In the snippet, Pablo (a TSOC-STEM; pseudonym) asks an institutional advocate to further unpack his idea to address the barriers at their institution. We extend the work of Aguilar-Valdez et al. (2013) on the stages of the path of conocimiento from a K-12 STEM teacher towards the BDGI institutional advocate.

D03-4: 3:36–3:48 p.m. Measuring Impact: Outcomes of the TYC Leadership Institute for Physics Faculty

Brooke Haag, Pathstream

The TYC Leadership Institute, a collaboration between the Organization for Physics at Two-Year Colleges and AAPT, has produced important outcomes for two-year college physics faculty. Our program pairs participants with experienced TYC mentors for structured leadership development. Participants have implemented targeted action plans addressing institutional challenges. These efforts have led to successful outcomes including data-driven curriculum reforms, learning environments that measurably increased student success rates, and strategic partnerships across departments that enhanced STEM initiatives campus-wide. Fellows report improvements in communication competencies, work-life management strategies, and leadership confidence. This presentation will examine data demonstrating the program's impact on professional advancement and institutional effectiveness. We will also discuss implications for future program iterations. OPTYCs is sponsored by AAPT and funded by NSF grant #2212807.

Session D04: PICUP: Ideas for Integrating Computation into Introductory Physics Courses and Labs

Location: Wilson/Roosevelt **Time:** 3–4 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Steve Spicklemire

D04-1: 3–3:12 p.m. The New PICUP Project — Come to DICE and SLICE with Us!

Larry Engelhardt, Francis Marion University

Come hear about new opportunities for you to get involved in PICUP: (1) The Distributed Institutes for Computational Education in Physics (DICE) are a new series of workshops coming to a city near you. (2) The Summer Leadership Institute for Computational Education in Physics (SLICE) is a week-long summer workshop. This project is funded in part by the National Science Foundation under DUE IUSE grants 2337049, 2337050, 2337051, 2337052, 2337053, 2337054, 2337055, 2337056.

D04-2: 3:12–3:24 p.m. Introducing Computations in Advanced Physics 1

Richard Calvin, MS Nuclear Engineering, United States Military Academy, Kevin Filip

All United States Military Academy graduates are required to complete an introductory mechanics course. Yearly, about 200 cadets are placed in an advanced course intended for students pursuing STEM degrees. To better prepare students for follow on courses, computational assignments using Python were recently introduced. These assignments were designed to promote critical thinking, scientific reasoning, and enhance problem solving skills in time-dependent problems where computational skills are vital. Assignments were presented as structured JupyterLab notebooks with intentionally omitted lines of code for the students to fill. Chosen omitted lines focused students' attention on physics equations, basic commands, and plotting rather than complex coding and loops. Codes were designed to be self-correcting by printing correct intermediate values and plots. Each assignment concluded with a set of questions concerning physics assumptions and coding fundamentals. Coding based learning objectives were to avoid hard-coding, choosing appropriate timesteps, introducing numerical methods, and plotting while reinforcing the physics learning objectives of the course. We intend to present our techniques and lessons learned from introducing these computational coding assignments in our advanced introductory mechanics course.

D04-3: 3:24–3:36 p.m. Computational Notebooks for Instructional Physics Laboratory: Practical Insights

Amir Bralin, Purdue University,

Ravishankar Chatta Subramaniam, N. Sanjay Rebello

Laboratory is a standard part of future scientists' and engineers' curriculum. The curriculum of today demands that instruction in physics be equipped with computational activities. In a large-enrollment, calculus-based, one-semester, introductory mechanics course, we designed a relatively novel laboratory curriculum that integrates computation with experiment. This was accomplished by implementing a web-based, interactive computing software Jupyter Notebook. Labs written in the Jupyter Notebook format seamlessly integrate text and code. The traditional, text-based part of the labs provides lab instructions, content information, and even special formatting for symbols and expressions (LaTeX). The computational part of the labs is contained in code "cells" where students work with simple programs (in Python) for analyzing and visualizing experimental data. The entire notebook document consists of a sequence of text cells and code cells, exhibiting well-ordered structure as a whole. In this presentation, we will share the benefits, challenges, and drawbacks presented by this curriculum.

D04-4: 3:36–3:48 p.m. Making Accessible WebVPython Simulations

Steve Spicklemire, University of Indianapolis

WebVPython makes creating interactive online simulations relatively easy, but until recently it was difficult to make them in a way that complies with online accessibility requirements. In this talk you'll learn a variety of techniques to add accessibility features to WebVPython simulations based on the latest version of the WebVPython libraries.

Session D05: Innovations in Quantum Curriculum: Part 3

Location: Cabin John/Arlington **Time:** 3–4 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Martin Kamela

D05-1: 3–3:12 p.m. Analysis of Quantum-related Textbooks for Concepts Related to Quantum Technology

Namitha Pradeep, Rochester Institute of Technology,

Ben Zwickl, Gregory Howland

A focus on quantum technology (QT) in education is crucial to building a diverse, skilled quantum workforce. Superposition and entanglement are the foundational quantum mechanical phenomena that undergird QT and their potential advantages. In this work, we examine how the current quantum-related curriculum addresses these topics. We identified six of the most commonly used textbooks in modern physics (MP), quantum mechanics (QM), and quantum computing (QC), and in each book, identified the relevant excerpts where these concepts appear, as well as the contexts in which they are presented. Using an analytic rubric, we then scored the mathematical depth, conceptual depth, and the distribution of these discussions. Discussions of superposition and entanglement were highly varied between texts. Superposition has in-depth discussion in both QC books and in a spin-first QM book. Within wavefunction-first texts for QM and MP, superposition is largely absent, and the closest related concept is interference in the context of wave-particle duality. Entanglement has extended coverage in QC texts, brief coverage in QM texts, and is absent in MP texts. Our work shows that the choice of spin-first vs wavefunction-first texts is not merely about representations or about whether to start with discrete vs continuous systems, but has larger implications around key concepts for QT. Such choices may impact students' preparation for future learning in quantum computing and other QT.

D05-2: 3:12–3:24 p.m. Mapping Quantum Physics Conceptual Understanding of Experts, Teachers, and Students

Bogumila Gierus, University of Calgary

This study investigates how conceptual understanding of quantum physics varies across experts, high school teachers, and high school students, employing conceptual metaphor theory as an analytical framework. This theory suggests that abstract concepts are comprehended by mapping them onto familiar, concrete notions. Interviews and focus groups were conducted with each group to elicit their explanations of key quantum physics concepts, and transcripts were analyzed to identify recurring metaphorical mappings. Experts demonstrated complex and interconnected metaphorical structures, reflecting a deep, nuanced understanding. They possessed a wide repertoire of metaphors and exhibited a high degree of integration between them, often using multiple concrete metaphors to explain a single abstract concept. In contrast, students displayed fragmented and less developed metaphorical mappings. They had access to fewer conceptual metaphors, which were often isolated and lacked interconnectivity, indicating a less nuanced and integrated understanding. These findings reveal how expertise influences the development of metaphorical understanding in quantum physics and that conceptual understanding is not based on simple, one-to-one mappings, but rather on a complex, blended network of conceptual metaphors. Teachers can utilize these insights to develop more effective pedagogical approaches that foster a deeper conceptual understanding of abstract concepts.

D05-3: 3:24–3:36 p.m. Quantum Measurement: Teaching Two-State Systems with PhET Interactive Simulations

Rebecca Vieyra, PhET Interactive Simulations, University of Colorado Boulder,

Ariel Paul, Amy Rouinfar, Martin Veillette, John Blanco, Agustín Vallejo, Katherine Perkins

Take a tour of PhET's newly-released Quantum Measurement and Quantum Coin Toss simulations, appropriate for high school and introductory college students. This simulation supports students' conceptual understanding of quantum states, superposition, and measurement. The simulation introduces the idea of superposition of states and quantum thinking with a novel comparison of a classical coin with a biased probability and a "quantum" coin. The simulation then scaffolds and deepens student understanding of measurement in the context of two-state systems. It progresses to an exploration of the polarization states of photons with a beam splitter, and how spin-½ particles interact with the Stern-Gerlach experiment. Students can also explore a spin-½ state using a Bloch sphere representation to show spin-½ basis transformations. When a magnetic field is applied the students can visualize the precession of the quantum state on the Bloch Sphere as well as force a collapse of the spin -½ state by performing quantum measurements.

D05-4: 3:36–3:48 p.m. Quantum Education Resources: From K-16 to the Future

Nancy Holincheck, George Mason Univ, Jessica L. Rosenberg, Benjamin Dreyfus, Jennifer Simons, Laura M. Akesson

This presentation shares innovative quantum education resources designed to engage students from elementary school through high school and beyond. Our team will discuss our process for developing elementary, middle, and high school curricular materials. We will also share details of a high school course focused on practical applications of quantum technology and an undergraduate course exploring quantum concepts and applications. The resources presented include individual lesson plans and hands-on activities that align with existing benchmarks in science and engineering practice. Additionally, we will highlight the importance of incorporating real-world examples and case studies to make quantum information science more accessible and relevant to students. This presentation aims to inspire educators to integrate quantum information science into their classrooms in order to prepare students for a future where quantum technology is increasingly prevalent.

Session D06: Building a Classroom Culture: Part 2

Location: Bulfinch/Renwick **Time:** 3–4 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Joseph Kozminski

D06-1: 3–3:12 p.m. Understanding the Theoretical Framing and Measurement of Communal Classroom Culture: Fostering Supportive Physics Classroom Communities

Chelsea Mateu, Zahra Hazari, Hulya Avci, Doctorate/PhD,
Pooneh Sabouri, Idaykis Rodriguez

There is much to understand beyond the impact of active learning environments with respect to how the culture of these classrooms effectively support social interaction. Communal Classroom Culture (CCC) theory presents two core features as necessary components for creating a supportive learning community within the classroom: Social Learning and Critical Caring . Though prior research has shown that physics classes exhibiting the features of CCC benefit students both affectively and cognitively, there is currently no tool for educators or researchers to assess/measure whether CCC is being fostered in classrooms. This talk will introduce a valid and reliable tool that includes two main categories for fostering CCC, configuration of the classroom norms and functioning of the classroom as a community. Along with presenting this tool and the constructs within the framework, this study will discuss the importance of measuring CCC due to the disparity between student and teachers' perceptions.

D06-2: 3:12–3:24 p.m. Interactive Online Interventions for Improving Belonging and Performance in Introductory Physics

Alexandru Maries, University of Cincinnati - Main Campus,

Kathleen Koenig, PhD, Robert Teese, Patrick Boyle, Lauren Bell

Socio-psychological interventions, particularly those focused on social belonging, have been shown to bolster the impact of evidence-based instructional strategies to improve student learning in STEM courses. However, these interventions have primarily been delivered face-to-face, and there is little research on the impact of delivering them online. We have been developing web-based Interactive Online Interventions (IOIs) based on prior research on socio-psychological interventions with the goal of improving students' sense of belonging and success in introductory physics. The IOIs make use of a narrator (a real person) and are designed to be interactive to mimic how the interventions might be delivered in person. They are also designed to be implemented at key points during a semester: in the first week to address student concerns about taking a physics course, the second week to normalize struggle and expose students to perspectives from graduating seniors, after the first exam to reinforce effective study strategies, and at the end of the course to help students reflect on their learning strategies and performance. This talk will focus on describing the interventions in detail, with a separate talk focusing on results.

D06-3: 3:24–3:36 p.m. Investigating the Effectiveness of Interactive Online Interventions to Promote Belonging

Kathleen Koenig, PhD, University of Cincinnati - Main Campus,

Alexandru Maries, Robert Teese, Patrick Boyle, Lauren Bell

Belonging interventions have been shown to improve student success and engagement in STEM courses, but their effectiveness when delivered as web-based interventions is not well studied. This presentation shares results of a study which compared student responses to structured belonging interventions delivered face-to-face and online. Free-response data reveal that students' written reflections in the online format are just as robust as those from the in-person intervention. Log data indicate engagement with the online module, with students providing thoughtful written responses, selecting multiple optional learning opportunities, and fully completing each module. Pre- and post-intervention survey results that measure belonging across both groups will also be shared. Our findings suggest that well-designed online interventions can be as effective as the more common in-person formats in fostering student belonging. Our results have implications for scalable, accessible interventions that support student success in physics.

D06-4: 3:36–3:48 p.m. Creating Fearless Physics Thinkers: How Peer Feedback Transforms Classroom Culture

Adam Love

Are your students afraid to take risks in physics discussions? Do they see mistakes as failures rather than stepping stones? Over six years of classroom experimentation, I've developed specific, actionable techniques that transform physics students from passive observers into active participants who eagerly debate concepts with peers. This presentation provides a step-by-step implementation guide for the interventions that most effectively transformed my classroom's culture—moving from teacher-centered instruction to student-led exploration where learners eagerly challenge each other's thinking. You'll receive concrete strategies and supporting materials to build a classroom environment where students feel safe enough to take intellectual risks—a crucial foundation for authentic physics sensemaking. Change the culture of your classroom with approaches that make physics personal, collaborative, and genuinely engaging for every student.

Session D07: Teacher Share-a-thon

Location: Penn Quarter AB **Time:** 3–4 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Meghan DiBacco

In this session targeting teachers, participants will each have a few minutes to share a favorite demo, lab, activity, resource, tool, or anything else that enhances their classroom and their teaching! This session will not have scheduled speakers and instead will be an opportunity for everyone who comes to have a chance to share.

Session D08: PER: Student Reasoning and Active Engagement: Part 2

Location: Constitution DE **Time:** 3–4 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** DJ Wagner

D08-1: 3–3:12 p.m. Supporting Student Success: Evaluating the Impact of Open-Access Learning Resources in Introductory Mechanics

James K. Hirons, Texas A&M University,
Tatiana L. Erukhimova, Jonathan Perry, Dawson T. Nodurft, Scott Crawford, William H. Bassichis

Success in introductory physics courses is crucial for persistence in STEM majors, as these courses provide the foundational knowledge necessary for advanced study. To support student learning, faculty at many universities have developed open-access, self-study materials aimed at enhancing conceptual understanding and problem-solving skills. In this work, we evaluate the impact of self-study materials on student success in an introductory, calculus-based mechanics course at a large, public, research-intensive university. The materials that were assessed include video resources targeting both conceptual understanding and the development of problem-solving skills, as well as prior years' exams. To gauge the impact of these resources, we collected data including course-level, university-level, and student engagement with open-access self-study materials from three spring semesters (2022–2024). Regression analysis will be presented to show how usage of supplemental materials and prior preparation impact students' success in the course. Additionally, student perceptions of these materials, gathered via anonymous surveys, will be discussed.

D08-2: 3:12–3:24 p.m. Examining Student Engagement in Science Practices in Introductory Physics Laboratory Courses

Kaitlyn Bolland, Western Washington University,
Tra Hyunh, Lina Dahlberg, Norda Stephenson, Jess Weaver, Kanaili Singkeo, Lukas Spring, Elayna Worline

Our work explores student engagement in science practices across introductory chemistry, biology, and physics laboratory courses, with an emphasis on the well-defined practices in the Framework for K-12 Science Education and the Next Generation Science Standards (NGSS). Specifically, we use the Three-Dimensional Learning Assessment Protocol (3D-LAP) to look for evidence of science practices in laboratory materials across the three disciplines. In this presentation, we will share our characterization of science practices in introductory physics labs based on our examination of laboratory manuals and video observation data, and discuss how science practices are situated in the physics laboratory curricula and expressed in the physics laboratory classroom. Our data analysis indicates that Developing and Using Models, Analyzing and Interpreting Data, and Using Mathematics and Computational Thinking are among the most highly represented practices in the physics curricula. We discuss the implications of our findings for the design and development of physics curricula, as well as the teaching and learning of physics.

D08-3: 3:24–3:36 p.m. Relative Benefits of Different Active Learning Methods to Physics Student Learning

Meagan Sundstrom, Drexel University,
Justin Gambrell, Colin Green, Adrienne Traxler, Eric Brewe

Extensive research has demonstrated that active learning methods are more effective than traditional lecturing at improving student understanding and reducing failure rates in undergraduate physics courses. Researchers have developed several distinct active learning methods that are now widely implemented in introductory physics, however the relative benefits of these methods remain unknown. Here we present the first multi-institutional comparison of the impacts of four well-established active learning methods (ISLE, Peer Instruction, Tutorials, and SCALE-UP) on physics student learning. We also investigate the types of activities that take place during instruction to explain differences in these impacts. Data include student concept inventory scores and 114 h of classroom video recordings from 31 introductory physics and astronomy courses at 28 different institutions in the United States containing a total of 2,855 students. We find measurable increases in student learning in all four active learning methods, and significantly larger learning gains in SCALE-UP than in both ISLE and Peer Instruction. Student learning gains in Tutorials are not significantly different from those in the other three methods. We also observe differences in classroom activities: ISLE and Peer Instruction courses are dominated by lecturing, while Tutorials and SCALE-UP courses dedicate most in-class time to student-centered activities such as worksheets and laboratory work.

D08-4: 3:36–3:48 p.m. Multi-institutional Assessment of Peer Instruction implementation and Impacts Using the FILL+ Framework

Ibukunoluwa Bukola, Drexel University,

Meagan Sundstrom, Justin Gambrell, Olive Ross, Adrienne Traxler, Eric Brewe

As research shifts away from asserting that active learning methods yield better results for student learning than traditional lecturing, it is essential to characterize and evaluate different instructors' implementations of active learning methods. Peer Instruction (PI) is one of the most commonly used active learning methods in undergraduate physics instruction. PI typically involves the use of classroom response systems (e.g. clickers), conceptual questions, individual student thinking, and group discussions. Since its introduction as an instructional strategy in 1997, research has identified that different instructors vary in the ways they implement Peer Instruction. These studies, typically, only take place at a single institution and do not link implementation of PI to student learning. In this study, we analyze variation in the implementation and impacts of PI using video and conceptual inventory data from 9 introductory physics instructors across different US institutions. We characterize implementation using the FILL+ framework, which classifies the interactions that occur in a PI classroom as interactive, vicarious interactive, or non-interactive. We investigate the type and duration of these interactions across the different classes and directly compare them with student learning gains measured from conceptual inventories.

D08-5: 3:48–4 p.m. Modeling the Jumping Ring: A Challenge in Electromagnetic Induction for Early-Career Students

Dawson T. Nodurft, Texas A&M Univ

A project developed for a fall 2024 Electricity and Magnetism course, challenged students to model Thomson's Jumping Ring demonstration. The goal was to encourage critical thinking by having students navigate complex physics concepts like electromagnetic induction and alternating current. The project emphasized holistic development, teaching students to approach difficult problems, collaborate, and communicate their findings, fostering skills crucial for future research and innovation.

Session D09: Teaching the Introductory Physics for the Life Sciences (IPLS) Course: Part II (Poster Session)

Location: Lafayette Park **Time:** 3–4 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** TBA

D09-1: 3–4 p.m. Student Spirometer Data Combined with Referenced Data in Different Life and Physics Contexts

POSTER – Nancy Beverly, Mercy University

In Mercy University's IPLS course, students take spirometer data and then use it in different life scenarios with a progression of different physics fluid topics (flow rate, continuity, fluid resistance, and Poiseuille) that also use referenced data to give the scenario enhanced meaning. The examples shared can be found in the Community library of the Living Physics Portal https://www.livingphysicsportal.org/

D09-2: 3–4 p.m. Enhancing Physics Education Through Interactive Biomedical Imaging Simulations

POSTER– Ralf Widenhorn, Portland State University, Cassandra Croft, Bethe Scalettar

As part of an effort to engage students who typically do not take any physics beyond the introductory level, we developed innovative interdisciplinary courses that connect biomedical imaging with fundamental physics principles. This presentation outlines our ongoing project to enhance this curriculum through interactive simulations of medical imaging modalities. We are developing four comprehensive modules covering ultrasound imaging, radiography, nuclear imaging, and magnetic resonance imaging. These simulations and their associated learning activities will be freely available through open education platforms such as the Living Physics Portal. Our presentation will showcase examples from three completed modules: ultrasound imaging, radiography, and nuclear imaging. The simulations are designed with flexibility in mind—appropriate for both upper-level interdisciplinary physics courses and introductory physics courses for life science students. We have started collecting student feedback on how these modules affect student engagement and will present early results. This project represents a step in making physics education more relevant by connecting theoretical concepts to practical applications in healthcare and biomedical sciences. This work is supported by the grant IUSE grants DUE-2315741 and DUE-2315742 from the National Science Foundation.

D09-3: 3–4 p.m. Physics for Life Sciences

POSTER–Peter Nelson, Ph.D., Fisk University

Life-science majors usually only take physics because it's required. They've probably heard that physics is hard, and don't see why it's relevant to things that they really care about – like biology, medicine, and how life works. The traditional physics approach of starting with kinematics and building up to Newton's laws of motion only reinforces those negative preconceptions of physics. In this poster, a new introductory approach is presented. Instead of kinematics, we start by playing the "Marble Game" – it's a simulation model of diffusion invented to introduce students to quantitative modeling using active-learning. Students already know that diffusion is central to the behavior of molecules in biology and the Marble Game leads them to discover that Fick's law of diffusion is a consequence of random Brownian motion that can be modeled by discrete jumps. Finite difference methods are then developed to predict and understand the Marble Game's ensemble-average behavior. Students then apply similar techniques to drug elimination, radioactive decay, osmosis, ligand binding, enzyme kinetics, the Boltzmann factor, entropy, membrane voltage, and the action potential to discover the consequences of model assumptions. Students validate their models by comparison with data from foundational life-science experiments and thus discover for themselves that science is an evidence-based endeavor with testable hypotheses that are supported by experiment. https://circle4.com/biophysics

D09-4: 3–4 p.m. An Optics Investigation to Differentiate between Reflection and Fluorescence an Introductory Physics Course

POSTER–Emmanuel Salazar, Marquette University, Melissa Vigil

Understanding spectra and the interactions of photons and matter can be important for students of the life sciences. For example, fluorescent dyes are now commonly used in biological applications to improve contrast or highlight the action of specific molecules. Many introductory physics courses limit their discussion of optics to refraction in prisms or image for mation by thin lenses. This poster presents an introductory physics lab activity in which students use an array of different pigments, multiple colored high-intensity flashlights, and a Vernier Spectrometer to differentiate between reflection and flurescence spectra.

D09-5: 3–4 p.m. Using Concentration Analysis on Preliminary Fluids Conceptual Evaluation Data

POSTER–Andrew J. Mason, University of Central Arkansas,

Liam G. McDermott, Ph.D, Mayuri Gilhooly, Daniel Young, Rebecca S. Lindell

Standardized conceptual learning assessments (SCLAs) attempt to measure individuals' conceptual understanding of a phenomenon through individual responses to several distractor driven multiple-choice items. When an individual encounters each item, researchers assume that one of several mental models are triggered. Concentration analysis is one justification of item validity that allows researchers and developers to determine the number of models each item triggers. As part of development of the Fluids Conceptual Evaluation (FCE), the authors performed concentration analysis on a set of preliminary responses from the preliminary FCE. A sample of 290 students from three universities were each randomly assigned eight two-tier items from a set of 59 such items, such that each item would have between 35 and 45 responses. Analysis of concentration factor with respect to score will show how each item will map to different prescribed models of concentration; we also examine differences in patterns that arose as an effect of sampling. Recommendations for future use of concentration analysis will be made accordingly.

D09-6: 3–4 p.m. Outdated IPLS Courses Do Not Serve Today's Life Science Students

POSTER–Rebecca S. Lindell, Tiliadal Solutions, DJ Wagner

Once seen as a soft science, life science now emphasizes modeling and analyzing complex systems using rigorous, quantitative approaches. Introductory Physics for Life Science courses must evolve beyond outdated physical science-based frameworks to meet 21st century life science student needs. To remain relevant, today's IPLS instruction must 1) embed biological contexts, 2) align physics instruction with life science goals, and 3) use evidence-based STEM teaching methods. This poster presents the new physics concepts for IPLS: Diffusion and Random Motion; Fluid Mechanics and Flow; Entropy and Statistical Physics; Non-Equilibrium Thermodynamics and Energy Transduction; Mathematical and Computational Modeling; and Molecular and Chemical Forces. Additionally, the poster includes practical suggestions for incorporating this content into your existing IPLS course.

D09-7: 3:00–4:00 p.m. Modeling Neuronal Circuits and Alzheimer's Disease Using RC Circuits in Physics Education

POSTER–Veneta Tountcheva, PhD, Worcester Polytechnic Inst - Worcester, MA,

Izabela Stroe, Jagan Srinivasan

This activity bridges the principles of physics and biology to deepen student understanding. Students have been exposed to RC circuit laboratory experiment before this activity. Students construct RC circuits to mimic the behavior of neuronal networks, particularly in Caenorhabditis elegans, and use capacitors and resistors to simulate signal transmission and delay. The activity further explores impairments observed in Alzheimer's disease by modifying circuit parameters, introducing greater resistance and capacitance to emulate disrupted neuronal communication. Through hands-on assembly and experimentation, students analyze circuit behavior, calculate time constants, and observe parallels between physical components and biological processes. Group discussions connect the findings to synaptic dynamics, signal propagation, and circuit limitations in modeling complex systems. Extensions allow students to simulate synaptic plasticity and recovery mechanisms, encouraging interdisciplinary applications. Ultimately, this engaging exercise prepares students to connect physics concepts with real-world biological challenges.

Session D10: What We Have Learned from JWST: Part 2

Location: Farragut Square **Time:** 3–4 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Thomas Herring

D10-01: 3–3:24 p.m. The Mystery of Dark Matter in the Universe

Invited–Katherine Freese, University of Michigan

The ordinary atoms that make up the known universe, from our bodies and the air we breathe to the planets and stars, constitute only 5% of all matter and energy in the cosmos. The remaining 95% is made up of a recipe of 25% dark matter and 70% dark energy, both nonluminous components whose nature remains a mystery. Freese will recount the stories of the dark matter puzzle, starting with the discoveries of visionary scientists from the 1930s who first proposed its existence, to Vera Rubin in the 1970s whose observations conclusively showed its dominance in galaxies, to the deluge of data today from underground laboratories, satellites in space, and the Large Hadron Collider. Theorists contend that dark matter most likely consists of new fundamental particles; the best candidates include WIMPs (weakly interacting massive particles), axions, light or fuzzy dark matter, or even primordial black holes. Billions of the particles would pass through our bodies every second without us even realizing it, yet their gravitational pull is capable of whirling stars and gas at breakneck speeds around the centers of galaxies, and bending light from distant bright objects. In this talk Freese will provide an overview of this cosmic cocktail, including the evidence for the existence of dark matter in galaxies. She will also talk about Dark Stars, early stars powered by dark matter, that may have already been discovered by the James Webb Space Telescope. Solving the dark matter mystery will be an epochal moment in humankind's quest to understand the universe.

D10-02: 3:24–3:48 p.m. Exoplanet Atmospheres Revealed: Insights from JWST Observations

Invited–Nestor Espinoza

The James Webb Space Telescope (JWST) is revolutionizing the field of exoplanet atmospheric science with its unprecedented stability and wavelength coverage. From revealing previously unexplored chemistry to signatures of 3-dimensional processes, exoplanet atmospheric observations, in particular from transiting exoplanets, are providing key insights to understand the interiors of these distant worlds. In this talk, I will showcase how current findings from JWST are reshaping not only our understanding of exoplanet atmospheres, but also how we approach interpreting and modelling exoplanet observations themselves. In addition, I will discuss the exciting new frontiers being explored by JWST observations of rocky and gas giant exoplanet atmospheres. Finally, I will discuss the challenges and opportunities that lay ahead for the field with cutting edge technology such as JWST's at hand, and highlight how these hold the promise of bringing us closer than ever to contextualizing our Solar System within the vast exoplanetary landscape.

Session D11: AAPT Sections: Making a Difference – Panel

Location: Salon E **Time:** 3–4 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Debbie Andres

Hear from AAPT Section leaders and members about their successes, challenges, and innovative approaches to strengthening the physics community. Discover how you can get involved in your local Section and contribute to making a difference in physics education.

Session D12: Honoring Alan Van Heuvelen (1938-2024)

Location: Salon A/B **Time:** 3–4 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Eugenia Etkina

Join us to honor the legacy of Alan Van Heuvelen (1938-2024) and celebrate his life, work, and impact on the physics education community. We will begin with a brief summary of his contributions to physics education and then open the floor for remembrances from former students, colleagues and anyone who loved him to come and share their memories. Alan is in the hearts of many members of our community; sharing your memories will enrich us all. Please come!

Session D13: Using Tracker Online, Web EJS (Easy JavaScript Simulations), and ComPADRE

Location: Salon C/D **Time:** 3–4 p.m. **Date:** Monday, Aug. 4, 2025 **Moderator:** Wolfgang Christian

An interactive tutorial teaching simple Video Analysis and JavaScript Modeling with web-based versions of our Open Source Physics tools. Participants should bring a laptop computer. No software installation is required. All materials are browser-based and will be downloaded from AAPT-ComPADRE.

POSTER SESSION II:
Location: Independence Ballroom **Sponsor:** AAPT
Time: 4–5 p.m. **Date:** Monday, Aug. 4

Astronomy

M-01: Using remote telescopes to perform astrometry on close-separation, hot-and-cold, double-star systems

Jeffrey Marx, McDaniel College, Anthony Maletta

We will present our group's experiences and finding using the Las Cumbres Observatory (LCO) remote telescope array to collect images of close-separation, double-star systems. By carefully selecting the surface temperature and magnitude of both stars in the system, close-separation double stars can be resolved by imaging the star system in two standard bandpass filters available to users of the LCO. Although double-star systems are very common, our technique requires specific relationships between the stellar companions, which greatly reduces the number of potential target systems. Our team has been collecting images to refine our understanding of the limitations of our approach and establish practical limits on the range of stellar temperatures and magnitudes we can reliably image. The basic physics and techniques of this project make it accessible to undergraduate physics and astronomy students interested in getting involved in a semester or multi-semester long project.

M-02: Using Planetary Magnetism to Increase Student Engagement in Solar System Astronomy Courses

Roger M. Hart, PhD, Community College of Rhode Island, Physics and Engineering Department, Karen M. Kortz

Solar System Astronomy courses at community colleges primarily serve general education students, emphasizing the scientific process to fulfill academic requirements. To enhance engagement in astronomy courses, we used a multi-tiered approach to study planetary magnetic fields where community college students practice the processes of science. This includes conducting research-grade observations with a proton precession magnetometer, using a smartphone magnetometer in a scaffolded lab activity, and contributing data to NOAA's CrowdMag citizen science project. These three activities encourage scientific inquiry, reinforce key concepts, and improve students' ability to communicate scientific ideas. All activities fit within one standard lecture and lab period (5 contact hours), and they can be used together or individually. Students compare their observations of Earth's magnetic field with data from USGS magnetometer stations and NASA resources on planetary magnetism. They distinguish crustal magnetism from broader planetary magnetic fields, and students examine how planetary magnetism contributes to habitability on planetary surfaces. By engaging in hands-on geomagnetic observations, students develop problem-solving skills, apply quantitative methods, and strengthen their physical science knowledge to meet general education requirements.

M-03: Physics Connections in NASA's Framework for Heliophysics Education

Rebecca Vieyra, University of Colorado - Boulder, Ramon E. Lopez, Shannon Willoughby, Bradley Ambrose, Ximena Cid, Darsa Donelan

Heliophysics is an exciting context for teaching many foundational ideas in physics, including motion, electromagnetic radiation, and magnetic fields. Learn about NASA's nine themes in their Framework for Heliophysics Education, with unique lesson recommendations for addressing many of the topics while enriching your introductory physics instruction, and an opportunity to contribute your own ideas well! Learn more about AAPT's work as a member of the NASA Heliophysics Education Activation Team (HEAT) at https://aapt.org/Resources/NASA_HEAT.cfm.

M-04: Bridging Computing and Astronomy: Investigating Student Learning through Agent-Based Modeling

Sona Chitchyan, Michigan State University, Marcos Caballero, Devin Silvia

CMSE 201 and CMSE 202 (Introduction to Computational Modeling and Data Analysis I and II) are introductory computing courses that use scientific contexts to develop computing skills for students from various backgrounds. The assignments for this course are Jupyter notebooks, where students go through tasks to develop their programming skills while exploring a given scientific context. This project explores how integrating an astronomy context into an introductory computer science class influences students' modeling skills and perceptions of astronomy. Working on a homework assignment, students use their agent-based modeling skills to simulate planetary migration. By analyzing student survey and interview responses, this research aims to inform interdisciplinary teaching strategies and pave a path for future exploration of other scientific contexts for teaching computing. On the other hand, this research creates opportunities for integrating computing in astronomy classrooms.

K-12

M-05: Comparison of Learning Environments Between Students in South Korea and the United States and Critics from a Korean Immigrant's Point of View

Yoon Choi, Ed. M. in Science Education (anticipated), Rutgers State Univ - New Brunswick

As a Korean American immigrant raised in both Korean and American learning environments, I noticed drastic differences between students' lives when comparing the two countries. This led me to question why the systematic and financial aspects of the education system failed to support students properly. Educators have discussed why our nation's educational system has been failing for a long time, but no clear answers exist. The goal of this talk is to compare the current American education system to a foreign one that I have direct experience with and provide suggestions to improve our current system, which will also include cultural and external influences that led to the lack of interest for careers in physics. The recommendations are supported by various data from the South Korean Ministry of Education, the U.S. Census Bureau, and the state of New Jersey on education spending for the year 2024. The findings conclude that the United States needs to invest more in education per student, create better food standards to keep a healthy diet ideal for learning, and rebuild infrastructures that are no longer fitting to be called a place for learning. The role of students is to learn, but without these changes, their education will fall behind.

M-06: Physics Demos Simulating Density Gradient Centrifugation Isolating Peripheral Blood Mononuclear-cells

Katherine Haas, 1106 Broadview Drive, Annapolis MD, 21409, Murray S. Korman, PhD Physics

Gravity, buoyancy, Stoke's drag, Brownian motion, centrifugal force, density, viscosity and temperature factor in isolating Mononuclear-cells from whole blood by Density Gradient Centrifugation. Add 15 mL of density gradient medium, Ficoll-Paque (TM), in a 50 mL conical tube. Carefully layer 35 mL of diluted blood over the F-P. Centrifuge 30 minutes at 400g's. Acceleration from rest takes 2 minutes, while deacceleration to rest is 15 minutes. Centrifugation and sedimentation generate a self-made density gradient - rearranged with increasing density (top to bottom). Blood components separate at neutral buoyancy locations: plasma, white blood cells (Peripheral Blood Mononuclear-Cells), F-P (powdered hydrophilic polysaccharide Ficoll, mixed with sodium diatrizoate to 1.077 g/mL), and red blood cells. Pipette to remove PBMCs. The centrifugation demo uses discrete layers of sucrose-water concentrations, (50,40,...,10%) for the density gradient and a suspension layer of polystyrene colored microspheres (several densities) illustrating separation.

M-07: DIY Electronics for Signal Detection in the Presence of Noise

Kevin McIlhany, Ph.D., US Naval Academy, Murray S. Korman, PhD Physics

For a classroom SONAR demo, a Do It Yourself (DIY) Probability Density Function (PDF) circuit is used to distinguish between two PDF distributions; one which is noise, the other a signal embedded within the noise. The output of the microphone is input into an analog energy detector. The energy distribution acquired by squaring the input and averaging over a time window (via a 1kHz LPF) is then (a) binned by a voltage window comparator, (b) chopped (multiplied) by a fast (112 microsecond) clock, and (c) coupled to a digital counter (6 digit display). Comparing the distributions (counts per bin) leads to a detection index (DI) whose value establishes the criteria for resolving the two PDFs. A Receiver Operating Characteristic (ROC) curve is generated for corresponding data probabilities: (a) false alarms (b) signal detection.

M-08: Waves and Wetlands: Teaching Wave Phenomena Through Local Tidal Marsh Restoration

Abigail Walston, The Morgan School

This poster presents a phenomena-based series of lessons on waves using a local tidal marsh restoration. Centered on restoration efforts at Hammonasset Beach State Park in Clinton, CT, the lessons connect wave physics to real-word coastal resilience, through the lens of coastal erosion and storm surge. Students investigate real storm surge data from Superstorm Sandy in their own and neighboring towns. Using mapped flooding extents and elevation data from UConn's CT Coastal Hazard viewer, they analyze the impact of wave-driven storm surge on the coastline. Students then apply their understanding of wave energy and its effects to explore how tidal marshes reduce storm surge and wave impact. They synthesize their learning by creating annotated scientific models showing how marshes act as natural barriers, dispersing wave energy and protecting infrastructure, and demonstrate the importance of current tidal marsh restoration in their own town. These lessons demonstrate how local, real-world data can ground wave instruction in authentic, meaningful phenomena.

M-09: 2-D Random Walk Probability Displayed Using "DIY" Electronic Circuitry

Sophia Santos, 613 Gallatin St NW, Murray S. Korman, PhD Physics

A class-room demonstration "two-dimensional random walk" involves random variable r , equal to the sum of the squares of two independent Gaussian random variables x and y . Each has zero mean with identical variance. "Do-It-Yourself" analog electronic circuitry includes: (a) an avalanche diode broadband white noise generator, (b) an L-R-C narrow-band pass filter of angular center frequency ωo coupled to an audio amplifier driving a loudspeaker. A receiving microphone signal is amplified and displayed. This BP filtered noise random variable is modeled by n(t)=x(t)cos(ωot) - y(t)sin(ωot). In-phase and quadrature circuitry isolates x(t) and y(t) random variables, x and y. Multiplier circuits, an op-amp adder and square root circuitry generate the r(t) random variable r characterized by the Rayleigh PDF distribution. An analog PDF circuit with a voltage window comparator output chopped on-off, is counted for 4 seconds. In sequence, {bin#, counts} histogram data is generated and displayed by an LED matrix.

M-10: Pre-service Teachers' Understanding of Scientific Inquiry

Ying Cao, Drury University, Edward Williamson, Natalie Precise

In this poster we present a mixed method approach to research pre-service elementary teachers' understanding of scientific inquiry. A survey was developed referencing the National Science Education Standards for Inquiry. Forty-one elementary education students participated in the survey. Likert-scale survey results were analyzed quantitatively. Two open ended survey responses were coded using the standards and emergent themes. Temporary results show that pre-service teachers display highest level confidence with the questioning of experimentation aspects of inquiry, medium confidence regarding data collection using different tools and generating explanations, and low confidence in communicating, publishing, and reviewing. Different representations—Likert-scale choices, textual answers, and drawings—yield different patterns in the medium confidence aspects. However, high and low-confidence aspects remain high or low regardless of specific representations. Our ongoing goal is to compare results with those from an earlier study at the beginning of the 21st century. We hope to capture some evolutionary patterns in pre-service teachers' understandings of scientific inquiry and generate implications to elementary science education, particularly concerning the evident shift away from an explicit usage of the term "scientific inquiry" in the Next Generation Science Standards.

M-11: Sparking Interest in Physics Teaching: Perceptions and Interventions Among Undergraduate STEM Students in a Noyce Capacity Building Project

Hamideh Talafian, University of Illinois Urbana-Champaign, Barbara Hug, Morten Lundsgaard, Maggie Mahmood, Tim Stelzer

Across USA, there is a shortage of high school physics teachers. In our Noyce Capacity Building project, we gather information on undergraduate physics and engineering students' perception of teaching as a profession, and we pilot inventions that seek to park and enhance students' interest in teaching physics. We gauge students' perception of teaching careers using the Perceptions of Teaching as a Profession (PTaP) survey. In addition, we survey students in selected physics courses about how access to a Noyce Scholarship will affect their likelihood of choosing teaching as a career. We believe that to stimulate students' interest in physics teaching, they must observe teaching in action and have access to teachers to hear stories from and ask questions to them. Two of our interventions provide these opportunities for students: 1) sponsored student visits to High School physics classroom; and 2) sponsored student meetings with invited High School physics teachers. In the poster we present the results from surveys and student responses to our interventions.

M-12: Communication and Space: The 2025 "Roger That!" Symposium

Bradley Ambrose, Grand Valley State University, Karen Gipson, Samhita Rhodes, Deana Weibel, Glen Swanson, Rob Schuitema, Amy Coon, Jack Daleske

"Roger That!" is an annual two-day public symposium held in collaboration between Grand Valley State University (GVSU) and the Grand Rapids Public Museum (GRPM). Supported in part by the Michigan Space Grant Consortium, the event celebrates space exploration and promotes K12 STEM education while commemorating Roger B. Chaffee, a native Grand Rapidian and astronaut who perished in the Apollo 1 fire. For 2025 the theme was "Communication and Space," and our featured keynote speaker was former astronaut John Herrington, Ph.D., regarded as the first Native American to fly in Space. The symposium includes a series of online academic presentations, in-person workshops and hands-on activities, and school field trips. Augmented MSGC funding supported the assembly and delivery of 150 STEM kits for local elementary students as well as a 4th – 8th grade design challenge, Design That! Plans are underway for the 2026 event, which will be the 10th anniversary of "Roger That!"

M-13: How ‘Bout a Physics and Engineering Festival at Your School?

Alan Schorn, Great Neck North High School

A physics and engineering festival, particularly one put on locally by a high school, is a spellbound, theatrical and participatory way for a school to contribute to the community at large and build relationships with people of all ages. This poster details the funding (in part through the AAPT Bauder Fund), planning, publicizing, execution and documentation of the first ever Great Neck North Physics and Engineering Festival, held at Great Neck North High School, Great Neck, NY on April 26, 2025. The festival attracted an audience of approximately 300 people many of whom were elementary age. The festival began with an hour long session of up-close demonstrations and many participatory activities. This was followed by a short outside session of fire and explosions – firing up Rijke tubes (glass tubes with wire mesh that sound like a foghorn when heated by a blowtorch) and firing off methanol cannons. The outdoor session was followed by a stage show in the auditorium of various physics demonstrations, some arcane, some well known, explained, and often performed by, student presenters.

Introductory Physics

M-14: Velocity First, then Speed, Average-Velocity, and Average-Speed

Rob Salgado, St Catherine University

We present a pedagogical approach to introducing velocity first, emphasizing its distinction from speed, average-velocity, and average-speed. Velocity is defined as the slope of the tangent line on a position-vs-time graph, modeled by a left hand riding the position graph. Speed is defined as the magnitude of velocity. Average-velocity is then defined as a time-weighted average of velocities and is interpreted as the steady velocity needed to make the trip with the same start and end positions in the same elapsed time. Average-speed is defined analogously for a trip with the same endpoints and same intermediate turning positions. We provide a piecewise constant-velocity example, accompanied by an interactive Desmos visualization.

M-15: Does Lecture/Studio Make a Difference at the University of South Carolina?

Alice D. Churukian, University of South Carolina - Columbia, David J. Tedeschi

In the fall of 2022, we began the conversion of our Calculus-based Introductory Physics sequence from a traditional format to a lecture/studio format first with the Mechanics course and then, a year later, the E&M course. As with any conversion, we have run into obstacles – some unexpected – but now have a successful program. But just how successful? To demonstrate our success, we will present student and faculty perceptions from interviews and anonymous surveys as well as student learning gains based on FCI and CSEM performance.

M-16: Electroacoustics as an Introductory Non-STEM Course

Jeremy Hohertz, Elon University

It is common for colleges to require non-STEM students to take at least one lab-intensive science course. Physics departments typically offer survey courses (introduction to astronomy, conceptual phsyics) or courses with broad appeal (energy and the environment, physics of sports). At Elon University, the pre-existing Physics of Sound course did not fully meet the desires of the Music Production and Recording Arts program, so a new course in electroacoustics was developed. This poster will address the course content, lab activities, lab materials, challenges in development, and feedback from the first iteration of the course, as well as future plans for the course.

M-17: A New Physics Homework Framework: Combating Procrastination and Physics Problem Paralysis

Sarah Mcgregor, Keene State College

Physics homework is essential for reinforcing problem-solving skills, but many students struggle with completing assignments due to procrastination, anxiety, and lack of self-regulation. Traditional homework structures often fail to support students, especially those with math or science anxiety, high intolerance of uncertainty (IoU), or lower self-efficacy. These students often delay starting homework, freeze when faced with difficult problems, or fail to seek help in time, leading to incomplete or incorrect solutions. This paper introduces a novel homework structure designed to mitigate procrastination, build self-efficacy, and address IoU. The system encourages students to begin homework early and provides them with guided resources to help them navigate problems when faculty or tutors are unavailable. These resources not only address common roadblocks but also help students with starting problems, ensuring they can make progress even when they don’t have all the answers upfront. By creating a system that fosters self-regulation and encourages students to recheck their work, the new structure aims to reduce “physics problem paralysis” and increase the accuracy of homework submissions. Through this student-centered approach, we aim to foster resiliency, reduce procrastination, and ultimately enhance academic success for all learners, particularly those who have traditionally struggled with physics homework.

M-18: “Well, that was unexpected:” Struggles and Successes of Course Improvement

Matthew Cass, Southwestern Community College, Chelsea Tiffany, Joseph Martinez

As educators, we have all had the experience of returning to the classroom after an invigorating conference or workshop on physics education, ready to implement the latest findings to improve learning for our students. But then, something happens and things don’t go exactly as planned… In this poster, we will highlight a few examples of new pedagogical implementation, such as group review and lab assessment and feedback in introductory physics courses, the unexpected challenges we met, and how we overcame them.

M-19: A University-Supported Course Re-Design for Engineering Physics

Jenna Smith, University of Notre Dame, Matthew A. Becker, Kathleen Quardokus Fisher, David G. Robertson, Kevin Lannon

The Foundational Course Transformation Academy is a new initiative at the University of Notre Dame. This 3-year process guides and supports a team of faculty members as they redesign a large-enrollment course. Engineering Physics was selected as the first course to undergo this process. The guiding principle in this redesign process has been to follow a learning-centered process that improves both the student and faculty experiences in the course. The effort is supported by a team of learning experts, institutional data on trends in student preparedness and performance, and data collected through surveys and focus groups of current and past students and instructors. This poster will describe the collaborative support provided by the university as well as the changes that students will see in Spring 2026.

M-20: An Online Asynchronous College Physics Course Designed From The Ground Up

Diego Valente, University Of Connecticut, Belter Ordaz

Online courses are often maligned as not being engaging or interactive enough or as having lower quality instruction, especially when compared against their in-person counterparts. Anecdotal evidence shows, however, that demand from students for such courses is higher than ever. We present here a first-semester College Physics course that was designed from the ground up in an online asynchronous format to be taught on a condensed schedule over a 6-week summer term at a large R1 public university. We address the issue of how to maintain desirable levels of student-content, student-instructor and student-student interactions and how elements of Universal Design for Learning were incorporated into the design of the course. We also address one of the biggest challenges for online asynchronous introductory physics courses, which is the lab component, and how authentic laboratory activities were implemented. Finally, we discuss how academic integrity was managed in the course and present student feedback and some lessons learned throughout the development and course deployment processes.

M-21: An interdisciplinary Course on Energy and Society with Virtual Exchange

Shawn Weatherford, University of Florida, Selman Hershfield

Energy & Society is a course introduced at UF in 2020 that examines the historical and current use of energy derived from natural resources through a multidisciplinary lens. The course is one of the univeristy offerings to satisfy the Quest 2 requirement, the hallmark general education component, which tasks courses to focus on a centralized question that focuses on the human condition. In 2024, the authors developed a virtual exchange component in collaboration with colleagues from the Ecole Nationale Polytechnique in Algiers, Algeria. A virtual exchange connects students from different institutions and tasks them to work collaboratively on a product that reflects the exchange of experiences and the relationship formed across a period of a few weeks. This poster will explore the course themes, student outcomes, and present the results of the virtual exchange experience.

Labs and Apparatus

M-22: Introduction to Machine Learning in Undergraduate Curriculum using LEGOLAS: A LEGO Based Low-Cost Autonomous Scientist

Tatiana Allen, UT - Chattanooga, Matthew L. Boone, Samuel Glandon, Jacob E. Humberd, Nathaniel Kroll

Cutting edge topics such as machine learning are frequently not covered in the undergraduate physics curriculum. We decided to introduce this topic to students through a project-based class, where students constructed a LEGO-based, low-cost autonomous scientist (LEGOLAS). It is a robot that uses machine learning techniques to autonomously derive the Henderson-Hasselbalch equation, reducing the tedious experimentation and calculations typically involved in acid-base experiments. Originally, it was developed via collaboration between NIST and UMD scientists as a teaching tool to introduce students to machine learning techniques and algorithms [1]. The robot was built by students from scratch. Funding for parts and electronics came from the SPS National Research Grant. The project took two semesters to complete. Students really enjoyed working on it and, along the way, learned about 3D printing; electronics such as Raspberry Pi's, Arduino computers, and pH sensors; and other topics and skills that are usually not taught in undergraduate curriculum. Machine Learning was introduced through Bayesian statistics and Gaussian process regression, which LEGOLAS used to derive the Henderson-Hasselbalch equation in our experiment. We plan to use this device to develop other autonomous experiments and for departmental recruitment and outreach. In this talk, we will share our experiences and lessons we have learned while constructing, calibrating, troubleshooting, and using LEGOLAS.

M-23: Keene State's Owl-Eyed Focus: A 1-Year Precision Optics Certificate

Sarah Mcgregor, Keene State College, Jim Kraly, Michelle Wood

Not every student sees college as the right path—but that shouldn't limit their access to high-paying, high-demand careers. Many students want a direct route into the workforce, bypassing traditional degrees for hands-on, job-ready training. At Keene State College in New Hampshire, the Precision Optics Certificate was designed for these individuals, offering a one-year, skills-focused program that leads straight to employment in the rapidly growing optics industry. The demand for skilled optics technicians has never been greater. Local companies are struggling to fill positions—so much so that they are hiring workers from grocery stores and machine shops with no prior experience. But they don't just need workers; they need workers with the right skills. Developed in direct collaboration with local optics employers (in the New England region), this program ensures students gain precise, industry-driven expertise in optics manufacturing, metrology, lens fabrication, thin film coatings, laser technology, and precision machining. The Precision Optics Certificate is more than a new program—it represents a new way for education and industry to work together, creating opportunities for students who may have never considered college while supplying businesses with the talent they desperately need. This effort marks a fundamental shift in how academia and industry collaborate, moving beyond traditional academic silos to build a truly responsive workforce pipeline. In this presentation, we will share how we worked with industry to create this certificate, the challenges and successes we encountered along the way, and how our continued partnership ensures that the program remains relevant and effective. By rethinking the relationship between education and workforce development, we are setting a precedent for how institutions can evolve to meet industry needs while opening new doors for students seeking direct entry into high-demand careers.

M-24: Hands-On Physics Learning through Portfolio Assessments

Laura Romanovich, MS, Johnson College

Two of the major goals of a non-majors conceptual physics course are (1) to get students to think critically about solving problems and (2) to apply fundamental scientific principles to observations they make about the world around them. I have found that traditional high-stakes mid-term and final exams do a poor job at assessing these student learning outcomes and are often punitive in terms of grading. For students enrolled in skilled trade programs, hands-on learning and hands-on assessment through portfolio projects enhances student comprehension and engagement with physics. Allowing for revisions on these assignments encourages students to actively learn the material while seeking ways to apply concepts to new situations. Feedback from students has generally been positive, with many appreciating the chance for a "do-over" and flexibility in timelines and formats. Students also say that this form of assessment is far less stressful than studying for exams and the mini-projects are "kinda fun".

M-25: Students and teachers can build their own photo-gate timing systems.

Shawn Reeves, EnergyTeachers.Org

Teachers and students can build their own systems of photo-gate timers from discrete components, for kinematics. Users can make their own code to time passages through an array of gates or to get speed from closely spaced gates, and display the values, using US$25 microcontrollers. Students using equipment they made themselves may have more investment in the work they do in kinematics labs. Students also may learn electronic circuits and coding at the same time as kinematics. Over the past few decades, coding the gates has moved from assembly to proprietary to Python—We provide versions of the code in all these forms. EnergyTeachers.org Inc. (ETO) is a twenty-year-old nonprofit started by members of the New England Section of the American Association of Physics Teachers looking to gather and share curriculum resources for modern topics like energy production and use, and electronics. ETO keeps a library of materials including books, curriculum guides, scientific instruments, and electronics parts, for developing, training, and lending.

M-26: Observing the Inverse Square Relationship in Coulomb's Law

Riya Chauhan, Andrew Schropp, Leonidas Park Taber

The Inverse Square Law in electric force is traditionally demonstrated by the Coulomb Torsion Balance, a fragile device that can be hard for students to use and not often found in physics labs. We present a novel way of observing the inverse square law with common materials from a college physics lab and hardware store, potentially offering a more student friendly and accessible lab. Our apparatus consists of a stationary metal sphere and a conductive foam ball, both of which are placed in proximity to each other and charged by a Van De Graaff Generator. By changing the angle of pendulum, we vary the force between the conductive foam ball and metal sphere and use video analysis to make distance measurements as this occurs. These measurements were entered into our mathematical model to obtain the relationship between force and distance. This method did not require the charges of the metal sphere or conductive foam ball to be known, and the relationship could be solely found through video analysis. With this design, we were able to confirm the inverse square relationship to a high level of accuracy.

M-27: Investigation of Transverse Standing Waves in Beams Free at Both Ends

Jonathan Bennett, North Carolina School of Science and Math, Brandon Lofton, Justin Weng

Standing waves provide a fertile area of learning for physics students at both introductory and advanced levels. We present results of an inexpensive laboratory investigation of the lowest unforced transverse modes of oscillation of PVC beams that are free at both ends. The damped oscillations are slow enough to make nodes and antinodes easy to observe. Through video analysis of standing waves in beams of identical composition and cross section but variable length, we study the relationship between oscillation frequency and length. By using beams with different cross sections, we also investigate the effect of the area moment of inertia of the beam on the oscillation frequency. Our measurements agree quantitatively with the dispersive frequency vs length relationship predicted by the Euler-Bernoulli theory for transverse waves traveling in beams. Beams that are free at both ends provide a medium that is complementary to other commonly used materials (for example, strings or springs fixed at both ends) for investigating transverse standing waves.

M-28: Developing a lab activity to model friction on a low-friction track

Jon Gaffney, Utica University, Adam Lark

Low-friction cart and track systems are often used to help students understand the effects of forces, momentum, and energy without friction "getting in the way." However, they can also be used to investigate the modeling process in physics by focusing on the friction itself. Because the amount of friction is so small, and because it is unclear whether the "sliding friction" model taught in introductory physics is applicable to rolling carts on tracks, students can engage authentically with the process of trying to model the resistive friction force acting on a cart as a function of its mass. Owing to the incredibly small amount of this resistive force, students will need to manage uncertainty as well as generate linear plots to create their models. This activity was heavily inspired by The Physics Teacher article by Amato and Williams (2010). We will describe our process of development as well as the results of an independent study conducted by a student during the Fall 2024 semester. We welcome feedback as we prepare this activity for deployment.

M-29: Demystifying Apparatus Via Thematic Demo Shows

Christopher Miller, SB, Technical Instructor, Massachusetts Institute of Technology

A showcase of demo-filled 90-minute lectures given to high school students as part of Splash, an annual MIT student-organized learning weekend - with a focus on the design of two recent courses. One class focuses on the experimental history of atomic theory and has evolved to focus on the nature of science emphasizing dead ends and real apparatus. This was driven in part by revisiting early quantum theory for the International Year of Quantum. Another is on the history of vacuum technology as told through demonstration apparatus while emphasizing orders of magnitude. Its design led to gathering comprehensive materials about the ubiquitous laboratory instrument.

M-30: Constructing a Beginner's Electric Circuit

Veneta Tountcheva, PhD, Worcester Polytechnic Inst

Students are using a 12"x12" cork tile, plastic clip-on connectors, jumper wires, and electrical components to build their first electric circuit. Most Introductory Physics Labs use manufactured Vernier/Pasco circuit boards based on PCBs. These circuit boards, as well as breadboards, can be confusing for students who are new to electric circuits. Many students struggle to relate the circuit boards to the circuit schematic found in textbooks and to follow the current flow. When students attempt to build an electric circuit in series or parallel and measure voltage and current using manufactured circuit boards, they often feel lost and sometimes frustrated. The setup we have developed offers a significant advantage: it allows students to follow the circuit schematic from a textbook or laboratory experiment handout and build the circuit simply by connecting jumper wires and electrical components with clip-on plastic connectors. These connectors are secured with tacks on the cork board to ensure mechanical stability—unlike using alligator clip wires, which is another way to introduce electric circuits. Our setup provides students with a visual depiction of the electric current flow. They can independently build a basic circuit, learn how to troubleshoot it, measure voltage and current, and study the relationship between the two. This setup can also be used for: i) More complex circuits to study Kirchhoff's rules ii) RC circuits to examine the charging and discharging of capacitors. Based on observations and student feedback during the first electric circuits lab, we conclude that students can easily replicate the schematic on the board and measure voltage and current at different points in the circuit. Additionally, the same board can be used to study electric potential by securing conductive paper with different charge configurations drawn with conductive silver pen or attaching copper tape. In conclusion, we have developed an electric circuit kit that is affordable, portable, easy to use, and can be used in at least three different electricity and magnetism laboratory experiments.

Two-Year Colleges

M-31: CPDW Program – The First 3 Years and What's Next

Thomas O'Kuma, Lee College, Paul Heafner, Kristine Lui

OPTYCs is The Organization for Physics at Two-Year Colleges (https://optycs.aapt.org). Part of the OPTYCs mission is to provide Continuing Professional Development Workshops (CPDW) and Tandem Meetings for TYC physics faculty across the country. In this poster, we will summarize the workshops and the Tandem Meetings that occurred during the first three years of the project. We will also highlight workshops at the current meeting and any currently scheduled future workshops. We will also invite TYC physics colleagues and others to submit ideas for workshop content (https://optycs.aapt.org/user/Contact.cfm). CPDW is open to all with an emphasis for TYC faculty. OPTYCs is supported by NSF-DUE-2212807.

M-32: Impact of OPTYCs: Quantitative Data

Kris Lui, OPTYCs/AAPT, Dwain Desbien, Sherry Savrda, Rachel Ivie

The Organization for Physics at Two-Year Colleges(OPTYCs) is three years into its four-year grant (NSF-DUE-2212807). Our long-term goals include: (1) reinvigorating and improving the quality of physics education in TYCs; (2) TYC physics and astronomy faculty feel connected to a national TYC community of practice; (3) TYC physics faculty have the support they need to thrive professionally; (4) TYC physics is integrated within national physics education in terms of attitudes and structure; and (5) OPTYCs is recognized as the organization and community for TYC physics faculty professional growth and development, supporting sustainability and serving as a national model for other STEM disciplines. This poster presents quantitative data on our progress towards these goals.

M-33: Flipping Physics: Engaging Students Through an Interactive Classroom Model

Qurat-ul-Ann Mirza, Masters of Physics, Instructor of Physics, Rowan College at Burlington County

This presentation explores the implementation of the flipped classroom model in a General Physics I course and examines student perceptions of this approach compared to traditional teaching methods. End-of-semester student results indicate a strong preference for the flipped model, with many students favoring its interactive and engaging structure. A subset of students who continued to General Physics II, taught using a traditional approach, provided insights into their comparative experiences, further reinforcing the effectiveness of the flipped model. Additionally, this study incorporates the use of online exams, which introduced non-traditional assessment methods, offering a unique contribution to the discussion on innovative teaching strategies in physics education.

M-34: Developing and Enhancing Access to Nuclear Physics Research for Community College Students

Emilie Martin, Marco Wehrfritz

The Pathways to Improved Representation in Advanced NucleAr science (PIRANA) program at Skyline College, San Bruno, CA, is in its second and final year, building on the foundation established by a previous two-year project funded under the US Department of Energy Office of Science "Research Traineeships to Broaden and Diversify Nuclear Physics" pilot program. Skyline College is the only community college part of the nEXO collaboration, giving students access to opportunities through an international community of physicists. The program has successfully supported ten trainees, who have taken part in hands-on research projects for nEXO while providing them with mentorship and opportunities for professional development in nuclear physics. Trainees acquired technical skills needed for their projects by participating in workshops, covering topics such as programming, soldering, electronics manufacturing, or 3D design. Collaboration with SLAC National Accelerator Laboratory was instrumental in enriching the trainees' experiences by providing projects, mentorship, and support. Outreach has also been an important mission of the group, at the college and beyond, with trainees presenting their research at national conferences. As the program enters its final summer, it continues to empower students to pursue careers in nuclear physics research and related fields. This work is supported by the U.S. Department of Energy Office of Science (Office of Nuclear Physics), under Award Number DE-SC0024677.

M-35: The 'transfer grid' as a qualitative interview tool to more fully understand the transfer student trajectory

Frank Dachille, Michigan State University, Vicky Phun, Vashti Sawtelle

Transfer students navigating the path from an associate degree granting institution to a bachelor's degree granting institution have unique and complex trajectories. In this poster we introduce a qualitative artifact, called the 'transfer grid', to allow researchers to better understand and explore these transfer student narratives. This tool makes visible a more complete narrative of the transfer student experience. Through mapping important moments before and during this transition, we provide researchers a method to: (1) support relationship building between the interviewer and participant; (2) discover what the participant sees as important to their transfer trajectory; (3) and generate a rich narrative with which to ground findings in context itself. This work was generously supported by the IMPACT STEM Transfer Network and Michigan State University.

M-36: Moving Forward: The Future of the OPTYCs Mentoring & Networking Efforts

David Marasco, Foothill College, Matthew Cass

The OPTYCs grant supported many great things in the Two Year College (TYC) ecosystem. A collection of mentoring and networking groups were built as part of the program. Unfortunately the funding for OPTYCs was terminated in May of 2025. The co-directors of the program will continue to facilitate the groups so that the participants can still derive benefit from the community they create. Additionally the co-directors will seek to create new groups as needed. This poster will share their thinking, and provide the opportunity for feedback.

Educational Technology

M-37: Enhancing Student Engagement in Physics: The Role of Passion Projects and Independent Study

Armita Ahmed, Student, Scarsdale High School

Traditional approaches to physics instruction, often emphasizing lecture-based delivery and mathematical problem-solving, frequently struggle to capture and sustain deep student engagement. This abstract proposes a pedagogical shift toward project-based learning and independent study as highly effective strategies for fostering genuine enthusiasm and improving learning outcomes in high school physics. By providing students with opportunities for self-directed inquiry and hands-on exploration, educators can significantly enhance conceptual retention, cultivate critical thinking skills, and foster a profound sense of direction for their students's learning journeys. This approach directly addresses the documented need for instructional methods that transcend passive information reception, instead promoting active participation and real-world application of physics principles. Our experience suggests that when students are given the freedom to pursue physics "passion projects" or independent studies, their engagement drastically increases. For instance, in my own school's lower-level physics class, this approach has proven instrumental in improving student success and sustained engagement. Allowing students to "breathe" and explore topics that genuinely excite them leads to deeper understanding and greater retention. This aligns with the idea that students are most engaged when learning is fun and personally relevant. This presentation explores alternative instructional strategies that actively promote engagement in the physics classroom, demonstrating how integrating such projects empowers students to develop stronger scientific reasoning and decision-making abilities. By embracing methods that prioritize student curiosity and allow for independent exploration, we can move beyond simply teaching physics concepts to truly inspiring future scientists and critical thinkers.

M-38: Educational Technology for High School Physics: Fostering Computational Literacy

Armita Ahmed, Scarsdale High School

The urgent need to integrate fundamental programming skills into secondary education is shown through the emerging role of computational methods in contemporary physics and broader STEM research. This abstract proposes leveraging educational technology to integrate coding (e.g., Python, MATLAB) within high school physics curricula, moving beyond traditional concepts and equipping students with essential skills for careers in STEM. A foundational understanding of programming is now a prerequisite for students to thrive in the modern academic and professional landscape. Introducing coding allows students to engage with physics in a more interactive and engaging manner, preparing them for higher-level studies and cutting-edge research. My proposed project-based learning model, ideally implemented in the latter half of the academic year, allows students to apply their accumulated physics knowledge. This integration commences with a focused, introductory "crash course" in a chosen programming language. The end goal is not a comprehensive mastery of the programming language, but instead having students utilize technology as a tool for deeper engagement with physical principles. This practical application of educational technology fosters a more interactive and relevant learning experience for students, making often strictly conceptual topics more approachable. This framework facilitates diverse and engaging "passion projects." For instance, students could develop sophisticated simulations of physical systems, model complex phenomena, or even explore fields like quantum computing using accessible libraries such as Qiskit. Such hands-on computational projects serve as powerful catalysts for student engagement, transforming abstract theories into tangible experiences and potentially inspiring students to pursue scientific research paths that extend beyond typical introductory physics. This strategic integration of programming cultivates computational literacy, significantly enhances student engagement, and effectively prepares them for the computational demands of the professional STEM world, fostering a generation of computationally adept scientists.

M-39: Characterizing Seiche Formed in a Backyard Pool

Hugh Gallagher, SUNY Coll At Oneonta, Jacob Ghiorse, Andrew Lutz, Melissa Marry

A barotropic seiche is effectively a standing wave that forms in the surface of an enclosed basin such as a lake. Artificial seiche can be created by rhythmically driving the water surface of a back yard pool. In three experiments, we excite different seiche modes in the surface of a pool and analyze their characteristics. An ultrasonic sensor positioned near the outer edge of the pool recorded the location of the water surface as a function time. The surface height time series is Fourier analyzed to determine the frequency of the observed modes. In cylindrical systems, the spatial solution to wave equation is provided by Bessel functions of the first kind. The admitted modes are those that meet the boundary condition that the gradient of the Bessel function is zero at the center and outer edge of the pool. A dispersion relationship constructed from the observed angular frequencies and wave numbers of the corresponding admitted modes shows excellent agreement with the general water wave dispersion relationship. The experiment provides students with experience applying Fourier analysis to a relatively straight forward data set, an appreciation for how the dispersion relationship relates the wave characteristics to the physical properties of the system and a tangible analog for visualizing quantum mechanical systems.

Beyond Intro

M-40: It's a lightboard … and a glassboard!

Craig Looney, Merrimack Coll

In this poster I present an innovative lightboard-glassboard design concept and prototype. The device, when not in use as a lightboard, is positioned against a wall in a low-profile configuration and used as an illuminable office glassboard. For video production, the device – supported and guided by a robust anti-tip rail system – is safely rolled away from the wall and used as a lightboard. This device has several advantages over traditional mobile lightboard designs including ease and reliability of setup, elimination of storage and transport issues, usability in modest-sized offices, and functionality as an illuminable glassboard when not in use as a lightboard.

Quantum

M-41: Can a CNOT Gate Affect the Control Qubit? Student Resources for Understanding CNOT and Entanglement

Jonan-Rohi Plueger, Gina Passante, Steven J. Pollock, Bethany R. Wilcox

The CNOT gate is a two-qubit gate that can entangle qubits and is used in most quantum computing circuits. We conducted think-aloud interviews with students using questions that explore the function of CNOT gates and their use in quantum circuits, then identified resources related to CNOT gates and entanglement. We explore how these resources can be leveraged productively or unproductively in response to our questions, and how students choose to either 'play quantum computer' or use conceptual arguments in different problem contexts.

M-42: Classical Spin Angular Momentum

Robert Close, PhD, Clark College

In the past two decades, several researchers have identified spin angular momentum in classical physics wave phenomena. It has long been known that many types of waves have both intrinsic and wave momenta. Waves on a string have intrinsic momentum of the string moving back and forth, and also have wave momentum associated with energy propagation along the string. Waves in a three-dimensional solid clearly have both intrinsic (spin) and wave angular momenta as well. Fundamentally, incompressible intrinsic momentum density is equal to half the curl of spin density. Examples of simple momentum density profiles with azimuthal symmetry show that classical spin angular momentum is precisely what we think of as ordinary angular momentum. It is related to the coordinate-dependent "moment of momentum" through integration by parts. Furthermore, the second-order wave equation for spin density in an elastic solid can be factored to construct a first-order Dirac equation with the same angular momentum operators as in relativistic quantum mechanics (the Schrödinger equation is just a simplifying approximation of the Dirac equation). Therefore, teaching classical spin angular momentum will give students an understanding of the physical significance of quantum mechanical operators.

M-43: Introductory Quantum Computing for Undergraduates: Curriculum, Tools, and Reflections

Rachele Dominguez, Randolph Macon College

I taught a 200-level quantum computing course using the textbook by Alice Flarend and Bob Hilborn, designed to bridge the gap between high school-level conceptual understanding and the advanced material typically covered in a 400-level physics course. The course was designed for students from a variety of disciplines, including physics, engineering, computer science, and cybersecurity. Core topics included qubits, superposition, quantum entanglement, and quantum key distribution. To reinforce theoretical concepts, students engaged in hands-on activities involving polarization and simulations of quantum key distribution. I also integrated IBM's quantum computing platform tutorials to offer students practical experience. In this poster, I'll present what worked, what didn't, and share insights and recommendations for future iterations of this course.

M-44: Integrating Visualization and Computational Modeling in Condensed Matter Physics

Haiying He, Valparaiso University

Despite being primarily an elective course in most physics departments, Condensed Matter Physics (CMP) is a natural extension and a vivid application of Quantum Mechanics and Statistics Mechanics. Condensed states of matter (solids & liquids) make up most of the material world around us and are responsible for almost all of the technology that we depend on. Therefore, it serves as an excellent bridge between physics and the field of applied physics and engineering. However, the complexity of the matter itself often leads to using highly simplified 1D or 2D models in instruction and hypothetical textbook problems in practice. To overcome these obstacles and develop a better appreciation of the modern topics in CMP, I have integrated visualization and computational modeling in the CMP course. We have primarily used the MIT Atomic Scale Modeling Toolkit (https://nanohub.org/resources/ucb_compnano) for visualization, computational modeling and simulation to enhance our understanding of basic concepts and physical models, and to make better connections to real-world applications. For instance, we have used the modules to visualize 3D crystal structures, to understand the bonding nature, to investigate the correlation of structure and scattering signals, and to calculate the electronic band structures. These tasks are completely done on the nanoHUB webserver. The toolkit plots results alive, and also provides the option to download results for students to include in their reports.

Belonging and Access

M-45: From Courses to Careers: Impact of workshop design on students' professional development

Mason D. Moenter, Texas A&M University, Michigan State University, Erin Syerson, Bella Tuffias-Mora, Jayden Butler, David Cassens, Tanya Adams, Theodore Bott, Erin M. Scanlon, Matthew W. Guthrie, Daryl McPadden

Recently, there have been many efforts to broaden participation in STEM to empower a diverse and knowledgeable workforce, which has been reflected in the 2022-2026 National Science Foundation's (NSF) Strategic Plan. As a part of these goals, efforts to create a more inclusive, accommodating, and accessible community are crucial for supporting disabled students, who make up 20% of undergraduate science & engineering students. The Courses 2 Careers (C2C) project aims to improve accessibility and inclusion in physics through a week-long workshop that facilitates mutually beneficial partnerships between disabled post-secondary physics students and faculty across multiple institutions. Throughout the development of the workshop, student members have been an active part of the design team, including working on activities for the workshop, serving on panels at conferences, co-facilitating the workshop, and writing a series of articles for the Just Physics? column of The Physics Teacher. By participating in this work, student design team members have gained valuable professional skills, which they have then translated into the professional development component of the C2C workshop. This contribution highlights the benefits of the collaboration between students and faculty as a part of the design and delivery of the workshop.

M-46: Temperature Dependence of the Refractive Index of Flint Glass

Jason Withers, Department of Physics, Lamar University, Christopher Lowe, Cristian Bahrim

The variation of the refractive index of a material with the frequency of light, $n = f(v)$ shows the optical response of that material. We study changes in n for flint glass to radiation when the interaction between light and glass is assisted by background energy. One way is by changing the environmental temperature, T. For a system in thermal equilibrium, such change adds kT average energy, where k is the Boltzmann constant. This energy goes into the vibration of the glass electric dipoles, hv. For an isotropic increase in kT energy, the glass dipoles change their vibrational energy according to $hv' = hv + kT$. In practice, we can add kT energy from a hot source (i.e. a flare) or using a blackbody radiation source placed near the glass. However, the efficiency is very small due to strong energy dissipation inside the glass. A more efficient way to change the energy is by supplying an isotropic energy across the glass. For this goal, we set up a capacitor configuration which has a glass placed between two conducting plates. In this way, changing the voltage, V, changes the frequency, v, of the vibratory dipoles as $hv' = hv + eV$, which is equivalent to a change in the temperature by kT. We assess the changes in n by measuring changes in the Cauchy parameter for $V < 10$ volts. Thus, for no voltage, we get C of 11180, which increases to 11224 at 5 volts, and 11278 at 10 volts, where the error bar stays at 0.5% in all cases. These values are clear proof of the temperature variation for index n. We acknowledge The Office of Undergraduate Research – SURF program and TEAM-UP grant for funding this research.

Physics Education Research: Assessment

M-47: Stereotype threat on low-stakes formative physics assessments

Jayson Nissen, Montana State University, Ben Van Dusen, Kevin Roberge

Stereotype threat occurs when awareness of a negative stereotype impairs performance or learning. This threat can come from common actions like asking for demographic data. Studying equity in student outcomes and the impacts of instruction on including or excluding minoritized groups requires collecting demographic data. Yet, no robust studies have measured if these questions on low-stakes assessments cause stereotype threat. We conducted a randomized control trial with about 12,000 students to address this gap by examining the impact of asking demographic questions before a test on student scores. Our presentation will discuss the results and their implications for teaching and research.

M-48: Using personas to help students explore science identity

Mary Bridget Kustusch, PhD, DePaul University, Susan Fischer

Research has shown that interventions that address sense of belonging and science identity can help improve retention and persistence in STEM. As a part of a redesign of our introductory curriculum, we have chosen to explicitly focus on learning goals related to science identity. In this poster, we will showcase the activities we have used to address these learning goals, focusing on a novel use of personas. Personas are imaginary people that are constructed out of well-understood and detailed data about real people. They are typically used by developers to allow them to design for individuals rather than data. In a similar way, students might be able to better engage with ideas about science identity if they are discussing individuals instead of data. By examining student responses to the activities, we will address how and to what extent the use of personas helped to facilitate learning around science identity.

M-49: From Learner to Leader: Professional Development for Incorporating DEI in Physics

Kristine Washburn, Everett Community College

As an educator, you may have done some work learning about equity and social justice and how that fits with STEM education and careers. These are great ways to help all students feel supported in their STEM careers. A next step might be to share some of your insight more broadly and support colleagues who are interested in the same topics. At Everett Community College, a recent grant-funded project provided professional development for STEM faculty to design and implement equity and social justice curriculum within the context of their disciplines. In this poster, I share key components that supported faculty in successfully participating:

1) providing examples of curriculum work to inspire and build from, and 2) offering regular, ongoing, substantive support as faculty explore new pedagogy in their classrooms.

M-50: Interactive Activities Inspired by Physics Observations and Research conducted by Historical Figures while Enduring Imprisonment, Racism, Sexism

Elizabeth Cavicchi, Dr., Ed.D., Instructor, Massachusetts Institute of Technology

Physics happens wherever we are. Physics goes on in: light and dark, motion and stability, breaking and making materials. At any place and time, there's something physical to observe, interact with, and consider. This poster depicts activities trialed by physics teachers at MIT Edgerton Center during the 2025 Spring NES AAPT meeting. These open-ended activities are inspired by physical observations and research expressed in writings by historical figures who concurrently endured imprisonment, racism, and/or sexism. The poster lists materials used in the activities, and illustrates what teachers did with them. Most materials were everyday: toilet paper tubes; string; stones; weight; lifesaver candies; light; prism; dark room. Teacher participants were invited to read aloud from a handout, enact, respond to, recreate, reflect on… physical observations related in prison memoirs and research excerpts. This handout will be provided at the poster session. Galileo Galilei (1564-1642) wrote on motion while imprisoned. Nobel Laureates who wrote under solitary confinement include: Santiago Ramón y Cajal (1852-1934) Spain on camera obscura; Wole Soyinka (1934-) Nigeria invented mobiles; Narges Muhammadī (1972-) Iran questions time. African American physicist Edward Bouchet (1852-1918) measured refraction in glass; US physicist Frances Wick (1875-1941) researched triboluminescence. Exploring these observations opens us to experience how humanity and history interrelate with learning physics.

Physics Education Research (PER)

M-51: Practice of the Core Curriculum in General Education Based on the PAD Class Teaching Model

Shihong Ma, Dr., Department of Physics, Fudan University, Shanghai 200433, China, Xiaxuan CUI

The "PAD (Presentation-Assimilation-Discussion) class" teaching model divides the class into four sequential stages based on the concept of partitioned teaching: lecture, internalization, discussion, and teacher-student dialogue, emphasizing the students' central role in the learning process. This model establishes a division of responsibility and authority: the teacher manages the lecture and dialogue stages, while students take charge of internalization and discussion. This approach fosters a genuine learning community and maximizes the value of education. Taking the general education core curriculum Physics and Culture at Fudan University as an example, this study explores its implementation. By collecting and analyzing students' learning data, the findings indicate that this innovative teaching model effectively improves students' learning outcomes, enhances multiple comprehensive skills, and, to some extent, alleviates their learning pressure compared to traditional teaching models.

M-52: An Overview and Comparison of Weighted Score Methods

Brett Ballard, West Virginia University, John Stewart

Many studies of conceptual instruments, such as the Force Concept Inventory (FCI) and Force and Motion Conceptual Evaluation (FMCE), investigate weighted sum scores; however, most studies utilizing conceptual instruments use simple sum scores. In a simple sum score, all items are given the same weight, typically one, and item scores are summed together to form a total score. A comparison of different weighted sum and latent variable scoring methods with FCI and FMCE student responses was conducted to understand the impact of scoring on individual students and what these scores tell us about students' proficiencies. The simple sum score will be compared with latent ability scores from a range of unidimensional and multidimensional Item Response Theory (IRT) and Confirmatory Factor Analysis (CFA), and Cognitive Diagnostic Modeling (CDM) models. The use of predictive linear models to generate weights for the items in a weighted sum score will also be compared.

M-53: Developing a STEM Transfer-Self Efficacy Survey: Methods of item generation and validation

John Byrd, Michigan State University, Vashti Sawtelle, Rachel Henderson

Research suggests that self-efficacy is a productive lens that can provide potential for better understanding the complicated experience [1] of transferring from two-year colleges (associate-granting institutions) to bachelor's degree granting institutions. We have begun the development of a survey to measure community college student's STEM Transfer Self-Efficacy (S-TSE). In this talk/poster we will present the goals and progress of this development. We discuss the critical step of developing a new survey; generating items from multiple sources. Our first step of developing items for the S-TSE survey was to adapt existing items from the Laanan-Transfer Students' Questionnaire developed by Lanaan [2] and refined by Moser [3-4]. We then generated additional items through reflecting on the first author's personal transfer experience. We also adapted results from qualitative work studying transfer self-efficacy [1,5] to generate additional items. We will also present preliminary data on the process of validating these items for alignment with and coverage of the construct of STEM Transfer Self-Efficacy. Acknowledgement- This work is supported by the PROSPECT S-STEM Grant, NSF DUE-2138084, 2138058, 2138120, 2138074, 2138066. This work was also generously supported by the IMPACT STEM Transfer Network. All findings and opinions are those of the authors and not necessarily of the funding agency.

M-54: Changing Conceptions of STEM Identity in a Learning Assistant Program

Bradley McCoy, Azusa Pacific University, Elijah Roth, Karstin Dupont, Kaitlyn Fitzgerald

This poster focuses on qualitative and quantitative analyses of the Learning Assistant (LA) program at Azusa Pacific University. Quantitative results from the STEM Identity Overlap and STEM Career Interest surveys show no indication of changes in degree of STEM identity in the LA program. However, preliminary qualitative analysis of student and LA focus groups indicates that the LA program may shift students' perceptions of what a STEM identity is.

M-55: The Examination of Unique Items and Potential Subscales of the Colorado Learning Attitudes about Science Survey

Amanda Nemeth, West Virginia University, John Stewart

The Colorado Learning Attitudes about Science Survey (CLASS) probes respondents' attitudes about learning physics. The CLASS consists of 42 total items (36 total which are scored), organized into eight categories. These eight categories contain 26 items total, with several items appearing in more than one category. Douglas et al. (2014) conducted a factor analysis study on the CLASS, and proposed a simplified factor structure for the instrument, consisting of three factors and 15 items, with no items loading on multiple factors. The current study examines the Douglas results on a different dataset. While a full factor structure was not obtained, two promising subscales emerged in the analysis; one evaluating personal and real-world experiences, and a second pertaining to confidence in solving physics problems. Upon evaluating the factor structures of the CLASS, several items stood out as being unique – these items probed ideas not measured by any other item in the instrument. One such item is item 25: "I enjoy solving physics problems." These unique items could provide valuable information on interesting constructs important in physics education while enhancing the usefulness of the CLASS. This poster will focus on analysis conducted on the two possible subscales, and the items identified as unique in more detail.

M-56: Learning Assistant - Instructor Partnerships: An example from Astronomy

Mel Sabella, Chicago State University, Jacquelyn Benchik-Osborne, Andrea Van Duzor

Involving peer instructors, Learning Assistants (LAs), in instructional delivery has the potential to create spaces that support student performance in a variety of courses, from in-person to online, asynchronous settings. Relationships between LAs and instructors can leverage the expertise of the LAs and place them in leadership roles within the instructional team where they co-think, co-design, and co-develop activities and lessons with faculty, as well as provide insights about the students in the class and the learning environment. In this presentation we leverage a developing framework for identifying LA leadership to analyse LA participation in an online astronomy course to better understand the development of instructional partnerships and how these partnerships foster leadership development. Funded by the Department of Education (CSER, RECESS), the National Science Foundation DUE#1911341 & 2412938, and the Illinois Space Grant Consortium.

M-57: Large language models are effective for summarizing student feedback

Nicholas Young, University of Georgia, Christopher Overton, Ania Majewska, Hina Shaikh, Nandana Weliweriya

Student feedback of instruction is important for instructors as it provides a means for understanding learning needs, preferences, and challenges. Yet, for courses with a large number of students, such as introductory physics courses, reading through the feedback can be a time-consuming task, a potential barrier for already time-strapped instructors to regularly collect feedback in their courses. Large language models (LLMs) offer a potential solution as they are effective at summarizing large volumes of text. Combined with their ease of use through chat interfaces, instructors could easily and quickly summarize large amounts of feedback. In this study, we compared the performance of four popular LLMs (ChatGPT, Claude, Gemini, and Llama) to actual course instructors to summarize end-of-semester teaching evaluations from three instructors and eight course offerings at a large university located in the southeastern United States. In general, we find that LLMs identify similar trends in the evaluations as the human summarizers do, though we did find some differences in the detected themes and that some models perform better than the others on this task. Our work then suggests that LLMs are a useful tool for quickly extracting insights from student feedback. We end by providing best practices for instructors interested in using LLMs in their courses to summarize student feedback.

M-58: Declining usage of undergraduate physics tutoring

Richard Pearson, Embry-Riddle Aeronautical University, Hajara Mahmood, Jessica Chamberlin

Undergraduate tutoring centers are a common feature of collegiate institutions. It provides opportunities for peer-teaching and peer-learning, which has been found to be a very effective way of enhancing learning in and out of the physics classroom. However, overall usage of these services seem to be declining across the United States. Data from a private, aeronautical-focused institution explores this phenomenon and its impact on student perceptions and learning.

M-59: How students can use coherence to reconstruct (partially) forgotten equations.

Katherine Gifford, University of Illinois Urbana-Champaign, Eric Kuo, Engin Bumbacher, Gabriel S. Ehrlich

Introductory physics instruction emphasizes fluency with routine problem-solving procedures; however, even when applying these procedures, students frequently encounter challenges. This project investigates how students navigate such moments while answering qualitative E&M problems during interviews. Students frequently noted they had partially forgotten a key equation on a problem involving RC circuits. We present focal cases to show how coherence-seeking approaches were used to overcome this problem-solving challenge. We found that attempts to reconstruct these equations were guided by identifying and chaining qualitative dependencies and seeking coherence between their qualitative and mathematical understanding of the physical system. These moments of forgetting and reconstructing equations are a useful site for studying broader physics learning goals. While prior work attempts to expand students' use of mathematical sensemaking via explicit prompts, our cases illustrate students' spontaneous use of mathematical sensemaking strategies. We reflect on these cases to consider how such adaptive reasoning can be a target for instruction and assessment.

M-60: Fostering STEM Identity through Academic and Community Engagement

John Guire, District 215, Teresa Bixby, Joseph Kozminski

This study investigates how students' engagement in academic community (one-on-one faculty meetings, participation in undergraduate research, involvement with student organizations and attendance at department colloquia) relates to their sense of belonging in a college STEM environment. We collected Likert-scale survey data from underclassmen and upperclassmen to measure sense of belonging and conducted interviews to explore how students perceive scientists and their place within the scientific community. Preliminary results indicate that upperclassmen reported an increased sense of belonging among those with higher levels of faculty interaction and research. A notable pattern emerged in interviews: underclassmen described scientists as innately "smart people," while upperclassmen typically defined scientists by their activities, such as conducting experiments. This study, part of our S-STEM grant, included students from physics, chemistry, biochemistry, electrical and computer engineering, and data science. Findings suggest structured academic engagement may support belonging, though further data is needed to confirm this.

M-61: Pre- and post-course assessment designed for advanced Electricity and Magnetism (E&M) courses

Seth Read, James C. Hecht, Matthew Rundquist, John S. Colton, Andrew J. Mason

We have begun developing a pre- and post-course assessment designed for advanced Electricity and Magnetism (E&M) courses to evaluate students' conceptual understanding of selected E&M topics, as a basis for assembling a comprehensive multiple-choice assessment tool. Throughout the Spring 2025 term, students were given 48 true/false conceptual questions along with open-ended responses to explain their answers. The responses were then used to identify which concepts proved most problematic for students in order to design meaningful assessment items for testing those concepts, such as creating distractor answer choices. We will present selected questions, including the methods of interpreting the open-ended answers into effective multiple-choice responses. We will also discuss plans for validating the assessment items moving forward. We hope that the assessment tool will allow instructors to gain insight into students' prior and post-course knowledge, identify areas of misunderstanding that persist throughout the course, and test the effects of differing lecture styles. Additionally, the assessment tool may reinforce students' confidence in their learning, as improvements in post-test performance offer tangible evidence of their growth.

M-62: Enhancing STEM Graduate Student Teaching: The Cultivation of Teaching Skills and Identity among Graduate Students

Nishchal Thapa Magar, George Mason Univ, Jessica L. Rosenberg, Jill K. Nelson

This study examines the development of Graduate Teaching Assistants' (GTAs') teaching identity through professional development (PD) and hands-on teaching experiences. While prior research highlights how PD improves teaching practices, less attention has been paid to their impact on the formation of a cohesive teaching identity. Understanding GTA identity evolution is essential for designing PD programs that enhance teaching effectiveness. This study explores how structured PD, including pre-semester workshops and classroom experience, influences GTAs' instructional roles and student engagement. Data were collected from seven focus groups (33 GTAs) following a two-day pre-semester workshop in August 2023, along with one-on-one interviews with 20 GTAs throughout the academic year and 10 follow-ups in summer 2024. Using open and axial coding methods, the analysis identified key themes related to the development of teaching identity, and the difficulties GTAs encounter as they grow into their instructional roles. Findings reveal that GTAs initially held a limited view of their roles but, through PD and experience, developed a deeper, student-centered approach. They integrated insights from PD, personal skills, and prior learning to refine their instructional methods. This study underscores the need for PD programs that not only provide teaching strategies but also support GTAs in shaping their evolving teaching identities.

M-63: The impact of collaborative learning on individual exam performance in a Introductory Physics class.

James Addison III, Lamar Univ, Binod Nainabasti

This study explores how collaborative learning impacts individual performance in a physics class. It aims to identify better learning strategies in group work that help students improve their understanding of physics concepts on their own. Students participated in two types of assessments: six group tesst, where they could freely discuss problems and use all available resources, and a subsequent individual exam after every 2 group tests with similar questions. The purpose was to determine how working together influences their ability to learn and apply physics concept independently. Both the group and individual test were graded using the Physics Problem Solving Rubrics. Observation notes were also taken to analyze student behaviors and identify the most and least successful groups based on their individual exam scores. The study compared how students interacted during the group test with their performance on the individual exam, focusing on effective group behaviors such as explaining ideas to peers, resource usage, and reaching consensus. Early results suggest that students who actively discussed concepts and took on different roles during group test tended to understand the material better and scored higher on the individual exam.

M-64: Exploring Multiple-Intelligences and their Connection to Students' Challenges in Preparatory Physics Class

Christopher Ezike, Lamar University, Binod Nainabasti

For over two decades, Lamar University's Department of Physics has offered the Preparatory Physics Foundational (PPF) course to better equip intended STEM students for calculus-based Physics 1. This study investigates how multiple intelligences (MI) affect academic performance and confidence in the course. Using Howard Gardner's MI framework, 232 students were classified as analytical, introspective, or interactive. Half were introspective, with the remaining students split evenly between the other two types. At end of the semester students were asked to report their confidence level to pursue their STEM degree, revealing that one-third of students felt less confident by the end, while almost half had no change. The primary goal of this research is to help teachers tailor their teaching strategies to better align with students' diverse intelligence types. Our results show that interactive learners demonstrated the greatest academic growth, as reflected in exam scores from our current way of teaching. Additionally, the results will serve as a guide for educators to run their class by using different teaching methods to effectively communicate course material and support all learners, regardless of their intelligence profile.

M-65: Weekly formative assessment with the LASSO Platform

Jayson Nissen, Montana State University, Vy Le, Ben Van Dusen, Jason W. Morphew, Jing Huang, Yuxiao Zhang, Kevin Roberge, Hua Hua Chang

The LASSO project has improved the Mechanics Cognitive Diagnostic (MCD) for introductory mechanics courses. Initially measuring three skills across four content areas, the MCD now incorporates 36 targeted learning objectives to closely align with standard physics curricula for introductory mechanics courses. Using data from existing research-based assessments, we applied cognitive diagnostic models to test these learning objectives. These models confirmed a good q-matrix fit for the 13 objectives measured by the available data from existing research-based assessments. The updated MCD, covering approximately half of the 36 learning objectives, is now available on the LASSO platform. Instructors have the flexibility to select specific learning objectives and assessment timing to best suit their course requirements.

M-66: Results from two semesters of implementing skill/competency-based grading in introductory university physics

Kyle Altmann, Elon University, Martin Kamela

In this poster we present outcomes from two years of implementing skill/competency-based grading in University Physics II, the second half of a two-semester introductory physics sequence that focuses on waves, electricity, and magnetism. Every skill could be assessed multiple times to show proficiency - twice scheduled in class, and up to once a day for the following week. Questions on quizzes, and in homework assignments, were labelled by specific skill at either satisfactory or advanced competence level. Student opinions on the assessment system were collected via survey, and student performance was compared to previous semesters in a more traditional instructional style.

M-67: Comparison of Student Performance on Open- and Closed-Response Versions of a Research-Based Assessment

Michael Freeman, University of Colorado at Boulder, Bethany R. Wilcox, Steven J. Pollock

Closed response assessments can be scored by computer and administered online, thus increasing the ease with which they can be given to large populations of students. We have translated the Colorado Classical Mechanics and Math Methods Instrument (CCMI) from an open-response format to a closed-response one. To determine if scores on this new, closed-form CCMI can be compared to the old, open-response CCMI, we performed a comparison of students' responses to both versions of the instrument. Preliminary findings suggest that many of the items show comparable responses in both formats, but a small number show significant differences. In this poster, we will both present preliminary results comparing the two formats and discuss characteristics of the items that translated well and those that did not. We believe that these findings will be found valuable by the assessment design community in understanding what kinds of assessment items can easily make the transition to closed- from open-response.

M-68: Developing a cognitive diagnostic of calculus skills for physics

Kevin Roberge, MA Mathematics, University of Maine, Vy Le, Jayson Nissen, Ben Van Dusen, Yuxiao Zhang, Jing Huang, Jason W. Morphew, Hua Hua Chang

Cognitive Diagnostic Computerized Adaptive Tests (CD-CAT) measures student skill development. To develop a CD-CAT for calculus skills, we analyzed data from the LASSO platform for 4,168 students on 3 math research-based assessments using item response theory and cognitive diagnostic models to evaluate the items from these assessments and their fit to our proposed learning objectives. The initial result shows good item psychometrics for almost all of the items. This indicates that calculus CD-CAT can provide a reliable and valid measure of calculus learning objectives that can inform instruction and research to improve student learning outcomes. A calculus CD-CAT can guide the research, development, and implementation of effective strategies and curriculum in physics education.

M-69: Constructing an Assessment Pyramid in Introductory Physics

Joshua Veazey, Ph.D, Grand Valley State University

Alternative grading systems can increase student engagement with instructor feedback, making homework and exams more useful for learning. But does an introductory course structure necessarily need to be designed with traditional homework and exams? I will discuss how key features of alternative grading systems--such as growth-oriented feedback and reassessment without penalty--enabled a reimagination of how to design and schedule formative and summative assessments. In the grading system for a recent undergraduate introductory mechanics course, three categories of assessments were structured into a hierarchy pyramid, where students earning A grades at the end of the course had demonstrated proficiency in more complex tasks than students earning C grades at the end of the course.

M-70: Synthesizing multiple theoretical frameworks to create actionable assessment feedback

Parker E. Poulos, Kansas State University, Michael Freeman, Bethany R. Wilcox, James T. Laverty

Assessment feedback is vital to course improvement. However, many research-based assessments (RBAs) don't center written feedback for instructors as a priority of their design. The theory of action (ToA) for the Thermal and Statistical Physics Assessment (TaSPA) centers this RBA as an instrument for course improvement through its written, actionable feedback. This feedback has been created using Evidence-Centered Design (ECD) and Self-Regulated Learning (SRL). These frameworks work within the theory of action to create feedback that promotes instructor reflection about the course and how it can be improved. We discuss how the feedback was created, how scores are compiled into meaningful categories, and how instructors react to this new format of feedback from RBAs.

Physics Education Research: Belonging and Access

M-71: Courses to Careers (C2C) Workshop: Professional Development through Student-Instructor Partnerships

Daryl McPadden, Michigan State University, Matthew W. Guthrie, Xian Wu, Theodore Bott, Tanya Adams, Erin M. Scanlon

Over the past year, we have developed the Courses to Careers (C2C) workshop, which is a dual-thread, professional development (PD) experience that is centered on creating faculty-student partnerships to address ableism in physics courses and careers. With both faculty and disabled students in the room, this workshop employs a unique model that elevates and centers disabled students' expertise and lived experience to aid in course reform, while the same disabled students also benefit from faculty expertise in potential STEM career pathways. In this poster, we present the structure of the workshop; highlight how multiple theoretical frameworks and the values central to our team influenced the activity design; and initial impacts on participants from the first implementation. This work is supported in part by NSF Grant Nos. DUE 2336367 and DUE 2336368.

M-72: Professional Development for Accessible Courses and Career-Building Using Student-Faculty Partnerships

Alex Reynolds, Andrea Wooley, Matt Guthrie, Xian Wu, Erin M. Scanlon, Daryl McPadden

With an increase in disabled students in physics, physics classes need to be more inclusive to students with a variety of disabilities, and disabled students need to be supported in their unique needs in finding careers with their physics degrees. Designed to meet both these needs, Courses and Careers (C2C) is a week-long professional development workshop that brings together faculty and disabled students to learn from each other. Faculty will focus on learning accessible classroom practices, with disabled students sharing their expertise on course accommodations and accessibility. In turn, disabled students will learn about career preparation, including how to navigate their needs and accommodations, with faculty guiding them. This study analyzes post-workshop interviews from attending faculty and students using thematic coding and revealed causal mapping. We will share preliminary analysis looking at participants' experiences in the C2C workshops and the successes and challenges of encouraging student-faculty partnerships.

M-73: Identifying Structural Barriers to the Inclusion of Transgender and Nonbinary Physicists

Erin Syerson, Western Michigan University, Charles Henderson, Adrienne Traxler, Ramón Barthelemy

Transgender and gender-nonbinary (T/GNB) people are often excluded from research studies investigating how gender shapes educational experiences in STEM. Nearly all of these studies focus exclusively on cisgender populations. T/GNB students encounter significant discrimination within physics courses and departments, often resulting in their departure from physics and, in some cases, from STEM fields altogether. To combat the negative climate towards T/GNB populations and assist efforts toward inclusion, this poster presents the preliminary findings of the first systematic documentation of T/GNB physicist experiences. This analysis identifies harmful department structures and cultural norms that affect both belonging and retention of T/GNB students. These findings will inform the next national LGBT+ Climate in Physics Report, scheduled to begin this fall. This work is funded in part by the CAS Graduate Research Assistantship at Western Michigan University.

M-74: A Journey to Become Aware of How Our Transfer Students of Color Experience Systemic Discrimination

Camila Monsalve, Michgan State University, Vashti Sawtelle

Advocates are people who support transfer students of color to obtain a bachelors in STEM while being aware of the students' needs and the demands of the institutions. These two could be at odds for TSOC-STEM but advocates do and learn about how to resist the dominant perception of scientists. We start by extending the work of Acevedo (2020). Her work was focused on high school teachers who are Nepantleras in supporting students to continue their education past high school, while my work is extending her codes towards a different space, the bachelor degree-granting institution (BDGI). Within the space the Nepantlera/o/x are faculty and staff who are supporting transfer students from an associate degree-granting institution to successfully confer their STEM degree. Similarly to extending Acevedo's work, I extend the Aguilar-Valdez and colleagues (2013) work on the stages of the path of conocimiento of a K-12 STEM teacher towards the BDGI space. In this work two new codes emerged and are named Mestiza/o/x consciousness and thoughtful language. These two codes have given me the opportunity to discuss the Nepantlera/o/x navigation of the path of conocimiento which has seven stages that are fluid and flexible to be at different stages at the same time.

Physics Education Research: Intro

M-75: Examining student engagement in science practices in introductory physics laboratory courses

Kaitlyn Bolland, Tra Hyunh, Lina Dahlberg, Norda Stephenson, Jess Weaver, Kanaili Singkeo, Lukas Spring, Elayna Worline

Our work explores student engagement in science practices across introductory chemistry, biology, and physics laboratory courses, with an emphasis on the well-defined practices in the Framework for K-12 Science Education and the Next Generation Science Standards (NGSS). Specifically, we use the Three-Dimensional Learning Assessment Protocol (3D-LAP) to look for evidence of science practices in laboratory materials across the three disciplines. In this presentation, we will share our characterization of science practices in introductory physics labs based on our examination of laboratory manuals and video observation data, and discuss how science practices are situated in the physics laboratory curricula and expressed in the physics laboratory classroom. Our data analysis indicates that Developing and Using Models, Analyzing and Interpreting Data, and Using Mathematics and Computational Thinking are among the most highly represented practices in the physics curricula. We discuss the implications of our findings for the design and development of physics curricula, as well as the teaching and learning of physics.

M-76: Examining the Effectiveness of a Self-Regulated Learning Intervention in Introductory Physics.

John Stewart, West Virginia University, Danielle Maldonado

This poster will detail the use of a previously developed self-regulated learning instrument that measures learning behaviors in a college calculus-based introductory physics course. Students received an intervention in the form of short instructional segments on self-regulation strategies and how to implement them in a physics environment. These techniques fell into one of five categories: Planning, Time and Study Environment, Comprehension Monitoring, Peer Learning and Help-Seeking, and Evaluation. Students were encouraged to use these techniques in preparation for course exams, with four surveys offered throughout the semester asking students to evaluate the extent to which they exhibited certain self-regulated learning behaviors. Student data were analyzed to identify trends in technique usage and compare them to their end-of-semester course grades. This poster will also explore the effectiveness of the intervention by comparing student technique usage and end-of-semester grades to previous semesters in which no intervention was used.

M-77: Connecting Culture and Curriculum: Climate Change and Energy in Introductory Physics Classes

Larissa Jalloul Guimaraes, Al K. Snow, Hanan Mohamed, Abigail R. Daane

Although much has been explored regarding introductory physics students' everyday ideas about energy, it is often still taught in much the same way as it was 30 years ago (e.g., cannons, roller coasters, skateboarding). During this period, the climate crisis and society's energy consumption has become a culturally important topic, largely neglected in physics courses. Instructors at a Pacific NW community college introduced activities designed to explicitly tie physics energy topics to climate change issues (Levy et al., 2023). We collected post-lesson student written reflections, stating their views of connections between energy topics in physics and climate change, from these classes and another class that did not implement this lesson. We coded responses using a phenomenographic qualitative analysis and found that a greater number of students who engaged with this lesson identified climate-change connections. We make recommendations for a more robust, culturally-relevant integration of climate change into physics education.

Physics Education Research: Beyond Intro

M-78: Affordances and challenges of formative self-assessment in upper-division physics

Molly Griston, University of Colorado - Boulder, Bethany R. Wilcox

In supporting student learning, it is necessary to foster conceptual understanding and metacognitive skills. By forefronting reflection as a part of problem solving, formative self-assessment can target both of these competencies. Here, we present a specific type of self-assessment, homework corrections (HWCs), in which students have the opportunity to earn credit by correcting their homework assignments. Using data from an upper-division physics course, we consider the potential benefits of HWCs, as well as the observed challenges. Specifically, we focus our attention on students' difficulties in identifying their errors, the insight this provides into their problem solving and reflective processes, and the necessary considerations for implementation to ensure meaningful and productive engagement.

M-79: Can Students Develop Meaningful Conceptual Reasoning for Quantum Measurement?

Jason Tran, Georgetown University, Jim Freericks, Leanne Doughty

In physics education, experiments play a crucial role in testing and validating theoretical concepts, providing empirical evidence to support or refute existing theories, and allowing students to apply theoretical knowledge to real-world scenarios by observing and measuring physical phenomena. Quantum mechanics has unique limitations in hands-on experiments due to challenges in conducting single-particle experiments (including their cost and the difficulty of setting them up properly). Our study examines the learning in a course designed to instead engage physics majors in conceptual discussions of quantum experiments, such as the Mach-Zehnder interferometer, through tutorial-based simulations in addition to more traditional formal treatments. This talk focuses on how students compare the mathematical formalism with the conceptual description of quantum experiments including their mastery of the material and their preferences for how to describe them.

M-80: Evaluating Large Language Models for Small-Scale Data Analysis in Physics Education

Matthew Rundquist, Brigham Young University, James C. Hecht, Seth Read, Andrew J. Mason, John S. Colton

This study investigates the potential of large language models (LLMs) to assist in the analysis of small-scale data sets, using previously collected survey responses compiled in an Excel spreadsheet. In this analysis, we compare the performance of several prominent AI platforms (e.g., ChatGPT, Grok, Copilot, Gemini, etc.) in a two-phase evaluation. In Phase 1, each AI was prompted with standardized, broadly applicable research questions (e.g., "What trends are present in this data set?" or "How might this data inform future studies?") without further clarification or correction. This phase is designed to assess each model's baseline utility and reliability when applied directly to social science data. In Phase 2, the same AIs were re-engaged with the same questions, but with limited human assistance—such as correcting factual or analytical errors while maintaining the original inquiry style. This comparative approach helps identify whether and how human intervention improves AI performance in qualitative and semi-quantitative data interpretation. By highlighting the capabilities and limitations of current LLMs in this context, this study aims to inform more effective, scalable approaches to analyzing student feedback and instructional outcomes—ultimately supporting evidence-based improvements in physics teaching, especially in settings where only limited data is available.

Session E0-1: Reframing How We Teach Physics for Engagement: Explorations

Location: Declaration A **Time:** 9–10 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Edgar Corpuz

E01-1: 9–9:12 a.m. Working for Veritasium

James Lincoln, San Mateo College

In 2021 I was recruited by Derek Muller, of YouTube's top science channel Veritasium, to contribute script content and demonstration equipment to the video "Risking my life to Settle a Physics Debate." In this video, Derek drives a car that is powered by the wind – yet – travels faster than the wind. The physics seems so impossible that many of us were asked to help explain how it is all possible. In this talk, I provide a backstage pass to see how these videos are made, explain my role in the project, and which explanations were written by me. I also demonstrate my prototype toy version of the "Black Bird" vehicle, built with found materials, that can be replicated in any high school or middle school classroom.

E01-2: 9:12–9:24 a.m. Power Play: An Energy Infrastructure Game

Evan Halstead, Ph.D., Skidmore Coll

Helping students grasp the complexities of transitioning to renewable energy requires more than equations—it demands an understanding of political, economic, and social constraints. In my Physics and Society course, I developed a role-playing game called Power Play where students plan energy infrastructure for a growing island community. Divided into four teams—residents, businesses, government, and science advisors—students negotiate competing interests while balancing costs, environmental impact, and public approval. Through this simulation, students confront real-world challenges such as grid reliability, policy incentives, and the role of science in decision-making. This talk will outline the game's design, share student reactions, and present lessons learned from the first iteration.

E01-3: 9:24–9:36 a.m. Teaching Students How to Explain Big Ideas with Simpler Words

Mike Florek, Glenvar High School

Special science language plays a big part in our lives. We often do not notice how confusing our language can be until either you or someone else just doesn't understand the words being used. The reason for this talk is to show you one way of teaching science-word-using to students in a fun and easy to remember way.The idea for this talk came from the book Thing Explainer, by Randall Munroe. This talk will step through the steps of writing a student-led Thing Explainer, from choosing ideas to reading science papers to drawing pictures to choosing words other people can understand. We will cover good things and bad things that go along with the Thing Explainer and enjoy pieces of student work.

E01-4: 9:36–9:48 a.m. Print, Launch, Learn: 3D Design Meets Physics in Project-based Learning

Ross Gunderson, Eastern York High School

Integrating 3D design and printing into physics education transforms traditional learning into an engaging, hands-on experience that fosters creativity, problem-solving, and engineering skills. This presentation explores how project-based learning (PBL) assessments can be enhanced using 3D-printed components, with examples including water rockets, cars, boats, and more. Attendees will gain insights into designing meaningful, standards-aligned projects that challenge students to apply their knowledge while developing critical thinking and technical skills. Practical implementation strategies, including software selection, printer accessibility, and student assessment methods, will be discussed. Additionally, the session will highlight student successes, common challenges, and best practices for integrating 3D design in a physics curriculum.

E01-5: 9:48–10:00 a.m. The Projectile Motion Challenge: A Differentiated Approach to Engage Students

Emily James, Brewster Academy, Justin Connell

The final assessment for the kinematics module, known as "Ball in the Cup," evaluates students' understanding of projectile motion. In this activity, students must predict the mid-trajectory location of a ball rolling off a ramp using only their knowledge of projectile motion, a ruler, and an angle indicator. A cup is placed at the student's predicted location. Students release the ball down the ramp to see if it will successfully land in the cup. To enhance their understanding and improve accuracy, students first conducted a laboratory experiment investigating the relationship between ramp height and the ball's range. This presentation will outline the experimental apparatus, instructional sequence, and grading rubric for the student's written reports. Leveling the project for different student capabilities will be addressed.

Session E02: Apparatus for Fluids: Part 1

Location: Declaration B **Time:** 9–10 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Randy Tagg

E02-1: 9–9:24 a.m. An Electromagnetically-Driven Flow Cell for Studying Flow Instabilities

Invited–Daniel Borrero, Willamette University

Flow instabilities occur when there is a sudden change in the behavior of a fluid as system parameters are varied. Typically, these instabilities involve spontaneous symmetry breaking and are mathematically closely related to second order phase transitions in statistical mechanics. In this talk, we will discuss a simple table-top experiment in which flow instabilities are induced in a thin layer of electromagnetically-driven electrolyte. This apparatus can be constructed inexpensively (~$300), takes minutes to set up, and is similar to systems used by scientists to understand the phenomenology of large-scale motions in atmospheric and oceanic flows. The apparatus can be used to demonstrate several different ideas in fluid dynamics including Reynolds similarity and flow instabilities using basic flow visualization, but can also be made quantitative using standard flow measurement techniques like particle image velocimetry. Such measurement techniquest are widely used in engineering applications ranging from aerodynamics and materials testing to biomechanics and cancer research.

E02-2: 9:24–9:48 a.m. Open-Source Hardware in Fluid Mechanics

Daniel M. Harris, Brown University

While open-source software has become relatively commonplace, advances and contributions in open-source hardware are far more limited. Nevertheless, the increasing accessibility of rapid prototyping tools and the proliferation of makerspaces over the past decade has dramatically expanded the potential impact. In this talk, I will review some recent hardware projects from our lab developed and released for research, educational, and outreach applications. Throughout this discussion, I will also highlight some of the current best practices associated with design and documentation in this space. Overall, open-source hardware represents a promising approach towards making experimental science more accessible, engaging, collaborative, and reproducible.

Session E03: Reframing How We Teach: Museum Collections, Art and Literature

Location: Franklin/McPherson **Time:** 9–10 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Jeremy Hohertz

E03-1: 9–9:12 a.m. Exploring Historical Atwood machines: Students Enact Democratic Science

Elizabeth Cavicchi, Dr., Ed.D., Massachusetts Institute of Technology

Doing physics immerses us actively in the unknown, involving eyes, minds, senses, hands and community in questioning and engaging with phenomena and possibility. The historical Atwood machine poses such an unknown for university students in the exploratory seminar I teach. Participants practice openness in: doing open-ended activities: listening with mutual respect; following curiosity; and intellectual risk-taking. Colleagues MIT physics demonstrator Chris Miller, physicist Peter Heering and historian Joshua Gorman and I invite students to explore MIT's 19th century Atwood machine. We provide excerpts from Atwood's 1784 Treatise; later we take students to Harvard's instrument collection. The apparatus is provocative, attracting curiosity in diverse ways. Having explored holes and light in other sessions, one student exclaimed "It's got holes!" That group noticed what fits in those holes: cylindric weights. Next they trialed dropping weights through holes. Another class spun the wheels; one wondered "What is the point of the wheels?" Each group collaboratively developed experiments from their questions and manipulations. Video excerpts illustrate these evolving activities. Students develop understanding and experiences together, through playfulness and puzzlement. They democratically enact physics process via their own creativity, evidence and tentative, changing ideas – characteristics identified in the research literature as fundamental for nature of science (NOS) instruction.

E03-2: 9:12–9:24 a.m. Atwood Machines: Close Looking and Design Thinking

Christopher Miller, SB, Massachusetts Institute of Technology

The canonical device used in George Atwood's 1784 "A Treatise on the Rectilinear Motion and Rotation of Bodies" was the recent subject of Recreate Experiments from History, Elizabeth Cavicchi's seminar in the MIT Edgerton Center. There, I have been showcasing an 1870s Atwood machine from MIT's lecture demonstration collection. This coincided with a talk by Peter Heering, Professor of Physics and its Didactics at Europa-Universität Flensburg, on the reconstruction of a 1795 model at the Deutsche Museum - used to train elementary educators on leading Nature Of Science investigations. Additionally, we visited Harvard's Collection of Historical Scientific Instruments with its new director, Josh Gorman, to see a number of Atwood Machines including Harvard's English model purchased in 1799. I'll share discoveries from close-looking at the design of these devices and broad themes that emerge from students as part of a pedagogy slowed down to focus on instrumentation. In particular, a number of elements reflect the device's original intent: to demonstrate proportionality in kinematic relations by synchronizing the sounds of release and collisions with metronome intervals - all through carefully pre-selected sets of weights. This is far from the idealized model in our intro courses of two masses and a (possibly massless) pulley being timed to measure g or simply being balanced at unequal heights to solidify force concepts - and which also hides the role of the designer and experimenter.

E03-3: 9:24–9:36 a.m. Teaching with Museum Collections: Exploring Comprehensive Didactic Use

Joshua Gorman, Collection of Historical Scientific Instruments, Harvard University

The rise of object-based education in American museums was frequently in conflict with core preservative impulses in the sector that regarded removing collections and art objects from the dangers of handling and use as a central function. In creating so-called "teaching collections" intended for direct didactic access and use, museum educators were afforded a second-tier collection of objects that they (and sometimes their students) could handle and use in the service of learning. Harvard's Collection of Historical Scientific Instruments is currently experimenting with a radical reframing of these parameters of access, understanding that unused collections are useless and presuming that all holdings should be available for direct didactic use. In conversation with Christopher Miller's use of historic Atwood's machines for Close Looking and Design Thinking; with Elizabeth Cavicchi teaching through Democratic Science; and reviewing multiple ongoing research projects utilizing historic instruments, I propose an outcome-based reassessment of risk that prioritizes student engagement and contextualization as primary goals of curation and care.

E03-4: 9:36–9:48 a.m. Light Beyond Physics

James Dakin, Ph.D., Appalachian State Univ

There is light beyond physics, both in the very many academic disciplines that involve light, and in the teaching about light using non-traditional methods. In retirement from an academic, then industrial, physics career, I have been heavily involved in such endeavors. I have published two books addressing light beyond physics, one with some STEM-friendly equations and graphs, and one without. 1,2 In 2023 I taught an interdisciplinary sophomore honors seminar at Appalachian State University, which followed my more STEM-friendly book, but focused on the students choosing individual topics of personal interest involving light, doing scholarly research on those topics, and then teaching their classmates. Topics included: optical illusions; role of color and vision in the world of plants and animals; historic pigmentation on classic marble sculptures; designing with color, psychology of color; iridescent phenomena; Light IS waves, Christiaan Huygens (1629–1695); greenhouse effect, global warming, Joseph Fourier (1768–1830); UV, pigmentation, and vitamin D; and Seasonal Affective Disorder (SAD). There was only one STEM student in the class, a math major. Many chose topics related to their majors. A psychology major, for instance, taught us about SAD, which led to a summer job for her. I learned things from every one of these presentations. One thing that I learned through teaching the course was that these non-STEM honors students found the material fascinating, but were generally turned off by the few STEM equations that I included in the core lectures.
This led to my book without equations and graphs, which uses images of art in museums to teach. 2

E03-5: 9:48–10 a.m. Recommended Books for you to Read

Frank Lock, B.S. chemistry & secondary science education, AAPT

This talk will provide information about books that have been reviewed in The Teachers Clearinghouse for Science and Society Education Newsletter, edited by John Roeder. The book reviews presented provide information about science, AI, engineering, climate chenge, science in government, and science education. All are enjoyable to read and informative.

Session E04: PICUP: Exercises and Laboratories that Integrate Computation

Location: Wilson/Roosevelt **Time:** 9–10 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Steve Spicklemire

E04-1: 9–9:24 a.m. Computations for a Finite Quantum Well

Invited – Michael Burns-Kaurin, PhD, Spelman College

Computers in physics teaching can do diffi9:cult or impossible calculations and can make pictures or animations that illustrate concepts not amenable to direct physical demonstrations. This talk will show both of these uses of computers. An example of the first use is the PICUP exercise set "Light Emission from a Finite Well", which has students write or adapt code to find the width and depth of a well that would produce a photon of a particular wavelength. An example of the second use is a program and a spreadsheet that each graphically shows how changing the well parameters affects the wavefunction and the energy of a bound level.

E04-2: 9:24–9:36 a.m. Wilberforce Lite: Energy Evolution of a Doubly-Resonant Elastic Pendulum

Invited – Bob Brazzle

A Wilberforce pendulum is a well-known system in which a mass bobbing on a vertical spring alternately shares energy between longitudinal and torsional oscillations. The geometry of a typical spring naturally couples these different oscillation modes. But the coupling itself makes the analysis of motion firmly beyond the level of an Introductory Physics course. There is a more-accessible system that can be analyzed in the Introductory Physics course (both experimentally and computationally). I do a lab in which students determine a spring constant both statically and dynamically. When a specific mass bobs vertically on a typical spring, the system begins swinging like a pendulum, and energy is periodically exchanged between these two oscillation modes. Interestingly, the bobbing frequency is exactly twice that of the swinging frequency. In my talk, I will discuss how to computationally model this system and compare the model to real data. I will also describe the equipment setup, and display the system's energy evolution on a ternary energy diagram.

E04-3: 9:36–9:48 a.m. Beyond Strings: Membrane Wave Explorer

Duncan Carlsmith, PhD, University of Wisconsin - Madison

Learn how to model waves on membranes with arbitrary shapes, anisotropic and shear stress, and spatially varying material properties with a free interactive educational Live Script "wave laboratory."[1] Topics to explore include normal modes of unusual shapes, tunneling, scattering, diffraction, and the effects of shear stress on wave propagation.

E04-4: 9:48–10 a.m. Presenting an Interactive Jupyter eBook on Relativity Theory

Donald Smith, Guilford College

I will present an overview of an interactive electronic textbook I have developed on Einstein's Theory of Special Relativity. Based on an original PDF text by my late colleague Prof. Rexford Adelberger, I have expanded his content into a 14-chapter Jupyter Book on four-vectors, spacetime, relativistic dynamics, electromagnetism, and a brief introduction to the ideas of General Relativity. I use VPython to create interactive animated illustrations that allow the user to change parameters like the relative speed between reference frames, or to rotate the simulation and view it from different angles. I have used this textbook in two classes so far (Fall 23 and 24) at the sophomore level. I also required students to develop homework sets in Jupyter Notebooks so they could program their own spacetime diagrams and Lorentz Transformations. I will show examples of how the book works and share student reactions. In closing, I will preview a second volume on particle physics, using a discovery-based approach that will allow the reader to follow in the footsteps of 20th Century Physics to develop the Standard Model. Together, these two volumes could be used as a interactive textbook for an Introduction to Modern Physics course.

Session E05: Developing Scientific Reasoning and Decision-Making Abilities: Part 1

Location: Cabin John/Arlington **Time:** 9–10 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Krista Wood, PhD

E05-1: 9–9:24 a.m. Introductory Physics Scientific Reasoning Labs with In-Class Collaborative Lab Report Writing

Invited – Kathleen Koenig, PhD, Professor, University of Cincinnati - Main Campus
Lei Bao, Krista E. Wood, Patrick Boyle

The ability to effectively engage in evidence-based decision-making is an important educational outcome, yet the typical college course does not explicitly address the necessary underlying skills. Over the past decade, we have developed and evaluated an introductory physics lab curriculum designed around the theory-evidence coordination (TEC) framework to advance subskills in three areas of reasoning, including control of variables, data analytics, and causal decision-making. While students showed gains in scientific reasoning (SR) as measured by the Inquiry in Scientific Thinking, Analytics, and Reasoning (iSTAR) assessment, we recently modified the curriculum to require students to write lab reports collaboratively in class rather than individually at home. The shift was driven by concerns over increased reliance on ChatGPT and past student reports. This presentation will highlight course features that support the development of essential reasoning skills, as well as how structured in-class lab report writing, supported by the use of embedded question prompts and graphic organizers, promotes deeper engagement with scientific reasoning. Research outcomes for the impact of the curriculum on targeted skill areas will also be discussed.

E05-2: 9:24–9:36 a.m. Sense of Belonging and Scientific Reasoning Skills in a TYC Physics Lab Course

Krista Wood, PhD, Univ. of Cincinnati Blue Ash College, Kathleen Koenig, PhD, Lei Bao

Student sense of belonging in physics classes has been shown to play a role in student course outcomes and student persistence. We wanted to know how sense of belonging affects student development of scientific reasoning skills in an Introductory Physics Lab course at a two-year college. Using pre and post-tests for a Sense of Belonging survey and the Inquiry in Scientific Thinking, Analytics, and Reasoning (iSTAR), we studied the relationship between student sense of belonging and their development of scientific reasoning skills. This talk will share our results.
*Partially supported by the NSF IUSE 2110334

Session E06: Improving Pathways to a Physics Degree and Career

Location: Bulfinch/Renwick **Time:** 9–10 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Kristin Oliver

E06-1: 9–9:12 a.m. Demystifying Organizational Change for Educators Seeking to Bring Research-based Approaches to the Physics Classroom

Diane Jammula, Rutgers University - Newark,
Anthony Mannino, Sheehan Ahmed, Joshua Rutberg

There is a gap between the development of research-based instructional practices and the implementation of these practices in physics classrooms. One reason for this gap is the lack of administrative and organizational support in educational institutions. In this presentation we review literature on organizational change and analyze a case study of the transformation of the physics department at Rutgers-Newark. A physics instructor with a newly minted PhD in Science Education initiated this transformation using her knowledge, passion, intuition and the Physics Education Research (PER) community. Battles were fought, coalitions made, and collaborators hired. Now, all introductory physics courses led by 20 instructors and serving 300 students/semester are taught using the constructivist approach Investigative Science Learning Environment (ISLE), and active learning permeates the full undergraduate program. This case is noteworthy as it was started by the lowest level of full time faculty (an instructor). Findings help pave the way and offer tools for educators seeking to implement research based approaches in their classrooms and beyond.

E06-2: 9:12–9:24 a.m. Who Do REUs Help? Results from Surveys of REU Students and Two-Year College Faculty

Jonan-Rohi Plueger, University of Colorado - Boulder, Bethany R. Wilcox

A major NSF goal in funding Research Experiences for Undergraduates (REUs) is reaching students with limited access to research, such as students from two-year colleges. Many such students have family and home circumstances that may impact their access to REUs. We surveyed (1) current REU students about their family and home circumstances and (2) two-year college faculty about whether they would recommend REUs to their students, and why. We present our results and their relevance to REU design and recruitment.

E06-3: 9:24–9:36 a.m. Cosmic Pathways: Developing a Career-Focused Regional Conference to Encourage High School and College Students to Pursue Physics in Higher Education

Matthew Wright, Adelphi University,
Carissa Giuliano, Angela Kelly, Robert Krakehl, Patricia Mueller

We have developed a novel conference for high school and college students with an interest in physics for the greater New York City area. The purpose of the conference was for students to explore answers to the following question, what can you do with a physics degree? This one-day conference occurred in March 2025 at City College of New York and had approximately 180 participants. This will be the first of many future conferences. Industry leaders, graduate students, and college physics departments were invited to participate in talks, panels, and an industry floor show creating presentations designed for first year college students and senior high school students. We will discuss data collected about attitudes about physics before and after the conference.

E06-4: 9:36–9:48 a.m. Utilizing Physical Science Applications To Become a More Versatile Life Scientist

Ramella Suber, Carnegie Instit of Washington

All STEM fields are interdisciplinary, including physics. Subfields such as biophysics, biomechanics, and bioinformatics are rapidly increasing in popularity, as scientists wish to study biological systems through a physical science lens. As a lab technician and life science educator with a background in Biology Pre-Medicine, I have gone through an interdisciplinary journey with the Carnegie Academy for Science Education (CASE). CASE's physical science program, First Light, widened my comprehension of physics, its applications, and how life science can support physics, thereby establishing my versatility as a scientist. I have also instructed life science students in biotechnology, while introducing physical science applications to amplify their knowledge base and utilize skills from multiple fields. This has helped them to become more effective, interdisciplinary researchers. In this presentation, I will share my experiences engaging your students to think about the intersection of biology and physics, and how it will support their careers.

Session E07: Towards a More Equitable Physics: Research and Practices for Inclusion: Part 1

Location: Penn Quarter AB **Time:** 9–10 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Camila Monsalve

E07-1: 9–9:12 a.m. Empathy in Practice: Applying the Two-Pathway Physics Empathy Framework

Alia Hamdan, Rochester Institute of Technology,
Scott Franklin, Dina Newman

We present a two-pathway framework for faculty empathy — the ability to understand and resonate with anothers' internal state — and demonstrate its applicability to datasets from a variety of educational contexts. The framework explicitly raises mediators and moderators for both cognitive empathy, a deliberate process that requires significant cognitive effort, and affective empathy, a quick, instinctive response that arises from a shared experience. Applying the empathetic framework provides a new lens to understanding faculty-student interactions and the new interpretation gives valuable additional information about relationships that are critical to students' success. By applying our work to a wide variety of data we demonstrate the flexibility and adaptability of the two-pathway empathy model and give concrete examples of how researchers and practitioners can apply it in practice.

E07-2: 9:12–9:24 a.m. Neuroinclusive Pedagogy – Results from a Systematic Literature Review

Liam G. McDermott, Ph.D, University of Connecticut,
Avery Point, Mason D. Moenter, George R. Keefe, Erin M. Scanlon

Neurodivergent students learn and perform STEM in ways which traditional pedagogical best-practices push to the margins. As more neurodivergent students enter college, it is critical that we, as instructors, interrogate and adapt the ways that we teach, construct curricula, and empower all students. We cannot, however,

construct neuroinclusive pedagogies without first having a picture of how neurodivergent students learn and perform the subjects we teach. To that end, we have conducted a systematic literature review of over 2,000 dissertations, theses, peer-reviewed journal articles, and conference proceedings which examine neurodivergent undergraduate learning/performance in STEM. In this presentation, we report on the findings of this literature review; describing the representation of neurodivergent undergraduates, gaps within the literature, critiques of the literature, and discuss implications for pedagogical praxis. Additionally, we solicit comments from the audience for ways in which we can use this research to benefit physics educators.

E07-3: 9:24–9:36 a.m. Cross-Disciplinary Coalitions: Applying Women, Gender, and Sexuality Studies to Physics Education Research

Leaf C. Kullgren, University of Maryland

The field of physics, and academia in general, is entrenched within a culture of racism, patriarchy, cisheterosexuality, and ableism. Many scholars throughout women, gender, sexuality studies and related fields bring critical eyes and theorizations to these problems. Within physics education research, some scholars apply and interrogate these frameworks, but there is much room for further investigations. What, then, can physics education research gain from the interdisciplinary approaches of women, gender, and sexuality studies? How can PER efforts apply knowledges from queer, trans, and crip theories? In this talk, I discuss what a further application of intersectionality, crip theory, and other such analytics can do for the field, and, most importantly, for the faculty and students it affects.

E07-4: 9:36–9:48 a.m. Critical Perspectives on Asian(American) Presence and Experiences in Physics

Tra Huynh, Western Washington Univ,
Shahnaz Masani, Amy Robertson, Veronica Velez

Mainstream media and literature often portray Asian(American)s as over-represented and over-achieving in STEM fields. In this presentation, using examples from physics, we assert that this story of Asian(American)s is distorted but convenient, made popular to advance agendas that aim to sustain systemic oppression. Starting with a quantitative case of Asian(American) enrollment in introductory physics, we use QuantCrit to critically examine the underlying assumptions and sociopolitical contexts that are hidden in quantitative studies, contributing to incomplete (and false) claims about Asian(American) presence and success. We then build on Asian Critical Race Theory and Racial Triangulation to foreground the complexities in Asian(American)s' racialized experiences, both as a racism targets and accomplices. Using interviews with Asian(American) physics students, we showcase how Asian(American)s position themselves and are positioned in physics class, and how their racial positioning is intimately tied to dominant social and physics cultures and epistemologies. We conclude with a call for Asian(American)s to leverage our agency for social justice and implications for physics scholarship to critically challenge and reject the dominant narratives surrounding Students of Color.

Session E08: PER: Beyond the First Year: Part 1

Location: Constitution DE **Time:** 9–10 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Jeff Saul

E08-1: 9–9:12 a.m. Development of a Concept Inventory for Energy Band Theory

Guofu Ma, MPhil, MA,
Lin Ding

Energy band theory is a fundamental concept in solid-state physics, yet no standardized assessment tool exists to evaluate upper-level physics and material science students' conceptual understanding of this topic. To address this gap, we are developing a concept inventory covering key topics, such as Bloch's theorem, the nearly free electron model, the tight-binding approximation, the Fermi surface, the density of states, and characteristics of energy bands. As an initial step, we conducted expert interviews with physics and material science faculty to identify essential concepts, common student difficulties, and differentiations in understanding. This presentation reports preliminary findings from the interviews and the inventory's developments, paving the way for future validation and implementation.

E08-2: 9:12–9:24 a.m. The Quantum Physics Assessment - A Flexible, Next-generation Quantum Assessment Tool

Bethany R. Wilcox, University of Colorado - Boulder

As quantum education continues to grow and change in response to the Second Quantum Revolution, it is becomming ever more important that educators and researchers must have effective tools to measure and compare student learning in different courses. However, accommodating the significant variation in topical content coverage in traditional quantum mechanics courses, the new content associated with quantum information science, and differing backgrounds associated with the growing interdisiplinary presence in these courses, presents significant and unique challenges for measuring student learning. In this talk, I will present the design and preliminary development of the Quantum Physics Assessment (QuPA) as a tool to address many of these challenges. The QuPA will allow for flexible assessment, in which instructors will be able to select which content areas are most applicable to their specific course/student population, while still being able to compare their students' outcomes to those from students in other courses. Here, I will discuss some of the challenges that must be overcome in the development of the QuPA and the current strategies to address these challenges.

E08-3: 9:24–9:36 a.m. Comparison of Student Performance on Open- and Closed-Response Versions of a Research-Based Assessment

Michael Freeman, University of Colorado at Boulder, Bethany R. Wilcox, Steven J. Pollock

Closed response assessments can be scored by computer and administered online, thus increasing the ease with which they can be given to large populations of students. We have translated the Colorado Classical Mechanics and Math Methods Instrument (CCMI) from an open-response format to a closed-response one. To determine if scores on this new, closed-form CCMI can be compared to the old, open-response CCMI, we performed a comparison of students' responses to both versions of the instrument. Preliminary findings suggest that many of the items show comparable responses in both formats, but a small number show significant differences. In this talk, we will both present preliminary results comparing the two formats and discuss characteristics of the items that translated well and those that did not. We believe that these findings will be found valuable by the assessment design community in understanding what kinds of assessment items can easily make the transition to closed- from open-response.

Session E09: PER: Introductory Courses, Labs, and Group Work: Part 1

Location: Lafayette Park **Time:** 9–10 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Neel Haldolaarachchige, Ph.D.

E091: 9–9:12 a.m. Using Drawing-Based Data to Visualize Student Perceptions of Instructional Labs

W. Brian Lane, University of North Florida,
Charlotte Dries, Gabriella Khazal, Thomas O'Brien, Tiffany Snow

Instructional labs are an important component of undergraduate physics education. With instructional labs taking up a significant place in the first year of undergraduate study, they impact student persistence and STEM identity. These labs not only develop students' conceptual learning, but they also enculturate students into STEM as a community-oriented profession based on cooperative work around shared resources. An instructional lab can be thought of as a Community of Practice, defined as a group of members pursuing a common set of goals by using conventional practices. Students can develop different perspectives of the community within an instructional lab, embedded in each student's mental model. We administered a survey in which N = 74 students drew a picture of their mental model of Introductory Physics for Life Sciences, an interactive course centered around lab-based explorations of physics content. We cataloged their drawing elements and categorized them as related to the lab's goals, members, and practices. We visualize the results of this analysis at two scales: a network diagram showing the most central elements from all the drawings, and a Venn diagram showing the unique combination of elements drawn by three students from the same lab group. Both these visualizations indicate how the students prioritize the selection of elements when drawing their mental models.

E092: 9:12–9:24 a.m. Student Preferences for Grade Weighting in Introductory Physics

Thomas O'Brien, University of North Florida,
W. Brian Lane, J. Caleb Speirs

Grading practices are known to influence student behavior and learning, particularly in introductory physics courses. On the road to researching and recommending grading practices, we must gain an understanding of how students think about grades. We administered a survey about grading to our introductory students, with a combination of free-response and numerical questions. The free-response questions generated feedback about students' experiences with stress related to grades and their perspectives on the representation of effort and mastery in course grades. The numerical questions asked about their preferences for weighting two important dimensions of grading in a physics course: their understanding of the course material, and their effort toward completing coursework. The numerical responses reveal that just over half our introductory students weighted effort more heavily than understanding. Filtering these numerical responses by students' discussion of stress, effort, and mastery reveals insights into their thinking about how grading is structured.

E093: 9:24–9:36 a.m. Transitioning to Larger Groups: Using Roles to Promote an Equitable Physics Lab Experience

Aidan Payton, University of Pittsburgh,
Russell Clark, Chandralekha Singh

Many institutions face resource constraints that necessitate larger group sizes in introductory undergraduate physics labs. This transition from smaller to larger groups raises an important question: How can we ensure every student has meaningful engagement with all experimental aspects—including equipment setup, troubleshooting, prediction, analysis, leadership, and responsibility—leading to equitable learning outcomes? Our institution recently transitioned from two-student to primarily four-student lab groups, initially prompted by the COVID-19 pandemic's online instruction requirements and maintained after returning to in-person learning. To address participation inequities observed in two-student groups (where students often settled into fixed roles in each lab), we implemented a system of weekly-rotated, pre-defined roles: First Experimentalist, Second Experimentalist, Theorist, and Manager. We will share our experience transitioning to larger lab groups and provide implementation guidelines to help other institutions facilitate equitable student experiences in physics laboratory settings.

E094: 9:36–9:48 a.m. A Strengths-based Conceptualization of Student Roles in Lab Groups

Katherine Ansell, University Of Illinois - Urbana Champaign,
Caitlin Mamaril, Samuel W. Engblom

Student roles in laboratory groups are often characterized using specific tasks and responsibilities. Yet, the process of working in a collaborative group is more nuanced than just the tasks taken on by individuals. In this talk we make a case for considering collaboration as the coordination of complementary strengths. Using group observations from second-semester University Physics lab activities and data from follow-up interviews, we show how students leverage - and sometimes suppress - their strengths in response to the needs of individuals and to the needs of the group. Seeing the different ways that individuals come together to coordinate strengths offers a new narrative for why some groups are more or less collaborative and can inform future group work interventions.

Session E10: Physics at HBCUs

Location: Farragut Square **Time:** 9–10 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Juan Burciaga, PhD

E10-1: 9–9:24 a.m. Physics at HBCUs: Morgan State University Cultivating Talent, Scientific Excellence while Expanding Opportunities in Physics

Invited – Stacyann Nelson, Morgan State University

Morgan State University (MSU), a Historically Black College and University (HBCU), founded in 1867, is a Carnegie-classification R2 institution of diverse, multiracial, multinational student body offering over 140 academic programs spanning undergraduate to doctoral degrees. MSU has twelve schools, the department of Physics and Engineering physics is housed in the School of Computer, Mathematical, & Natural Sciences playing an integral role in cultivating the next generation of physicists with a strong commitment to mentorship providing hands-on research opportunities, a rigorous curriculum, empowering students in areas of optics, nuclear and particle physics, condensed matter physics, and climate studies. The department continues to leverage partnerships with national laboratories, governmental agencies, and industry expanding its impact through participation in major research collaborations equipping students with the skills and experiences necessary to thrive academically and professionally. Morgan State University continues to shape the future of physics, ensuring that HBCUs remain an integral contributor to scientific discovery and innovation by investing in research, mentorship, and outreach.

E10-2: 9:24–9:48 a.m. Outcomes and Lessons Learned from the Research Experiences for Undergraduates (REU) in Physics Site at Howard University over a 10-Year Period

Invited – Prabhakar Misra, Howard University

The major goal of the REU in Physics Program at Howard University has been to provide hands-on and meaningful research experience to undergraduate STEM students in the areas of experimental, theoretical and computational condensed matter physics, optics and laser spectroscopy, with special focus on the characterization of condensed phase systems at the nanoscale. Besides cutting-edge research, another significant goal of our REU program has been to provide enrichment activities that help broaden the academic and professional perspective of the REU students enrolled in the program, with a special focus on underrepresented students. The REU program included midterm and final research presentations via electronic posters and PowerPoint slides, along with faculty seminars, and enrichment activities, such as field trips, python programming, and career path workshops and panel discussions. Key results of the physics research conducted will be highlighted, and outcomes from the comprehensive surveys conducted before and after the Summer REU program over a ten-year period (2015-2025) will be presented.
Financial support from the National Science Foundation (NSF) Award #s PHY-1358727, PHY-1659224, PHY-1950379, and DMR-2349300 is gratefully acknowledged.

Session E11: Student Experiences in Physics and Astronomy Graduate Programs: Part 1

Location: Salon E (Metro Center Hotel) **Time:** 9–10 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Chandra Turpen

E111: 9–9:24 a.m. Mental Health of Physics and Astronomy Graduate Students: Results from a National Study

Invited – Patrick Banner, University of Maryland,
Kellen O'Brien, Chandra Turpen

We share key results of the first national-scale survey study of physics and astronomy (P/A) graduate students' mental health (MH). Across eight US graduate programs (N~250), we measure depression, anxiety, impostor phenomenon, and loneliness using validated inventories. Our P/A graduate student respondents reported a much greater prevalence of these MH struggles than samples of the general population. Female and non-binary P/A graduate students reported significantly more anxiety, depression, and impostor phenomenon than their male peers, while international students reported significantly more loneliness than their domestic peers. We also assess graduate students' perception of several program features and environmental variables, including advisor support, work-life balance, and sense of progress toward future professional goals. We discuss the impacts of these variables on graduate students' MH using regression and structural equation modeling techniques. We discuss implications for graduate students, faculty, and department administrators.

E112: 9:24–9:48 a.m. Improving the Experiences of Physics PhD Students by Supporting their Search for a Research Group

Invited – Michael Verostek, Rochester Institute of Technology
Ben Zwickl, Casey Miller

One of the most critical, but least supported, aspects of the first year of a PhD is the search for a research group. To students, finding a research group feels like a high-stakes decision that impacts their graduate school experience and their future career. Additionally, research groups can support persistence and growth as independent scientists. In this talk, I will examine factors that influence when and how students join research groups and the impact of this process on their graduate experience. Semi-structured interviews with 40 first- and second-year physics PhD students revealed widespread concerns about the lack of structured departmental support in finding a research group. With scarce departmental guidance, some students were able to rely on their prior experiences, such as undergraduate research, to access the resources, advice, and knowledge needed to navigate these challenges. Students with ample prior research experience often entered their programs with well-developed research interests, which facilitated earlier integration into a group and enhanced their sense of belonging. Conversely, students who described having fewer research opportunities and limited mentorship prior to graduate school tended to have broader interests and more commonly struggled to find a group. Those students who faced difficulties finding a group frequently reported feelings of isolation, anxiety, and doubts about their program fit, highlighting the need for improved departmental support in the group search process. We propose several options for physics programs to consider in order to better support incoming PhD students, including formal structures that promote equitable early involvement in research. Such reforms could help departments enhance PhD student retention and improve the overall graduate experience. This work was supported by NSF Award HRD-1834516.

Session E12: Helping Our Students Develop Hypothetico-Deductive Reasoning Skills

Location: Salon A/B (Metro Center Hotel) **Time:** 9–10 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Eugenia Etkina

How do we teach our students to think like physicists? One of the most important types of reasoning that physicists employ is hypothetico-deductive reasoning. What does this reasoning entail? It starts with the attempt to explain experimental data - generating multiple hypotheses explaining the observations. Thus - the "hypothetico" part. And then deduction starts. To test the hypotheses deductively means to design experiments whose outcomes can be predicted by the hypotheses, then running the experiments to compare the experimental outcomes to the predictions. This is done, not to verify the hypotheses, but to rule them out. In this session the participants will have a taste of this process and receive guidance on how to engage their students in similar activities and learn about research on student difficulties with this process.

Session E13: The Science of Nuclear Medicine: Part 1 Diagnostic

Location: Salon C/D (Metro Center Hotel) **Time:** 9–10 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Chad Ronish

In this session we will provide history and context about the development of Nuclear Medicine and its origin with the Manhatten Project. John and Ernest Lawrence utilized the technology of the cyclotron to create processes that created the field of nuclear medicine. Participants will utilize geiger counters and radioactive sources to simulate how PET scans and CAT scans are used to diagnose diseases and map physiological processes in the human body. Participants will leave with directions and resources to implement in their classrooms.

Session F01: Reframing How We Teach Physics for Engagement: Intro Physics

Location: Declaration A **Time:** 10–11 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Roger M. Hart, PhD

F01-1: 10–10:12 a.m. From Exploration to Equation: Redesigning Optics Instruction for All Learners

Sarah Mcgregor, Keene State College

In traditional physics and optics instruction, foundational concepts are often introduced with mathematical equations first, typically followed by labs, activities, and demonstrations to reinforce them. However, this expert-driven approach that emphasizes the early introduction of mathematical techniques can be particularly challenging for students who experience math or science anxiety, as well as those who are neurodiverse. For these students, mathematics often feels disconnected from the underlying concepts, leading to confusion and disengagement. This presentation advocates for a student-centered approach that prioritizes conceptual understanding before the introduction of mathematical techniques. Examples from optics curriculum, such as Snell's Law and the Thin Lens Equation, will demonstrate how student conceptual understanding can be built before mathematical techniques are introduced. By allowing students—especially those with math-phobic, science-phobic, or neurodiverse experiences—to explore optical phenomena through hands-on experimentation, they develop a deeper connection to the material. This approach alleviates anxiety, fosters engagement, and makes mathematics more meaningful by introducing it as a tool for verifying and enhancing the concepts they have already internalized. By shifting away from the expert-driven model and allowing students to build knowledge through exploration, we create an inclusive learning environment. This method supports students in integrating scientific concepts and mathematical techniques in ways that are both accessible and engaging, helping those who traditionally struggle with science and math to succeed in physics and optics courses.

F01-2: 10:12–10:24 a.m. Two Years of Teaching an Integrated Mechanics and Calculus I Course within an NSF S-STEM Project at Penn State Abington

Andrei Blinkouski, PhD, Pennsylvania State University, Abington College,
John Majewicz, Daniel Pearson

This presentation reflects on two years of implementing an integrated PHYS 211 (General Physics: Mechanics) and MATH 140 (Calculus I) curriculum within the NSF S-STEM project "Integrating the Teaching of Mathematics, Physics, and Engineering Courses to Improve Retention of Engineering Students at Penn State Abington." We will discuss the evolution of the course, key pedagogical strategies, student feedback-driven refinements, challenges encountered, and areas for future improvement.

F01-3: 10:24–10:36 a.m. Comparing Instructor Intention with Student Perception: Teaching Strategy and Philosophy

Gaby Treble,
Catherine Herne

Previous research shows that student-centered teaching is the most effective way to teach physics. Student-centered teaching involves strategies including differentiated instruction, inquiry-based teaching like think-pair-share activities, and problem-solving in class. However, it is also evident that faculty don't often practice these strategies effectively. We investigated the student population taking physics classes along with their instructors at our university to explore how faculty's intended strategies are being interpreted by the students. Our research questions are: How do students interpret instructors' teaching strategies? What teaching strategies do students feel are most effective for them? Is there a congruence between instructors' stated pedagogical values and students' interpretations of those values? We surveyed faculty on what strategies and values they intended to implement. At the beginning of the semester we surveyed students on their preferred strategies and pedagogies, and at the end we asked them what they felt was happening in the class and what was most effective for them. We share the survey outcomes to illustrate the congruence of student responses with faculty intentions and whether students believed that student-centered strategies were effective for them.

F01-4: 10:36–10:48 a.m. Classroom Kinesthetic Activities for Teaching Introductory Physics

Jonathan W. Alfson, Bushnell University,
Noah Mancione, Jameson Hussey

Kinesthetic activities show promise for improving student understanding of content and can be a fun way to break up the normal class period. In the fall of 2024, we developed several short kinesthetic reinforcement exercises to build students' embodied experiences of physics. We then used these activities in an algebra-based introductory college physics course. Each activity was usually about 10 minutes long, and only required household materials, if any. These activities were not designed as lab experiments or demos, but helped to bridge life experiences with physics concepts while engaging students' bodies. We present some of the activities, and lessons that were learned in the design and implementation process. This work was supported in part by the Council of Independent Colleges and the W.M. Keck Foundation.

F01-5: 10:48–11 a.m. Implementing Peter Liljedahl's Best Practices in the Calculus Physics Sequence

Martin Kamela, Elon University,
Kyle Altmann

Peter Liljedahl's Building Thinking Classrooms in Mathematics lists 14 best practices to improve student engagement and depth of learning in K-12 math classes. These recommendations have been adopted by some High School Physics instructors with positive impacts on students' engagement. In this talk we will discuss our implementation of Liljedahl's ideas in the 1st year calculus physics sequence, which resulted in the improvement of class engagement over past years and an improved sense of fairness in summative assessments.

Session F02: Apparatus for Fluids: Part 2

Location: Declaration B **Time:** 10–11 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Daniel Borrero

F02-1: 10–10:12 a.m. Blending Fluid Mechanics and Art in the Classroom

Jack-William Barotta, Brown University,
Avery Trevino, Madeline Federle, Roberto Zenit

Fluid mechanics offers a unique combination of scientific principles and aesthetic appeal, highlighting the inherent beauty of both natural and engineered phenomena. Here, we present low-cost projects developed for the "Art-Fluids Engineering" course at Brown University, which explores the integration of engineering concepts with creative expression through three distinct projects. In Part I, students use a peristaltic pump and an Arduino-controlled camera setup to capture striking images of fluid droplet impacts, manipulating lighting, timing, and fluid properties to explore viscosity and surface tension. Part II features a tabletop setup where students generate vortex rings using smoke and laser illumination, enabling them to visualize vorticity and appreciate the aesthetics of both laminar and turbulent flow. In Part III, students design and create an art piece that represents a fluid mechanics phenomenon, merging their engineering knowledge with creativity while considering factors such as budget and spatial design for a course exhibit. Examples from the implementation of the projects in Spring 2023 and Spring 2024 iterations of the course will be shared throughout.

F02-2: 10:12–10:24 a.m. Exploring Fluid Dynamics: A Large-Scale Student-Driven Investigation of Torricelli's Theorem

Frederick Heyler, MS, MEd, Iolani School

This investigation upscales a classic Torricelli Theorem investigation into a collaborative class activity; facilitating an understanding of fluid dynamics, reviewing kinematics/ energy concepts and enhancing student engagement. Using a 1.8 m (6 foot) high, 150 cm (6 inch) diameter PVC pipe with tapered openings at 30 cm vertical intervals; students take measurements and calculate flow velocities from varying heights using the concepts of projectile motion. After maintaining constant water elevation for flow measurements at different heights, students then assess the relationship of falling water elevation to flow velocity; something that can be done with a larger apparatus. A large-scale apparatus facilitates student development of theoretical predictions, collaborative experimental design with peer teams responsible for different portions of the investigation, data presentation, error analysis, consideration of experimental limitations, as well as practical applications. The laboratory materials are comparatively inexpensive and doing a laboratory on this scale leads to greater experimental precision. Also included in the presentation are general principles for developing quality laboratory investigations, including the use of Artificial Intelligence on the more formal laboratory investigations. Students doing this fluid dynamics investigation will have just concluded a more formal fluid statics investigation of the nitrogen/helium mix in party balloon tanks

F02-3: 10:24–10:36 a.m. Using a Schlieren Imaging System to See Fluid Flow

David Jackson, Dickinson College

A schlieren imaging system allows one to see things that are normally invisible. The way such a system works is to use a lens or a spherical mirror to focus a point light source onto a thin metal wire so that none of the light is transmitted into a camera that sits behind the wire. With this setup, any density changes in the air will refract the light coming from the source, deflecting it past the wire light block and into the camera. In this way, any density changes in the air will become visible in the camera, allowing one to observe the effects of temperature or pressure changes in the air. In this presentation, I will describe the details of an off-axis single-mirror schlieren system and discuss several experiments that reveal spectacular fluid motion that is normally hidden from view.

F02-4: 10:36–10:48 a.m. Technical Competencies and Resources in Support of Fluid Experiments

Randall Tagg, Univ of Colorado - Denver

A variety of skills and objects enables versatile development of apparatus for using and experimenting with fluids. Helping students acquire the know-how and keeping resources at hand provides on-demand support for creative thinking and prototyping. Elements include basic parts for piping and ducting and the methods for assembling them, pumps and blowers, sensors for temperature, pressure & flow, flow visualization techniques, electronic and optical systems for measurement and imaging, and entire experimental systems like water channels and wind-tunnels. This can be part of a larger framework for technical design and innovation.

F02-5: 10:48–11 a.m. Same Day Microfluidics: Design and Fabrication in Under Three Hours

Nathan Tompkins, Wabash College

Microfluidic devices are used in numerous scientific fields and research areas and a fantastic teaching tool for fabrication and laminar flow. However, typically device fabrication is a time and resource intensive process largely confined to the cleanroom or similarly well equipped research laboratory. Due to this many instructional laboratories are unable to include microfluidics in the curriculum. This talk outlines a method to create microfluidic devices in under three hours using the silicone polymer polydimethylsiloxane (PDMS) and a laser cut positive master using PDMS double casting. This method can be taught to an undergraduate student and used in an instructional laboratory setting with a modest budget, no cleanroom or other large capital equipment required. The method will be outlined with timing, materials, equipment, and technical considerations for each step and demonstrated in the context of a Y-channel flow-focusing device.

Session F03: Phenomena-based Approaches to Teaching and Learning About Waves

Location: Franklin/McPherson **Time:** 10–11 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Brian Lee

F03-1: 10–10:24 a.m. Using Biomechanics of Concussion as an Anchoring Phenomenon for Teaching and Learning about Mechanical Waves

Invited – Dimitri Dounas-Frazer, Lakeside School,
Christie Barchenger

We used the Ambitious Science Teaching framework to develop, implement, and revise a unit in which students coordinate key ideas across physics and neurobiology to construct a scientific explanation of a complex phenomenon. The anchoring phenomenon for this month-long unit involves an athlete who sustains a concussion during a soccer game. Throughout the unit, students focus on a system consisting of the soccer player's head, i.e., skull, cerebrospinal fluid, and brain. They learn about the structure and function of the brain and neurons, relationship of external contact forces on the system to internal buoyant forces within the system, propagation of mechanical waves through different mediums, and reflection and transmission of waves across medium boundaries. At the start of the unit, students develop an initial model for how the soccer player's concussion happened. As the unit progresses, students revise their models based on evidence from experiments conducted during class. Ultimately, students use diagrams and language to construct evidence-based explanations for how a head injury causes concussion symptoms. Students' final explanations include depictions and descriptions of wave motion in the soccer player's head at both macroscopic and microscopic scales. In this presentation, we will present the objectives, deliverables, success criteria, and plan for this unit. We will also show examples of student work.

F03-2: 10:24–10:36 a.m. Light Refraction Analogy for Seismic Shadow Zones

Jung-Bog Kim, Korea National Univ of Education
Chang Hyun Ryu, Yu Jin Ahn

We propose analogy modeling of seismic wave refraction using light refraction to enhance the understanding of P-wave and S-wave shadow zone formation. In the first experiment, we simulate an earthquake within a fishbowl using a point light source, where the water represents the Earth's mantle and a glass ball represents the outer core, demonstrating observable shadow bands on the opposite side. The second experiment introduces a simplified 2D method for observing shadow zones using a transparent cylindrical beaker and a water tank. In the third experiment, we measure shadow zones in a plane using computer simulations. By analyzing the data obtained through angle measurements, we calculate the refractive index. These experiments not only aid in comprehending the historical development of knowledge regarding seismic waves and Earth's internal structures but also provide valuable educational insights for teaching physics and earth science, despite the inherent limitations of the educational model.

Session F04: Educational Technologies: AI

Location: Wilson/Roosevelt **Time:** 10–11 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Robert Hilborn

F04-1: 10–10:12 a.m. Investigating Problem-Solving in Physics Using NLP-Based Analysis of Chatbot Interactions

Syed Furqan Abbas Hashmi, Purdue University - West Lafayette,
N. Sanjay Rebello

Assessing and improving problem-solving skills in physics remains a challenge. This study explores how an AI-driven chatbot supports students' problem-solving development through Natural Language Processing (NLP) analysis of interaction transcripts. Using text classification, topic modeling, and linguistic complexity measures, we examine the types of questions students ask, their specificity, and their progression from novice to expert-like behavior. We categorize queries into conceptual, procedural, and verification-based types while evaluating broad vs. specific questioning patterns. Additionally, a Likert-scale survey assesses students' confidence, engagement, and perceived chatbot effectiveness in structuring problem-solving, fostering metacognition, and improving efficiency. Preliminary findings suggest that the chatbot may help students refine their approach and engage in reflective inquiry. This study highlights the potential of NLP-driven educational tools to enhance problem-solving in STEM education.

F04-2: 10:12–10:24 a.m. Translating Physics Concept Inventories Using Large Language Models

Ralf Widenhorn, Portland State University,
Marina Babayeva

This study explores the use of artificial intelligence in translating and validating physics concept inventories across multiple languages, with a specific focus on the Force Concept Inventory (FCI). Although the FCI has been translated by expert physicists into many different languages, many physics concept assessments remain unavailable in languages other than English, creating barriers to global physics education research. We discuss the challenges that arise when machine-transcribing and translating physics concept inventories. Subsequently, we analyze how an AI large language model performs for translated versions in fifty different languages. While acknowledging that human physics experts with appropriate language skills remain essential for full validation, we demonstrate that AI can provide preliminary insights into translation validity. We analyze how formatting issues, special characters, equations, figures, and connected question sequences affect machine translations. Our findings offer practical guidance for physics educators and researchers seeking to use AI for translating educational content and highlight both the limitations and opportunities of machine translation in physics education. This research contributes to broader conversations about AI's role in making STEM education more globally accessible while maintaining conceptual accuracy across linguistic boundaries.

F04-3: 10:24–10:36 a.m. Applying Computational Grounded Theory to Analyze Student Misconceptions Using Chatbot Interaction Data in a Modern Physics Course

Atharva Dange, University of Texas Arlington,
Ramon E. Lopez

An AI-powered chatbot, the UTA Study Buddy Bot, was deployed in a university-level Modern Physics course to assist students through peer-like, interactive problem-solving conversations. Over the course of the semester, more than 10 million tokens of student-chatbot dialogue were collected, providing a rich corpus for analysis of student thinking. To investigate conceptual understanding and common misconceptions, a Computational Grounded Theory (CGT) approach was applied. This process involved (1) pattern detection through natural language processing and unsupervised clustering of sentence-level vector embeddings, (2) pattern refinement through human-guided interpretation of emergent themes related to student reasoning and learning challenges, and (3) pattern confirmation using supervised models to evaluate the generalizability of the identified categories across the dataset. Preliminary analysis revealed recurring misconceptions in topics such as relativistic momentum and quantum energy levels, along with trends in the structure and phrasing of student inquiries. The findings demonstrate the potential of CGT to extract scalable, theory-aligned insights from chatbot interaction data and inform the design of more adaptive, AI-driven educational tools in physics instruction.

F04-4: 10:36–10:48 a.m. Integrating AI into Introductory Physics Labs: Enhancing Data Analysis and Student Learning

David Rakestraw, PhD, Lawrence Livermore National Laboratory

The extraordinary and rapidly advancing capabilities of artificial intelligence are transforming science and engineering, reshaping how we conduct experiments, analyze data, and interpret results. As educators, we face a dual challenge: preparing the next generation of scientists and engineers to harness AI effectively while ensuring that students develop strong foundations in physics and critical thinking. This presentation explores how generative AI can be integrated into introductory physics labs to enhance student engagement and improve data analysis. We will showcase several hands-on experiments where students collect complex data sets using smartphones and analyze them with AI-driven tools. Examples include: 1) Data Visualization and Statistical Analysis: AI-assisted plotting and interpretation of large experimental data sets to help students identify patterns, assess uncertainties, and build statistical reasoning skills. 2) Numerical Integration of Sensor Data: Using AI to perform real-time integration of acceleration and angular velocity data, allowing students to connect kinematic equations with sensor-based motion tracking. 3) AI-Assisted Video Analysis: Leveraging machine learning models to extract spectroscopic information from video recordings of biological phenomena, such as blood flow and the cardiac cycle, making physics more relevant to students in health sciences. Each of these investigations can use AI to provide instant feedback, help students troubleshoot errors in their data, and guide them through complex calculations. By incorporating AI tools into physics labs, we can reduce barriers to advanced data analysis, encourage deeper conceptual understanding, and prepare students for a future where AI is an essential part of scientific inquiry. Attendees will gain practical insights into how these methods can be implemented in their own courses, along with discussions on pedagogical strategies to ensure AI enhances—not replaces—critical thinking and problem-solving.

Session F05: Developing Scientific Reasoning and Decision-Making Abilities: Part 2

Location: Cabin John/Arlington **Time:** 10–11 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** David Sturm

F05-1: 10–10:12 a.m. Teaching Problem Solving and Hands-On Skills Through High School STEM Programs

Jennifer Greco, St. Ursula Academy

How do we get students who can problem-solve easily? How about young women who are confident in their hands-on skills? These motivations prompted the development of the after-school STEM Program at St. Ursula Academy, a private all girls school in Toledo, Ohio. Through this program, students in grades 8-12 participate in various science competitions throughout the school year including: Falcon BEST Robotics, NASA's Planet Mars Competition, and Science Olympiad. Through participating in these competitions, students learn to approach big questions such as "How do you build a robot that can drive on the Moon?" and break them down into smaller sections and find solutions for each one. When their designs need parts, students must design and build them: developing skills with woodworking, power tools, wiring, and more. Presenting their work at competitions helps students build skills in marketing, team-building, and public speaking. Students involved in this program have reported increased confidence and joy in learning skills outside the typical curriculum. Alumni from this program have applied these skills to pursue careers in engineering fields.

F05-2: 10:12–10:24 a.m. Role of Instructors for Coaching and Cueing Scientific Reasoning

Bradley McCoy, Azusa Pacific University

We recently redesigned the labs in our introductory calculus-based sequence to focus on teaching scientific thinking skills. In each lab project, students are given a research question and then they work with a group to design and execute an experiment. In this walk, I will show results of effective instructor interventions in labs that coach for or cue for students' scientific reasoning, as well as ineffective instructor interventions that preclude or demotivate students' scientific reasoning.

F05-3: 10:24–10:36 a.m. Modeling Skills in the Physics Lab: Using the Model of the Brain as an Ecosystem

Nathan D. Powers, Brigham Young University,
M. Jeannette Lawler, PhD

Developing strong modeling skills is essential for scientific reasoning and experimentation. Traditional laboratory instruction often emphasizes mastering specific models rather than constructing and testing them, limiting students' ability to develop flexible, adaptive mental frameworks. This talk presents an alternative approach that encourages students to propose, test, and refine their own models based on observations. Inspired by the metaphor of the brain as an ecosystem, this method aims to help students recognize the diverse models they use to interpret the world. Models are evaluated based on their predictive power and usefulness within defined limits rather than as strictly right or wrong. By engaging with models from multiple disciplines, students cultivate creativity, adaptability, and interdisciplinary problem-solving skills.

F05-4: 10:36–10:46 a.m. Teaching and Assessing Reasoning and Deductive Logic in an Introductory Physics Course

Josh Rutberg, Rutgers University - Newark
Sheehan Ahmed, Diane Jammula

Like many physics professors, we have noticed that our students seem to struggle to answer specific conceptual questions. They are distracted by surface-level features of a problem which are not relevant to the solution, their answers change significantly with slight changes to the wording or presentation of a question and, most worryingly, they are capable of verbalizing correct conceptual knowledge only to immediately give answers which contradict that knowledge. Our explanation for this observation was that our students struggled with reasoning; their difficulty lay not in lacking the physics knowledge necessary but the ability to use that knowledge productively. To address this we redesigned our course in the Spring 2025 semester to emphasize reasoning and deductive logic when answering physics questions. We also redesigned our exams to help us determine the extent to which student struggles could be attributed to lack of content knowledge or difficulty reasoning. Here we will discuss what reasoning skills we taught and how we integrated them into our curriculum. We will also discuss the implementation and design of these new exams and demonstrate how we analyzed the results to better understand our students.

Session F06: K-12 PER

Location: Bulfinch/Renwick **Time:** 10–11 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Dan Crowe

F06-1: 10–10:24 a.m. Exploring the Impact of Collaborative Writing on Student Engagement and Scientific Ability Development in an ISLE Approach High School Physics Classroom

Invited – Danielle Bugge, West Windsor-Plainsboro High School South

National organizations such as AAPT and NGSS set goals of engaging students in experimentation and authentic scientific reasoning in the classroom. In Investigative Science Learning Environment (ISLE) approach classrooms, students participate in the practices of scientists on a daily basis. They design and carry out observational, testing, and application experiments and write up their findings as laboratory reports. A key element of the ISLE approach is fostering a scientific community among students. Given the expectation of collaborative lab work, it is a natural extension to have students collaborate writing up their findings. Building these skills can serve as preparation for future careers as scientists and researchers, where co-authoring papers, grants, and presentations is common. Despite the benefits of collaboration, K-12 educators typically require students to write up their findings individually. Thus, there is a need to explore the realities of student collaboration during lab report writing, including workload distribution and accountability. This talk examines how first-year high school physics students collaboratively report on their findings from investigations. Through a quantitative analysis of the revision history of their Google Documents, we tracked individual student contributions to laboratory reports. This allowed us to explore correlations between involvement in the collaborative writing process and the development of scientific abilities. Knowing which abilities students consistently contribute to can help teachers model and scaffold expectations that support a more balanced development of these practices.

F06-2: 10:24–10:48 a.m. Conceptual Progressions in Quantum Information Science and Technology Outreach

Invited – Angela Kelly, Stony Brook University

There is an international imperative for quantum information science and technology (QIST) workforce development in response to rapidly expanding technological advancements. Precollege QIST educational outreach is one way to promote interest and excitement among high school students as they develop career aspirations and decide upon their academic pathways to post-secondary study and the workforce. This talk will focus upon a university-based outreach for high school students and teachers in the Long Island/New York City region. This National Science Foundation-funded project, Quantum Education for Students and Teachers, has provided professional learning for 68 teachers and summer camp and one-day immersive activities for 262 high school students since its inception in 2022. Three university physics and physics education researchers designed and implemented a vertically progressive conceptual design to educate students and teachers in classical physics, quantum physics, and quantum computing principles and skills. Assessment data indicated knowledge growth in all three domains, as well as attitudinal gains in QIST pedagogical self-efficacy in teachers and QIST student attitudes. Ongoing efforts to facilitate grassroots efforts in precollege QIST informal and formal education during the 2025 International Year of Quantum will also be discussed.

F06-3: 10:48–11:12 a.m. A Perfectly Inelastic Collision: Teaching Computational Modeling in High School Physics

Invited – Luke Conlin, Salem State University, Elroy Murray

In high school physics classrooms, students should get opportunities to learn physics by doing physics. Computational modeling is increasingly recognized as the "third pillar" of physics along with theory and experiment. The importance of computational modeling for high school physics is increasingly reflected in curricular frameworks, for instance the Next Generation Science Standards, but little guidance is available for how to implement this in practice. Adding computational modeling to physics classrooms runs the risk of adding complications that can distract from learning physics. In this research-practitioner partnership, we collaboratively designed two units to leverage the advantages of computational modeling for doing physics (visualizing hard-to-see concepts and phenomena). In this talk, we describe our 5-lesson instructional unit on collisions and present evidence of significant learning gains in students' physics concepts and computational modeling skills.

Session F07: Towards a More Equitable Physics: Research and Practices for Inclusion: Part 2

Location: Penn Quarter AB **Time:** 10–11 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Jayson Nissen

F07-1: 10–10:12 a.m. An Autoethnographic Study of the Experiences of a Physics Student with Psychiatric Disabilities

Jessica Randolph, Michigan State University,
Daryl McPadden, Katie Hinko

This autoethnographic study intends to explore and understand the experiences of a physics student with psychiatric disabilities. I, the first author, reflect upon and analyze my experiences as an undergraduate physics student with major depressive disorder, generalized anxiety disorder, and inattentive attention-deficit/hyperactivity disorder (ADHD). In the data collection process, I gathered notes and journals written throughout my years as an undergraduate physics student and formulated a timeline of events and memories. Identifying themes from the data and utilizing an arts-based approach as part of the analysis, I investigated the experiences and challenges I encountered as a physics student related to my psychiatric disabilities. The resultant work considers the realities and complexities of earning a physics degree with psychiatric disabilities, explores the impact of student experiences on physics identity, sense of belonging, and perception of and relationship with physics, and calls for structural and cultural changes to physics programs to better support physics students with psychiatric disabilities.

F07-2: 10:12–10:24 a.m. Strategies for Improving Access in Group Work from Physics Students with ADHD

Alex Reynolds, Michigan State University,
Daryl McPadden, Harsna Chahal

The enrollment of students with disabilities broadly, and ADHD students specifically, in STEM courses has dramatically increased in the past decade. While there have been many studies that show active learning strategies are beneficial for students, the results are not disaggregated for disabled students and their specific learning needs. We analysed sets of 4 interviews from 3 students with ADHD about their experiences in introductory group-based physics courses in comparison to their other STEM courses. This study uses inductive coding to distill broad themes in ADHD student experiences, including the importance of classroom structures and positive interpersonal interactions within these courses. From this analysis, we present overarching considerations for instructors in designing for accessibility in their course generally and group work activities in particular. Additionally, we will provide strategies and recommendations to adjust specific course structures to be more accessible.

F07-3: 10:24–10:36 a.m. Layering Theoretical Frameworks in Curriculum Design: An example from the C2C Workshop

Daryl McPadden, Michigan State University,
Matthew W. Guthrie, Xian Wu, Theodore Bott, Tanya Adams, Erin M. Scanlon

The Courses to Careers (C2C) workshop is a dual-thread, professional development (PD) experience that is centered on creating faculty-student partnerships to address ableism in physics courses and careers. With both faculty and disabled students in the room, this workshop employs a unique model that elevates and centers disabled students' expertise and lived experience to aid in course reform, while the same disabled students also benefit from faculty expertise in potential STEM career pathways. Through the creation of this workshop, we drew on multiple theoretical frameworks, including Universal Design for Learning, Critical Disability Theory, Academic Ableism, Communities of Practice, Students as Partners, Social Learning Theory, and the Bond & Blevins PD framework. In this presentation, we focus on the ways in which these theoretical frameworks fit together and influenced the activity design, schedule, and goals of the workshop. This work is supported by NSF Grant Nos. DUE 2336367 and DUE 2336368.

F07-4: 10:36–10:48 a.m. Designing an Inclusive Courses to Careers Workshop with Universal Design for Learning

Xian Wu, University of Connecticut,
Matthew W. Guthrie, Theodore Bott, Tanya Adams, Daryl McPadden, Erin M. Scanlon

Persistent barriers faced by disabled students in STEM highlights the need for a fundamental shift in how physics education is designed and delivered. Universal Design for Learning (UDL) offers a framework for fostering inclusive and equitable learning environments. This framework is central to the design of the Courses to Careers (C2C) workshop that addresses ableism in physics through faculty-student partnerships. By integrating UDL principles, the workshop enhances support for physics instructors in creating more accessible classrooms while equipping disabled students with tools to navigate STEM careers. This presentation examines the curriculum design process and key insights gained from applying UDL in the design of the workshop.

F07-5: 10:48–11 a.m. Learning Differences and Physics Teaching

Sean Lally, Jemicy School

You have likely come into contact with many students who have learning differences - some slight, some moderate, and some severe. I currently teach at a school that focuses on the teaching of students with dyslexia and related language-based learning differences and I see all sorts of issues among college-bound high school students. In this talk, I wish to address some of the things you may see exhibited by your students. There is no solution that helps everyone, but there are strategies for teaching physics (and indeed all sciences) that I have found useful. I will chat about executive function, note-taking, lab preparation, classroom practices, and other possible ways to help address learning differences.

Session F08: PER: Beyond the First Year: Part 2

Location: Constitution DE **Time:** 10–11 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Jonathan Perry

F08-1: 10–10:12 a.m. Building Strong Mathematical Backgrounds in Physics Part I: Re-evaluating Course Structure to Encourage Deeper Learning

M. Grant Roberts, University of California - Santa Cruz,
Pierce Giffin

With the advent of AI tools, graded homework has become outdated as a metric for assessing student knowledge of course material; in practice, graded homework acts as large percentage buffer on students' overall grades. Because of this, students are able to pass a class without mastering the material, which will often hinder their learning in subsequent classes. Course structure should intentionally reflect that mastery is expected and what mastery looks like. Along this line, given that grading homework is a large proportion of TA time allocation, this reduces the impact that any given TA can have upon student success in the course. We will present our overall course structure, student course reviews and outline our plans to incorporate this structure into other courses within the physics undergrad cirriculum.

F08-2: 10:12–10:24 a.m. Building Strong Mathematical Backgrounds in Physics Part II: From Deeper Learning to Maturity

Pierce Giffin, University of California - Santa Cruz, M. Grant Roberts

As students continue to mature as physicists and engage with more complex mathematical concepts, they often struggle to connect previous coursework to new topics that build upon prerequisite material. We present modifications to course structure as students advance through our undergraduate degree program in physics. In the second course on Mathematical Methods in Physics, we continue to emphasize regular low-stakes assessments of student knowledge, clear expectations of performance, and availability of course resources. However, we shift to a smaller set of broader learning objectives and the option to retake high-stakes midterm exams to emphasize the growth mindset of learning complex topics in physics and mathematics. We present our qualitative findings from this course and discuss ideas for future implementation in upper-division physics courses.

F08-3: 10:24–10:36 a.m. Adapting Learning-Objective-Based Grading for Sophomore Math Methods Course

DJ Wagner, Grove City College

In Spring, 2023, I experimented with a more traditional standards-based approach in my low-N 4th-semester math methods course. Due to student feedback and my own concerns about the time required for large-scale reassessment with a larger N, I did not repeat the experiment in 2024. This Spring, I adapted a different, "Learning-Objective-Based Grading" approach based on a talk by Andy Royston.[1] Royston used the approach in a large-N calculus-based introductory course. My course involves very different types of test questions than introductory physics, so I had to adapt Royston's approach. In this talk I will discuss the challenges in defining learning objectives that were "just right" (not too broad yet not too specific), what adaptations I made, and feedback from myself and my students.

F08-4: 10:36–10:48 a.m. Longitudinal Study of Grant Funded Undergraduate Research Lab Experiences

Shannon Willoughby, Montana State Univ

Providing long term mentorship for undergraduate students is an overlapping goal of two current grants at an R1 institution. One grant involves students working in a number of different research labs to explore how biological processes can be used to create mechanical structures. For the second grant, the goal is to build a satellite that will look at features of the Sun. A longitudinal study is underway with both grants, with the goal of understanding what practices, mentoring styles, and lab skills best situate undergraduate students to successfully earn STEM degrees. Each grant is recruiting four to five students per year, with the goal of maintaining each cohort for two to three years. Another core goal is to study how professional development workshops differ in both research projects, and to explore how STEM identity and persistence change over time. Both projects have had a cohort for over a year, and in this work we present initial comparative findings.

F08-5: 10:48–11 a.m. How Much Do Students Learn From Resubmission of Lab Reports?

Sergej Faletic, Ph.D. in Physics, University of Ljubljana,
Nastja Mahne, Ph.D. in Physics, Andreja Šarlah, Aleš Mohoric, Gorazd Planinsic, Ph.D.

The Applied Physics program at the University of Ljubljana Faculty of Mathematics and Physics is based on the Investigative Science Learning Environment. The whole class meetings, problem solving sessions, and labs are synchronised so that they form a coherent whole. In the labs, students work in groups of three or four. They solve one lab assignment per week and submit one group report per week. The groups change every week. The reports are scored on the Rutgers Scientific Abilities Rubrics. For each lab, between three and four abilities are chosen to be evaluated. Students have the opportunity to resubmit each report twice after the first submission. We have investigated patterns in students' scores over a year. Previous research has shown that significant improvement occurs between resubmissions. We investigated in what way students transfer their improvement in one lab to their reports in subsequent labs. Our findings show a general trend of improvement. By triangulating this research with interviews with students we have found that many factors affect their initial score on any particular lab. We will discuss some of the factors that negatively affect students' performance in our setting, and ways to mitigate them that we have already used in class. We acknowledge financial support by ARIS P1-0060 program and NOO ULTRA project.

Session F09: PER: Introductory Courses, Labs, and Group Work: Part 2

Location: Lafayette Park **Time:** 10–11 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** John Stewart

F09-1: 10–10:12 a.m. Barriers to Student Epistemic Agency During Collaboration in Introductory Labs

Samuel W. Engblom, University of Illinois Urbana-Champaign, Caitlin Mamaril, Katherine Ansell

In group work, the way in which individual group members frame the work they do together influences the group's engagement with the task. Prior work studying group behavior in introductory physics labs has prized framings that promote student epistemic agency, in which students view their own sensemaking as valid and useful for successfully carrying out their task. However, barriers exist to groups consistently taking up these high epistemic agency framings. To explore an example of these barriers, we present a case of three students working together on an introductory physics lab in which two group members expressed a desire to shift their group toward a higher epistemic agency framing, but failed to do so in practice. We examine the specific dynamics present within the student group that prevent the group from shifting into higher epistemic agency framings, and argue that student perceptions of their group members' framings of the task can serve to "trap" members of the group in lower epistemic agency framings.

F09-2: 10:12–10:24 a.m. Building an Experimental Physics CURE: Lessons from the First Year

Rachael L. Merritt, University of Colorado Boulder/JILA,
Heather J. Lewandowski

As part of our ongoing efforts to develop a framework of effective practices for designing and sustaining Course-based Undergraduate Research Experiences (CUREs) in physics, we designed, developed, and implemented a new CURE focused on improving metal halide perovskite solar cells in collaboration with the National Renewable Energy Laboratory. Using course artifacts—particularly weekly reflections and a 'Report to Future Researchers' assignment—we evaluate how students perceived their engagement with the five core CURE components: scientific practices, discovery, relevance, collaboration, and iteration. Additionally, we outline key insights and next steps for refining future iterations of the CURE.

F09-3: 10:24–10:36 a.m. Reforming the Applied Physics Program at the University of Ljubljana

Aleš Mohoric, University of Ljubljana,
Andreja Šarlah, Sergej Faletic, Ph.D. in Physics, Nastja Mahne, Ph.D. in Physics, Gorazd Planinsic, Ph.D.

The University of Ljubljana reformed its Applied Physics program using the Investigative Science Learning Environment (ISLE) approach to enhance physics education. The course integrated recitations and lab work, transformed the classroom into a studio for group activities, and introduced semi-open investigations for authentic lab experiences. The goal is to produce graduates equipped to solve real-world problems through active student participation and collaboration. The shift focuses on student-centered, skill-based learning. Previously suffering from low enrolment, high attrition, and low motivation, the program now engages students in developing physical knowledge and actively shaping their learning processes. ISLE emphasizes inquiry-based activities, logical reasoning, and the development of scientific abilities. Reforms included opportunities for students to revise their work. Improvements in retention rates, class attendance, and student performance indicate increased knowledge. The successful reforms will continue, with hopes of attracting more students to the program. We acknowledge financial support by ARIS P1-0060 program and NOO ULTRA project.

F09-4: 10:36–10:48 a.m. Transformation of Experienced Traditional University Teachers into Reformed Teachers

Andreja Šarlah, University of Ljubljana,
Sergej Faletic, Ph.D. in Physics, Nastja Mahne, Ph.D. in Physics, Aleš Mohorič , Gorazd Planinsic, Ph.D.

We at the University of Ljubljana are reforming the Applied Physics study program using the ISLE approach. This holistic student-centred approach is built around the idea that the students should develop scientific abilities and habits by practicing it through inquiry-based activities. The role of a teacher in such an environment differs from the role of a traditional teacher. Our teachers did not have prior experience in reformed courses. We organized individualized professional development to help them develop the needed skills and habits to change their teaching practices. It consisted of ISLE training before the start of the semester and continuous activities during the semester, such as co-planning of teaching activities, team-teaching, observations of lessons, and reflections. We examined the challenges in implementing ISLE to teaching by employing a qualitative case study. We present the data collected from the classroom observations triangulated with semi-structured interviews. The results from the first year show that while it was easy for the teachers to adopt ISLE terminology and arrange students to work in groups, organizing group work effectively was more challenging. The most effective training for teachers appears to be observing experienced instructors during team-teaching.We acknowledge financial support by ARIS P1-0060 program and NOO ULTRA project.

F09-5: 10:48–11 a.m. Development of Attitudes Towards Group Work in an ISLE-based Physics Course

Nastja Mahne, Ph.D. in Physics, University of Ljubljana,
Andreja Šarlah, Sergej Faletic, Ph.D. in Physics, Aleš Mohoric, Gorazd Planinsic, Ph.D.

At The University of Ljubljana's we are reforming the Applied Physics study program using the ISLE approach. ISLE is designed to engage students in learning physics by engaging them in the processes that mirror scientific practice. The reformed program emphasizes group work and encourages students to share ideas, and develop social awareness.Using case-study methodology we examined how students' attitudes towards group work developed over a year. Using students from diverse backgrounds we conducted face-to-face semi structured interviews, used their CLASS and E-CLASS questionnaires, attendance records, exam and lab report revisions to find patterns between attitudes towards group work, and participation, and success. When the students joined our program, some felt uncomfortable, while others immediately enjoyed group work. Results after 10 weeks indicated that the majority of students already felt more at ease contributing, while some remained unchanged. After one year, all students had a change in attitudes towards group work. In the interviews they explained their changes and gave reasons, which we triangulated with other data. We acknowledge financial support by ARIS P1-0060 program and NOO ULTRA project.

Session F10: Integrating Quantum Across Levels

Location: Farragut Square **Time:** 10–11 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Anne Leak

This session will share new directions in research on curriculum, pedagogy, assessments, and resources in quantum education that expands quantum learning across different levels (K-career) beyond quantum physics courses. The session will be formatted as a panel of invited speakers in order to share a broad range of perspectives across levels and research areas.

SPEAKERS:
Richard Ross
Heather J. Lewandowski
Benjamin M. Zwickl
Emily Edwards

Session F11: Student Experiences in Physics and Astronomy Graduate Programs: Part 2

Location: Salon E (Washington at Metro Center) **Time:** 10–11 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Chandra Turpen

F11-1: 10–10:24 a.m. Beneath the Surface: Documenting Culture to Drive Change in Physics Graduate Programs

Invited – Diana Sachmpazidi, Rochester Institute of Technology,
Michael Verostek, Diane Codding, Audrey Claar, Geraldine Cochran, Sara Woods, Bennett Goldberg

This talk presents findings from the Inclusive Graduate Programs: An AGEP Pilot in Physics, a project aimed at exploring the culture of equity, inclusion, and approaches to educational change within participating AGEP physics graduate programs. To investigate these dimensions, the research team used instruments, including the Aspects of Student Experience Scale (ASES) to capture graduate students' experiences, and the Culture around Systemic Change (CSC) survey to assess departmental practices related to change efforts. We will share results from both surveys, as well as insights from interviews with students and faculty. We conclude by highlighting how departments are using these data to inform and guide their equity and inclusion initiatives.

F11-2: 10:24–10:48 a.m. Leveraging Familial Capital to Improve Graduate Students Experiences

Invited–Geraldine Cochran, The Ohio State University,
Corey Ptak, Jenna Tempkin, Téa Boone, Stella Nelson, Sabrina Henige, Diana Sachmpazidi

Graduate programs have increasingly sought to implement research-supported, practices and policies that improve experiences for physics graduate students. In this presentation, I will share a study that contributes to the growing body of work on improving graduate education by examining the role of familial capital—knowledge, values, and support systems derived from kinship and community—in the experiences of students in physics bridge programs. Our findings highlight the importance of recognizing and valuing familial capital in graduate education policies and practices. We propose actionable recommendations, including institutional support for maintaining familial connections, milestone celebrations that are open to family, and financial support for graduate students. By integrating familial capital into departmental structures, physics graduate programs can create more supportive environments that acknowledge and leverage the strengths marginalized students bring to academia.

Session F13: The Science of Nuclear Medicine: Part 2 Radiation Therapy

Location: Salon C/D (Washington at Metro Center) **Time:** 10–11 a.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Chad Ronish

In this session we will explore the development of radiation therapy as a tool to treat cancer. We will discuss the effects of radioactivity on cells and using a beam of particles to irradiate cells. Students will compare the challenges of traditional gamma knife treatments and the promise of new processes like proton therapy. These processes will be experienced in hands-on simulations to increase student understanding. Participants will leave with directions and resources to implement in their classrooms.

Session G01: Beyond Intro: Quantum

Location: Declaration A **Time:** 2–3 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Alberto Rojo, Ph D

G01-1: 2–2:12 p.m. Using Popular Media to Teach Modern Physics: A Reflective Case Study on "The Atom"

Aula Al Balad, The Ohio State University, Zhenis Kenzhekey, Lin Ding., Ph.D.

Teaching atomic and quantum theory in high school is challenging due to their abstract nature. Research shows that students struggle with wave-particle duality, quantum uncertainty, and probabilistic reasoning, as these concepts contradict classical intuition. Misconceptions and confusion between classical and modern interpretations further hinder learning, necessitating innovative teaching strategies. This study examines how popular media, specifically documentaries, can enhance engagement and understanding. The BBC documentary "The Atom", narrated by Jim Al-Khalili, was used in 9th-grade physics classes to contextualize the historical development of atomic and quantum theory. Its narrative reinforced the idea that science evolves through experimentation and debate. To further engagement, a mock trial based on Episode 2 of The Atom recreated the historical debate between George Gamow, supporting the Big Bang theory, and Fred Hoyle, advocating the Steady State theory. Students took on roles such as scientists, advocates, and judges, critically analyzing arguments and evidence. This activity fostered critical thinking, argumentation skills, and epistemological awareness. Observations suggest that combining visual storytelling with interactive learning enhances scientific literacy and conceptual understanding. This study invites educators to reflect on the role of media in physics education and explore future research to assess its impact.

G01-2: 2:12–2:24 p.m. Survey of Undergraduate Physics Students' Perceptions of the Quantum Industry

Kristin Oliver,
Shams El-Adawy, Bethany R. Wilcox, Heather J. Lewandowski

As companies in the quantum industry have grown and become more numerous, there has been an increased demand for qualified individuals to work within the industry. Particularly, industry professionals have called for the development of talent at the Bachelor's degree level to meet their companies' workforce needs. Thus far, the community's understanding of undergraduate students' desire to enter the industry and perceptions of the industry is not well developed. In order to ascertain student perceptions of the industry, we have developed a survey for undergraduate physics students across the United States. We will share results about student interest in the industry, knowledge about the industry, feelings of preparedness for the industry, and ideas about the industry's existing and future culture.

G01-3: 2:24–2:36 p.m. Finding Ourselves in the Capital of Quantum: A General Education Course at UMD

Erin Ronayne Sohr, University of Maryland - College Park

The growth in the field of quantum information science and engineering (QISE) has spurred a growth in educational programs. These programs are largely focused on recruiting and training the next generation of the quantum workforce. Courses and programs for those in majors other than STEM are also becoming more common. These courses tend to address what an informed citizen should know about QISE and what they can learn, given "limited" mathematical backgrounds. This presentation explores the development and redesign of a general education course about QISE, the history of its development, and its potential societal impacts at the University of Maryland, College Park (UMD). In this course, students drive two parallel threads of inquiry, in one examining the field of QISE, how it works and how it came to be. And in the other, they explore their own connection to our university (UMD) as the "Capital of Quantum." This presentation will focus on the mechanisms by which these threads of inquiry meaningfully connect, as students construct their own answers to the big question, "Why is UMD the Capital of Quantum?"

G01-4: 2:36–2:48 p.m. Teaching Quantum Mechanics Without Waves or Matrices

Jim Freericks, Georgetown University

In 1925, quantum mechanics was discovered by Heisenberg in the form of matrix mechanics, which was quickly superseded by Schrödinger's wave mechanics in 1926. The former worked in an energy eigenspace representation, while the latter predominately in a position-space representation. There is a third way to formulate quantum mechanics in a representation-independent fashion, that I call operator mechanics. In this talk, I will describe how operator mechanics works and show how to teach quantum mechanics this way. I will emphasize the importance of learning goals, of teaching conceptual ideas before formalism, of emphasizing experiments, and of modernizing topics to the second quantum revolution. This strategy has been used both in classes taught at Georgetown (primarily to undergraduates) and at edX (primarily to lifelong learners). Mathematicians often emphasize the importance in deveoping materials in a representation-independent way, but quantum mechanics is an outlier here, where nearly all treatments focus on the position-space representation. One of the interesting consequences of this approach is that it lowers the mathematical preparation required---in fact, one needs only high-school level algebra, geometry and trigonometry. It requires no calculus! The work discussed in this talk is summarized in a forthcoming book called Quantum Mechanics Done Right from Springer-Nature. It will be published in an open access format, with the electronic version being freely available to all.

Session G02: Cross-disciplinary Labs

Location: Declaration B **Time:** 2–3 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Ashley Carter

G02-1: 2–2:12 p.m. Geomagnetic Fields, Magnetite, and Neural Behavior: A Physics-Based Approach

Vitalina Bialiauskaya

The physics of magnetoreception remains largely unexplored, with increasing evidence linking geomagnetic fluctuations and magnetite (Fe_3O_4) to neural activity. This study investigates the interaction between geomagnetic fields and biological systems by exposing C. elegans to Earth-strength magnetic field variations within a controlled Helmholtz coil setup. Four experimental conditions—control, magnetic field exposure, magnetite bath, and combined exposure—allow for the analysis of locomotion dynamics, directional bias, and clustering. Real-time tracking and computational modeling quantify these effects, testing whether geomagnetic interactions induce neurodegenerative-like behaviors through biophysical mechanisms. By integrating geomagnetism with neurobiology, this research explores fundamental questions in field-matter interactions, biological magnetosensitivity, and potential implications for human neurological health.

G02-2: 2:12–2:24 p.m. Intermediate Physics Snactivities

Kenneth Pestka, II, Ph.D. Physics, Longwood Univ

Popular food or snack based physics activities are often not geared towards the advanced high school or college level. In this talk I will introduce several intermediate snack-based physics activities suitable for physics courses that utilize integral and differential calculus, and at the algebra level. These intermediate physics snactivities are designed to use common household materials to explore physics topics that range from thermodynamics, decay laws, elasticity and other food-based physics applications. These intermediate physics snactivities can be used as laboratory or in-class exercises and, in many cases, provide a snacking opportunity during a physics lesson! Topics will include marshmallow loaded pasta cantilevers, donut decay laws and others.

G02-3: 2:24–2:36 p.m. Undergraduate-Level Demonstrations, Problems, and Simulations Inspired by the Physics of Cranberry Bogs

Caroline Martin, Brandeis University,
Jack-William Barotta

Connections between classroom physics and real-world observations provide a pedagogical opportunity for students to appreciate unexpected applications of their curriculum. For example, the common New England sight of a cranberry bog contains a rich tapestry of phenomena governed by fluid mechanics and soft matter physics. We develop a set of four connected problems and accompanying demonstrations inspired by the physics of the cranberry bog. We explore the behavior of cranberries in their stages of harvest, from their buoyancy in the flooded bog to their aggregation and collection with a boom to their flow through a hopper as they are sorted and transported. We model these phenomena from first principles and develop simple computational models of their collective behaviors, both accessible to an undergraduate physics student. We draw connections to broader physical principles in soft condensed matter and fluids, allowing the real-world example of the cranberry bog to serve as a bridge between an undergraduate curriculum and current soft matter research.

G02-4: 2:36–2:48 p.m. AGISETI: Bringing the Search for Extraterrestrial Intelligence to Every Classroom

Joel Earwicker, SETI Institute,
Vishal Gajjar

The search for extraterrestrial intelligence (SETI) inspires curiosity about one of humanity's oldest questions: Are we alone in the universe? The AGISETI curriculum aims to bring the foundations of SETI into classrooms everywhere, offering students an opportunity to explore the science, technology, and profound questions within this field. By leveraging accessible tools and real data from cutting-edge instruments like the Allen Telescope Array, the AGISETI curriculum introduces students to the fundamentals of SETI research such as radio astronomy, signal processing, and data science. Here we will highlight how the project not only provides practical educational resources, but also fosters a new generation of scientists and amateurs who are passionate about SETI. By making SETI more accessible and engaging, AGISETI broadens the scope of participation in the search, and highlights the importance of public engagement in advancing the field.

Session G03: Interactive: Sunrise, Sunset: Deriving the Duration of Our Days

Location: Franklin/McPherson **Time:** 2–3 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Shane Wood

What time does our Sun rise and set at any day of the year and at any location on Earth? Join us as we answer these questions and strengthen our understanding of the Earth/Sun system. We will start by addressing four "assumptions:" the duration of a year, the tilt of the Earth, the shape of our planet as a sphere, and the shape of our orbit as a circle. From describing a sphere to deriving the length of any day at any location on Earth, we will move through a series of steps using high school algebra and geometry. We will complement the derivation with original GeoGebra simulations modeling the system as seen from space and Earth. This experience gives students a meaningful exploration of the relationship between earth and sun and an appreciation of how proof-based methods can be married with modern technology to deepen understanding.

SPEAKERS:
Elissa Levy
Lawrence Whitfield
Paul McDowell

Session G04: PER: AI in the Classroom and Research: Part 1

Location: Wilson/Roosevelt **Time:** 2–3 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Ralf Widenhorn

G04-1: 2–2:12 p.m. Encouragement of AI in Introductory Mechanics: Sentiment Analysis and FCI Impacts

Kevin Filip, United States Military Academy

The application of AI in education has great promise, though there is still much to understand about student perceptions on AI and its impacts on performance. A one-semester controlled study at the United States Military Academy1 examined how students responded to unstructured encouragement to use AI chatbots in introductory mechanics. An experimental group (n=43) was encouraged to use AI as a study tool for physics while a control group (n=23) received no encouragement but had no restrictions on usage. Surveys at weeks 5, 10, and 15 showed student sentiment towards AI as a useful study tool began higher in the experimental group yet both populations saw relative increases over the semester (58% control, 22% experimental). The most widely used bot was ChatGPT (79% of respondents). Likert data showed that AI was perceived to be more helpful than the textbook and student's sentiment towards the benefits of learning with AI increased significantly based on a two sample t-test (p=0.028). Self-reported AI usage increased in both groups over the semester but regression analysis showed no statistically significant effect on FCI gains (R2=0.0078, p=0.504), likely due to the unstructured nature of the intervention. Students reported the greatest barrier to AI use was academic integrity concerns (70% of responses) followed by a lack of trust in the AI output (49% of responses). This study confirms that students find AI tools useful, but more structured interventions are needed to assess its full impact on learning.

G04-2: 2:12–2:24 p.m. Integrating ChatGPT into a Physics Classroom: How Can Students Use AI to Tackle Complex Physics Problems?

Qurat-ul-Ann Mirza, Masters of Physics, Rowan College at Burlington County,
N. Sanjay Rebello

As large language models like ChatGPT become increasingly prevalent, their potential applications in physics education continue to expand. This study examines the integration of ChatGPT in a first-semester calculus-based physics course at Rowan College at Burlington County (RCBC) in the 2024- 2025 academic year. Students were given the option to engage with ChatGPT on an assessment question to enhance their understanding of a complex physics problem. Later in the semester, they received a brief introduction to prompt engineering before completing a second assessment. This study presents both quantitative and qualitative analyses of student engagement, learning outcomes, and the effectiveness of using AI-assisted problem-solving in physics education. Additionally, students' perceptions of using ChatGPT as a learning tool will be explored, providing insights into their experiences, challenges, and attitudes toward AI in the classroom.

G04-3: 2:24–2:36 p.m. Large Language Models Are Effective for Summarizing Student Feedback

Nicholas Young, University of Georgia,
Christopher Overton, Ania Majewska, Hina Shaikh, Nandana Weliweriya

Student feedback of instruction is important for instructors as it provides a means for understanding learning needs, preferences, and challenges. Yet, for courses with a large number of students, such as introductory physics courses, reading through the feedback can be a time-consuming task, a potential barrier for already time-strapped instructors to regularly collect feedback in their courses. Large language models (LLMs) offer a potential solution as they are effective at summarizing large volumes of text. Combined with their ease of use through chat interfaces, instructors could easily and quickly summarize large amounts of feedback. In this study, we compared the performance of four popular LLMs (ChatGPT, Claude, Gemini, and Llama) to actual course instructors to summarize end-of-semester teaching evaluations from three instructors and eight course offerings at a large university located in the southeastern United States. In general, we find that LLMs identify similar trends in the evaluations as the human summarizers do, though we did find some differences in the detected themes and that some models perform better than the others on this task. Our work then suggests that LLMs are a useful tool for quickly extracting insights from student feedback. We end by providing best practices for instructors interested in using LLMs in their courses to summarize student feedback.

G04-4: 2:36–2:48 p.m. Investigation of the Inter-Rater Reliability between ChatGPT and Human Raters in Qualitative Analysis

Nikhil Borse, M.Sc., Purdue University - West Lafayette,
Sean Savage, Ravishankar Chatta Subramaniam, N. Sanjay Rebello

Qualitative analysis in science education is typically limited to small datasets as it is time-intensive. Moreover, the services of another human are required to establish the reliability of the findings. Artificial intelligence tools like ChatGPT can potentially substitute for human raters if we can demonstrate high reliability compared to human ratings. This study aimed to investigate the inter-rater reliability of ChatGPT in rating audio transcripts that were coded manually in an earlier study. Participants were 14 undergraduate student groups from a university in the midwestern United States who discussed problem-solving strategies for a project. We used prompt engineering techniques to replicate the coding process described by the author of the earlier study with ChatGPT and calculated Cohen's Kappa for inter-rater reliability. We present our preliminary findings, which show satisfactory levels of reliability, suggesting that qualitative researchers can leverage AI tools like ChatGPT for analyzing large data sets efficiently.

Session G05: Developing Scientific Reasoning and Decision-Making Abilities: Part 3

Location: Cabin John/Arlington **Time:** 2–3 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Bradley McCoy

G05-1: 2–2:12 p.m. Using Individual and Group Projects to Promote Transdisciplinary Skills Through Creative Application of Learning: A Decade-Long Practice Across Three Countries

Ajith Rajapaksha, Purdue University - West Lafayette

A curriculum designed to promote disciplinary content knowledge inevitably fosters transdisciplinary skills that students can continue to apply beyond the classroom. These skills can be either assumed or intentionally integrated into the instructional process. Over a decade and across three countries (USA, Sri Lanka, China), individual and group projects have been used to enhance transdisciplinary skills and encourage creative applications of learning in physics, differential equations, computing, and philosophy of science. Projects fall into individual, small-group, and whole-class categories. Individual projects often involve iterative poster designs, where students distill complex concepts into a single-slide visual, linking real-world applications to theoretical foundations. Group projects require students to produce independent products, such as digital stories in mechanics or engineering heat engine applications in thermodynamics, reinforcing hands-on problem-solving. Whole-class projects engage teams working on different sections of a larger project, cultivating leadership and responsibility. For instance, during the COVID-19 pandemic, a 400-student philosophy of science course produced a peer-reviewed journal, and in Spring 2025, 275 students in an introductory electricity and magnetism course will design a space colony. Through these projects, students learn to creatively apply knowledge, navigate ethical standards, utilize diverse tools, and develop a sense of responsibility and community, cultivating critical thinking, leadership, and communication skills for challenges beyond academia.

G05-2: 2:12–2:24 p.m. Assessing Expert-Like Attitudes and Scientific Reasoning Skills with Multiple Instruments

Raymond Zich, Illinois State University

This was a longitudinal study comparing assessments of the effects on student expert-like attitudes and scientific reasoning skills produced by two instructional interventions in a general education physics course. Expert-like attitudes were measured by the Colorado Learning Attitudes about Science Survey (CLASS) and scientific reasoning skills were measured by Lawson's Classroom Test of Science Reasoning (CTSR) and Montana State University's Formal Reasoning Test (FORT). Earlier results showed low correlations between pre- and posttest CLASS and posttest CTSR results. Additional results were obtained from pre- and posttest scores from Montana State University's Formal Reasoning Test (FORT). Low correlations between results from all three instruments were observed. Comparison of results from two control and eight treatment semesters of data from the CLASS, CTSR, and FORT are presented along with implications for instruction given this apparent decoupling of expert-like attitudes and reasoning skills.

G05-3: 2:24–2:36 p.m. Looking at NGSS through Reasoning

Marla Glover, Purdue University

Creating activities so students can practice reasoning skills is not a simple task. Creating activities that fit within the NGSS 3-Dimensional learning framework is also not easy. Jonathan Osborne is a science education researcher who has put these ideas together. This presentation will focus on an activity created through the lens of Osborne's "Styles of Reasoning" and how that can apply to NGSS labs and activities.

G05-3: 2:36–2:48 p.m. Gen AI as a Reflective Companion in Physics Education: Guiding Student Self-Reflection Without Surrendering Agency

Andrea Jimenez Dalmaroni, Cardiff University

As GenAI becomes more accessible, educators face a critical challenge: how can students use GenAI to support self-reflection without outsourcing their thinking or losing their learning's ownership? We introduce a structured educational framework designed to guide physics students in using GenAI as a reflective partner. The framework centres on a four-stage reflective cycle with optional GenAI interaction at each stage to prompt metacognitive dialogue, challenge assumptions, and scaffold critical thinking. Students engage in guided templates, AI-prompted reflection, and meta-reflection on their own AI use, fostering both conceptual understanding and digital agency. This presentation will show how to implement this framework effectively for reflective tasks in an undergraduate physics course, exploring instructor tools, ethical considerations, and classroom routines that support meaningful, student-centred use of AI. We will provide practical strategies, a ready-to-use reflection model, and guidance on how to make GenAI a catalyst for deeper learning, not a shortcut around it.

Session G06: Identity and Belonging in Physics Learning

Location: Bulfinch/Renwick **Time:** 2–3 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Diana Sachmpazidi

G06-1: 2–2:12 p.m. Introductory Physics Student's Perspectives on Their Social Identities

Clare Bentley, Western Washington University,
Tra Huynh

Physics students often see their social identities as irrelevant to their physics learning. This perpetuates a culture in which physics is neutral and objective while ignoring broader social issues' impact on physics students. We analyzed 669 written survey responses from calculus-based introductory physics courses, where students were asked "how has your perspective influenced your understanding of physics?" Using the Critical Physics Identity framework, we characterized the kinds of experiences and perspectives students brought up. Most students agreed that their perspective influenced their physics understanding, but very few connected their perspectives to their social identities, despite previously being asked about their demographics in the survey. We also found that students most commonly referred to their Personal Characteristics of the Ideational Resource construct, followed by their Material Resources. We argue that these results are a reflection of greater physics culture which is centered on privileged identities and disregards marginalized physicists' lived experiences.

G06-2: 2:12–2:24 p.m. How Students Think and Learn in Physics: Insights from Learning Approaches, Identity, and Metacognition

Yaren Ulu, PhD student, Texas Tech University,
Beth Thacker

A complex interaction of cognitive and identity factors shapes students' learning experiences in physics. Their approaches to learning, reflections on their thought processes, and self-perceptions as physics learners greatly impact their engagement and persistence in the subject. This study explores the connections between learning approaches, metacognition, epistemic cognition, and physics identity, seeking to better understand how these components interact in the context of physics education. By analyzing survey data, we identified trends in students' metacognitive awareness, epistemic beliefs, and learning strategies, as well as their feelings of belonging in physics. The results will provide valuable insights into how teaching strategies can enhance deeper learning and develop stronger physics identities, ultimately leading to improved student success in physics courses.

G06-3: 2:24–2:36 p.m. Empowering Women in Physics: How Leadership, Mentorship, and Career Conceptualization Programs and Practices Impact Identity and Belonging

Laura M. Akesson, George Mason University,
Jessica L. Rosenberg, Nancy Holincheck, Benjamin Dreyfus, Julia Lipman

Understanding identity development for women in physics is important for their persistence in a field that still struggles with underrepresentation of women. In this presentation, we will discuss our qualitative interview study that explores how undergraduate women developed their physics identities, with a particular focus on their experiences with leadership, mentorship, and learning about careers in physics. Our team analyzed 15 interviews to understand how women in physics define physics identity and how our theorized factors (leadership, mentorship, and career conceptualization) were associated with an individual's physics identity. Our findings have implications far beyond undergraduate education. K-12 educators and informal science educators may be positioned to provide STEM leadership and mentorship opportunities to underrepresented students, which can help to build students' identities before they go on to college.

G06-4: 2:36–2:48 p.m. Exploring Leadership Identity Development in a Physics Community of Practice: A Multifaceted Perspective

Hamideh Talafian, University of Illinois Urbana-Champaign,
Maggie Mahmood, Morten Lundsgaard, Eric Kuo, Tim Stelzer

Communities of practice have been shown to play a crucial role in shaping educators' professional identities through negotiation of meaning, collaboration, and strategy exchange. Educators from diverse backgrounds come together in these communities, fostering personal and professional growth that extends beyond classroom practices. While professional development programs are often evaluated based on their impact on instructional methods, this work takes a deeper look at leadership identity development within such communities. Through a multifaceted lens, we examine the personal, social, and professional dimensions of a physics educator's evolving leadership identity, drawing insights from her own perspective, her peers, and professional development designers.

Session G07: Creating Inclusive and Supportive Physics Communities: Part 1

Location: Penn Quarter AB **Time:** 2–3 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Brianne Gutmann

G07-1: 2–2:12 p.m. Aspects of Disabled Students' Experiences from the C2C Design Team

Erin Syerson, Western Michigan University,
Jayden Butler, Bella Tuffias-Mora, David Cassens, Mason D. Moenter, Matthew W. Guthrie, Theodore Bott, Xian Wu, Tanya Adams, Erin M. Scanlon, Daryl McPadden

The Courses to Careers student design team is part of a collaborative project that facilitates partnerships between students with disabilities and faculty in physics education. One of the many projects that this group has worked on includes developing a series of articles for the "Just Physics" column in The Physics Teacher. Our series delves into several topics, including disabled student experiences, intersectionality, and empathy, and we give suggestions regarding best practices for supporting students, handling accommodations, and how to celebrate disabled students. In this talk, I will discuss the disabled student writing process, focussing on my personal experiences. I will also provide a brief summary of the published column topics and a sneak peek into the next segment of the column. We hope that this talk and the column itself can give insight into aspects of the disabled student experience and help break down the current exclusionary climate towards students with disabilities. This work is supported in part by NSF Grant Nos. DUE 2336367 and DUE 2336368.

G07-2: 2:12–2:36 p.m. The C2C Design Team: Insights from the Experiences of Disabled Physics Students

Theodore Bott, Michigan State University,
Erin M. Scanlon, Matthew W. Guthrie, Xian Wu, Tanya Adams, Daryl McPadden

We present a study stemming from the Courses to Careers (C2C) project, aimed at creating a mutually beneficial professional development experience for physics faculty and disabled students. A central component of the C2C project is to build partnerships, including in the design of the workshop. To that end, we recruited the C2C design team, comprised of six disabled physics students with different disability identities and academic trajectories. The design team and primary investigators meet virtually for one hour every week to discuss their experiences as disabled students in postsecondary physics, what they wish instructors knew or considered about their experiences, and the challenges they've faced in their own career preparation. Prior to the meetings, the design team members answer a couple questions in an asynchronous working document that prompt ideas for that week's meeting. From the working documents and recordings of the design team meetings, we utilize frameworks such as community cultural wealth, critical disability theory, and critical discourse analysis to identify emergent themes. In this talk, we present the analysis and emergent themes elucidated from the design team's experiences. This work is supported in part by NSF Grant Nos. DUE 2336367 and DUE 2336368.

G07-3: 2:24–2:36 p.m. Designing Student-Led Near-Peer Mentorship Communities

Gloria Lee, PhD, Scripps College, Emily J. Griffith

Near-peer mentorship programs, which connect undergraduate students with their more experienced peers, can play a vital role in helping students build community, cultivate a sense of agency, and navigate science. The Access Network, a collection of nine student-led, diversity-oriented STEM communities at universities across the country, recently published the first chapter of its "Starter Kit for Diversity-Oriented Communities for Undergraduates," which focuses on near-peer mentorship programs. This resource synthesizes the working knowledge and best practices developed by student leaders from the Access Network, and offers practical advice for students interested in setting up mentoring communities in their own departments. The starter kit outlines best practices for designing, running, and sustaining near-peer mentorship programs, including lesson plans for mentor and mentee training and other template resources. While the Access Network specifically focuses on undergraduate-serving programs in STEM, their community-building framework easily extends to other disciplines and student demographics. We hope student leaders and faculty advocates find this guide useful as they create programs that foster vibrant inter-student relationships in their local communities.

G07-4: 2:36–2:48 p.m. How do Physics Identity and Perceived Recognition Ggrade for Women and Men

Jaya Shivangani Kashyap, PhD, Graduate stduent, University of Pittsburgh,
Chandralekha Singh

Perceptions of recognition and identity can be shaped by various forms of feedback and experience. Here we focus on the potential effects of course grades. We analyze statistical patterns in changes in identity and perceived recognition from pre to post course in three years of data of students enrolled in many sections of calculus-based Physics 1 (N=1034). In particular, regression models predicted post-semester survey means using pre-semester survey means and grade. Effects of gender and interactions of grade with gender were also included. All students showed declines in identity and perceived recognition after receiving lower grades. However, women showed larger declines, with a decline after receiving only a B grade that was similar to the declines men showed after receiving a C grade or a non-passing grade.

Session G08: PER: Conceptual Inventories: Part 1

Location: Constitution DE **Time:** 2–3 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Harish Moni Prakash

G08-1: 2–2:12 p.m. Achieving Good Fit to the Rasch Model Through Intentional Item Design: The Case of the Quantum Computing Conceptual Survey

Josephine Meyer, Ph.D., University of Colorado Boulder,
Gina Passante, Steven J. Pollock, Bethany R. Wilcox

Compared to other item-response theory models for assessment validation, the Rasch model features a number of intrinsically desirable psychometric properties for assessment development within PER -- particularly the mathematical property of "specific objectivity" which helps guarantee metrological soundness of the instrument by mathematically separating item difficulty and student ability estimates. However, achieving acceptable fit to the Rasch model has sometimes been viewed as impractical in the PER community given the heavy constraints the model places on item development, motivating the adoption of more general IRT models that sacrifice these metrological properties. Drawing on 3 semesters of pilot data for the Quantum Computing Conceptual Survey, we demonstrate that it is indeed possible to achieve good fit to the Rasch model on a PER upper-division conceptual assessment through intentional item design, with implications for the development and validation of next-generation PER assessments moving forward. This work was funded by the NSF GRFP and NSF grants nos. 2011958, 2012147, and 2143976.

G08-2: 2:12–2:24 p.m. Problem-Property Dependence of Student Responses to Thermodynamics Problems

David Meltzer, Arizona State Univ At the Polytechnic Campus,
Mary Jane Brundage, Chandralekha Singh

We analyzed interview data along with students' responses to multiple-choice assessment items in introductory thermodynamics to investigate the relationship between students' responses and the specific properties of the individual assessment items. These items incorporated a wide variety of problem types, designed such that 2-5 different problems all targeted the same physics concept; 13 different thermodynamics concepts served as the targets. The problems differed from each other by using diverse physical settings and scenarios, as well as various types of potentially distracting features. (Examples: gas compressions and expansions; isothermal, adiabatic, and isochoric processes; with and without PV diagrams; diagrams that display or do not display temperatures or process types explicitly.) Collectively, we refer to these different settings, scenarios, and features as problem "properties." We found numerous instances in which very minor changes in problem properties were associated with very large changes in correct-response rates even on problems that targeted identical concepts. Among our findings was that specific features of PV (pressure-volume) diagrams as well as specific terms such as "adiabatic" and "reversible" often triggered unproductive lines of reasoning, distracting students from the features of the problem most relevant to finding a solution. In general, students were prone to focus undue attention in predictable ways on the "most salient" variable (such as heat or work) while ignoring other variables that were essential to solving the problem. We discuss implications for instruction and offer suggestions for addressing these issues.

G08-3: 2:24–2:36 p.m. Discovering Misconceptions by IRT and Machine Learning from FCI Data

Aaron Adair, MIT,
David Pritchard, Martin Segado, Elaine Christman, John Stewart

Student misconceptions result in associated patterns of distractors on research-designed multiple choice instruments. We wrote a Hierarchical Bayesian realization of the Multidimensional Nominal Categories Model. Applying non-orthogonal rotations (from the r-package) in the multi-dimensional space generated one "Newtonian Correct" dimension and ~20 "sparse" dimensions each of which loaded heavily on only several distractors. These proved to be highly robust with respect to different rotation methods and to selecting new data sets using bootstrap methods. On most dimensions, the sparse vectors of our bootstrap samples correlated with the best sparse vector at above 0.9. Intellectual similarities among distractors associated with each vector enabled us to identify its misconception or misunderstanding. We found many known misconceptions (i.e., last force governs direction, gravity stronger near ground, etc.), that separate misconceptions for impetus force on linear and circular paths, and new misconceptions like moving masses accelerated sideways travel on straight paths.

G08-4: 2:36–2:48 p.m. Effects of Instruction on Students Holding Various Non-Newtonian Misconceptions

David Pritchard, Massachusetts Institute of Technology,
Aaron Adair, Martin Segado, Elaine Christman, John Stewart

We analyzed individual wrong responses from 34k administrations of the FCI using our bayesian implementation of a multidimensional item response theory followed by transformations in the vectorspace of all responses (1). We discovered ~17 coherent, non-orthogonal student misconceptions and misunderstandings, including some not previously found in the PER literature, e.g. "objects with force perpendicular to their path go straight" and "air resists motion and pushes downwards". We can find the amount of each misconception held by a small class, allowing us to find the diminishment of each misconception after instruction for each pretest score (1-30) from our whole data set. We see examples where instruction leaves low-skill, high-skill, and all-skill students unimproved; the all-skill misconception being "impetus force for linear motion". Insights into what misconceptions students have and who benefits more or less from instruction can help instructors focus their lessons to make learning more effective and equitable.

G08-5: 2:48–3 p.m. Using chatGPT to Efficiently Create Large Numbers of Isomorphic Assessment Problems

Zhongzhou Chen, University of Central Florida

Rapid advancements in generative artificial intelligence (GenAI) present new opportunities to enhance STEM education. This study explores the use of GenAI, specifically ChatGPT, for efficiently creating large sets of isomorphic physics problems at the introductory physics level. Isomorphic problems share the same underlying structure but differ in context and specific details such as the direction of forces or motion, as determined by the educator. We outline a multi-step process that guides GenAI to strictly adhere to the instructor's detailed criteria, significantly improving problem quality over simpler prompt-based approaches. Our methodology not only creates diverse and contextually appropriate problem scenarios, but also generates and validates consistent and context appropriate random numerical values. This approach demonstrates the potential of GenAI to scale high-quality, varied practice material, enriching student engagement and understanding in introductory physics.

Session G09: PER: Assessment Tools and Methods

Location: Lafayette Park **Time:** 2–3 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Harish Moni Prakash

G09-1: 2–2:12 p.m. A Novel Method for Clustering Student Problem Solving Strategy Essays

Winter Allen, Purdue University,
N. Sanjay Rebello

Problem-solving is a critical skill for STEM students entering the workforce. The Next Generation Science Standards (NGSS, 2013) emphasize defining problems and designing solutions as essential science and engineering practices. Research shows that writing-based problem-solving strategies, combined with appropriate scaffolds, help students focus on the deeper structure of problems, starting with conceptual analysis and avoiding unproductive novice strategies. To detect emerging patterns in students' problem-solving essays, we use clustering, an unsupervised learning technique. K-Means and Hierarchical Density-Based Spatial Clustering of Applications with Noise (HDBSCAN) are among the most widely used clustering methods. We introduce a hybrid approach that combines K-Means and HDBSCAN to enhance clustering performance. We evaluate the method using scatterplots and clustering metrics and compare it to K-Means and HDBSCAN alone. Our results show that the hybrid method effectively clusters student responses into five strategy groups, correlating significantly with their multiple-choice answers.

G09-2: 2:12–2:24 p.m. Exploring Alternative Factor Structures for the Colorado Learning Attitudes about Science Survey

Amanda Nemeth, West Virginia University,
John Stewart

The Colorado Learning Attitudes about Science Survey (CLASS) probes respondents' attitudes on learning physics. The CLASS consists of 42 total items (36 total which are scored), organized into eight categories. These eight categories contain 26 items total, with several items appearing in more than one category. Douglas et al. (2014) conducted a factor analysis study on the CLASS, and proposed a simplified factor structure for the instrument, consisting of three factors and 15 items, with no items loading on multiple factors. The current study examines the Douglas results on a different dataset. This dataset comes from a large eastern US land-grant institution and focuses on post-test CLASS responses from the introductory calculus-based mechanics course. Initial confirmatory factor analysis (CFA) results indicate that neither the Douglas factor structure nor the originally published categories fit the data for this study. This study then looks at applying the exploratory factor analysis (EFA) method employed by Douglas to this new dataset to analyze differences between the two studies. Differences were identified in initial EFA results; the manner in which the data was split also impacted the results. Results also varied depending on the cutoff values used in the EFA process. This presentation will discuss the process used, variations found between results, and the application of CFA to the EFA results. Finally, the identification of subscales and unique items will be highlighted.

G09-3: 2:24–2:36 p.m. Quantitative Ethnography: Utilizing Qualitative and Quantitative Methods to Strengthen Physics Education Research

Sabrina Henige, The Ohio State University,
Geraldine Cochran, Stella Nelson

As physics education researchers work to imrove the experience of people in physics, it is essential to develop and apply methodological tools that support and strengthen our research. In this presentation, we explore quantitative ethnography, a novel methodology, as a promising approach to centering the lived experiences of marginalized populations while maintaining statistical rigor in analysis. We discuss how this methodology can provide qualitative researchers with statistical power to make stronger claims regarding participants' connection of concepts, meaning making, and interpretation. In this presentation, we will discuss several aspects of the coding process essential to quantitative ethnography.

G09-4: 2:36–2:48 p.m. The Role of Integration in Understanding Self-Efficacy: A Mixed Methods Approach

Carissa Myers, Michigan State University,
Vashti Sawtelle, Rachel Henderson

Research on self-efficacy (SE) has shown to be a predictor of academic achievement and persistent in the sciences [1-3]. This talk continues to present the mixed methods approach we have been designing to explore the interaction between students' in-the-moment experiences and their SE [4]. Employing an explanatory sequential mixed methods design, we combine the Experience Sampling Method (ESM) via survey data with daily journal reflections to gain a holistic understanding of how students' real-time experiences influence their sense of SE. Here, we will examine how the integration of these data sources shape the claims we can make about SE. Integration is a process and product, in which the quantitative and qualitative elements are connected [5]. This process of integration impacts the insights we can derive about how real-time experiences influence a student's SE. By highlighting this process, we will demonstrate how the integration process informs the conclusions drawn about students' SE in relation to specific experiences.

Session G10: Celebrating 20 Years of Physical Review Physics Education Research – Part 1

Location: Farragut Square **Time:** 2–3 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Paula Heron

G10-1: 2–2:24 p.m. Physical Review Physics Education Research: Twenty Years of Growth and Impact

Charles Henderson, Western Michigan University, Eric Brewe, Noah Finkelstein

Physical Review PER started in 2005. Over the past two decades, the journal has played a pivotal role in advancing PER as an important research area within physics, providing a rigorous platform for scholarship that supports and shapes the field's development. It has grown significantly in number of publications, impact, and international scope. In this talk we will provide an overview of key journal trends over the past 20 years. We will also discuss successes, challenges, and highlight some impactful papers.

G10-2: 2:24–2:48 p.m. A Brief Review of History and Purposes of Physical Review Physics Education Research

Noah Finkelstein, University of Colorado - Boulder,
Charles Henderson, Eric Brewe

While Physical Review PER may be considered staple and the leading journal in physics education research, it did not always exist, nor, once launched, was it clear that it would necessarily continue. It is because of community-led efforts by individuals (especially Bob Beichner, the founding editor) and the American Physical Society that the journal has grown and thrived. In this interactive session, we will discuss the need, origins and early days of the journal (and this era of the field of Physics Education research, which was still establishing itself). Furthermore, we will consider from both theory and practice what the purpose of such a journal is in supporting individuals, the PER community and the many and significant goals we have to advance physics education.

Session G11: Advances in Medical Physics: What You and Your Students Should Know

Location: Salon E (Washington at Metro Center) **Time:** 2–3 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Mohammad Yousef

The field of medical physics has undergone many technical advances in the areas of diagnostics, therapy, and education. There is also a growing need for medical physicists. Three invited panelist from the American Association of Physicists in Medicine will present. It will cover educational pathways for your students and will end with a Q&A panel.

SPEAKERS:
Rachel Ger
Rao Khan
Dustin Gress

Session G12: Graduate Student Life: Contemporary Issues in Graduate Programs

Location: Salon A/B (Washington at Metro Center) **Time:** 2–3 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Paul DeStefano

A discussion-focused session on contemporary issues affecting graduate students entering, working, and persisting in graduate programs. Invited speakers and attendees with share their perspectives on the graduate school experience and what AAPT can and should be doing to improve graduate education.

Session G13: Interactive: Using Arduino for Labs and Student Projects

Location: Salon C/D (Washington at Metro Center) **Time:** 2–3 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Paul DeStefano

In this session, the invited presenters will have hands-on demonstrations of labs and student projects with Arduinos. Initially each presenter will give a 2-minute elevator pitch. Then, participants will move from table to table where they will participate in demonstrations with Arduinos. Leaders will have handouts and will make source code (and electronic materials) available.

PRESENTERS:
Livia Luo, Greg Mulder, Geroge Trammell and Don Smith

Session H01: Reframing How We Teach for Engagement: Modern Physics

Location: Declaration A **Time:** 3–4 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Sebastian Kilde Westberg

H01-1: 3–3:12 p.m. Estimating all Fundamental Constants from Your Kitchen

Alberto Rojo, Ph D, Oakland University

We explore fundamental constants by connecting them to everyday phenomena using simple estimations. By blending direct observations with basic theoretical principles, we aim to reveal the quantities that shape our physical reality in an intuitive way. Physics often emphasizes that dimensionless ratios are the most fundamental—physical laws should not depend on arbitrary unit choices. In this spirit, we compare scales: How heavy is an atom relative to a liter of water? How does the frequency of visible light compare to a human heartbeat? How many Planck constants contribute to the angular momentum of coffee swirling in a cup? Using basic equations and reasonable approximations, we estimate key physical constants, including Loschmidt's number, Boltzmann's constant, Planck's constant, the charge of the electron, the mass of the proton, the gravitational constant, and the speed of light. In all cases, our results are within an order of magnitude of accepted values, demonstrating the power of simple, order-of-magnitude reasoning. This approach aligns with the spirit of Victor Weisskopf's Search for Simplicity in the American Journal of Physics and the classic Powers of Ten by Morrison, highlighting how fundamental physics can be understood through everyday intuition.

H01-2: 3:12–3:24 p.m. Modern Physics as Introductory Course for Physics Majors: Capturing the Futuristic Problem Solvers

Richard Gelderman, Western Kentucky University

"We think it is important and desirable to introduce students sooner than usual to some of the major ideas that shape contemporary physicists' views of the nature and behavior of matter." is a quote from the promotional blurb for the text "Introductory Modern Physics, 2e" (2010 Holbrow, Lloyd & Amato, Springer). Capturing the efforts of Colgate University's Charlie Holbrow and Joe Amato to reinvigorate the curriculum for physics majors, the argument is that learners deserve to motivated and intrigued by the physics behind most of the current research and jobs today's physicists will encounter. Western Kentucky University restructured its introductory sequence for majors to commence with a pre-calculus presentation of special relativity and quantum science. We have found that ALL students appreciate being able to work with these inherently interesting topics, while continuing to build their foundations of calculus and linear algebra skill.

H01-3: 3:24–3:36 p.m. Information and Entropy, Energy and Exergy for Non-majors

Michelle Tomasik, Massachusetts Institute of Technology,
Krishna Rajagopal, Robert Jaffe, Aidan MacDonagh, Rosie Anderson

This past winter saw the first run of a flipped class for any first year undergraduate who had taken mechanics, that taught them to think their way rigorously through questions like: 1) Why is it so much harder to remove CO2 from the atmosphere than to pump it into the atmosphere? and, 2) If energy is conserved as we learned in mechanics, what do we mean by the consumption or production of energy and why do we have an energy crisis? This course introduced information entropy, Boltzmann entropy, and the second law of thermodynamics and ended with a discussion of exergy, all without the blizzard of partial derivatives featured in more advanced classes, but nevertheless in a way that the students came away with an understanding of the essence of these fundamental concepts that they can rely upon throughout whatever they do in future, including as critical thinkers. In this talk, I will discuss the goals, development, and content of this course, as well as the initial reception and future directions, and share a way for everyone to access the online content.

H01-4: 3:36–3:48 p.m. Project-Based Learning and Student Engagement in the Upper-Level Undergraduate Physics Curriculum

Tatiana Allen, Department of Chemistry and Physics, University of Tennessee at Chattanooga,
Matthew L. Boone, Jacob E. Humberd

We will discuss a series of courses listed under an umbrella name of Phys 4999r (Group Studies) that we offered during the last two years, with typical enrollment of 10 students per semester. These courses are based on modern physics concepts and are intended for upper-level students; however enthusiastic sophomores can also participate. Each course is centered on a contemporary research project, where students build a functional device. The first device they built was the LEGO model of the Kibble Watt Balance [1] to measure gram-size masses using the SI definition of kilogram based on the Plank's constant. Then they built LEGOLAS - a LEGO-based, low-cost autonomous scientist [2], a robot that uses machine learning techniques to autonomously derive the Henderson-Hasselbalch equation, reducing the tedious experimentation and calculations typically involved in acid-base experiments. Then they built a 3D-Printed Laser Autocollimator [3], a device that precisely measures the angular deviation of a translational stage while also being a low-cost and compact alternative to commercially available autocollimators. These courses are closely interrelated with the activities of the local chapter of the Society of Physics Students (SPS). We observe an unprecedented level of student engagement in these courses: they not only built the devices but frequently improve the ease of use, calibration and functionality by changing the design, incorporating custom 3D printed parts, and writing better manuals and instructions.

Session H02: Labs/Apparatus

Location: Declaration B **Time:** 3–4 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Joe Wyatt

H02-1: 3–3:12 p.m. A Capacitors Experiment for Introductory College Physics Using Logger Pro

Scott Gianelli, Suffolk County Comm Coll - Ammerman Campus

An experiment has been designed for introductory-level physics students to study the behavior of capacitors using Logger Pro. The students connect the current probe in series with a capacitor and a resistor of several hundred ohms. The LabQuest interface allows them to see the current as a function of time. From this, they can use the software to integrate over the time interval and obtain the total charge that builds up on the capacitor. After repeating this process for multiple voltage values, they plot charge vs. voltage and use the slope of the graph to obtain a value for the capacitance. Students obtain the capacitance for two capacitors individually, together in series, and together in parallel. Random noise is significant at low levels of current, but agreement with DMM-measured values of the capacitances within 10% is readily achievable. In addition, students can observe when a capacitor breaks down and learn how to correctly interpret the result.

H02-2: 3:12–3:24 p.m. Using Everyday Materials to Shield Nuclear Radiation

Grant D. Thompson, Wingate University, James W. Hall

A well-known lab experiment has students collect data from a Geiger counter and a radioactive beta-emitting source to determine a radioactive half-life. Over time, this radioactivity lab has expanded to analyze the distance dependence of Geiger counter data counts and also the shielding effects using plastic, aluminum, and lead sheets. We have moved further in this shielding direction and have students experiment with common everyday materials to see how effectively they 'protect against radioactivity' by determining the materials' half-thickness. From the expanded lab, students have a better understanding of nuclear energy and have become more comfortable with nuclear power plants as an energy source.

H02-3: 3:24–3:36 p.m. Make a Halo with Diffuse, Specular, and Total Internal Reflection

Paul DeStefano, University of Portland, Ralf Widenhorn

In this presentation, we explore the fascinating and educational physics behind the halo formed by a laser spot in shallow water. Using geometric optics, we present a straightforward model to explain this phenomenon, supported by empirical evidence. We also delve into extensions of this model that account for variations in the visual pattern, such as a double halo pattern and a disk of dim light. Despite varying complexities, all models are grounded in the principles of ray optics, including refraction, and diffuse, specular, and total internal reflection. We will discuss practical ways to incorporate these halo effects into undergraduate physics courses, offering a rich, real-world application of key optics concepts suitable for diverse teaching environments.

H02-4: 3:36–3:48 p.m. Blackbody Radiation, Incandescent Bulbs and LED Detectors

Patrick Polley, Ph.D.

The study of the quantum world often begins with blackbody radiation and Planck's quantization hypothesis. While incandescent light bulbs have long provided light sources that closely approximate black bodies, the classroom investigation of this phenomenon can be limited by the need for spectrometers.1 In this paper I examine the use of incandescent light bulbs to study blackbody radiation, and the use of LEDs as photodetectors to provide an accessible alternative to spectrometers. The dependence of the power radiated by a blackbody on the fourth power of the temperature is shown, as well as the dependence of the intensity of blackbody radiation as a function of temperature at discrete wavelengths in the visible and infrared portions of the spectrum.

H02-5: 3:48–4 p.m. Development of 8+2 Experiments Using Apparatus with Cycloidal Curves

Hyunggun Park, Sangwon High School, Jung-Bog Kim

Cycloidal curves, known for their properties as brachistochrones and tautochrones, offer valuable insights into fundamental mechanics concepts. This study presents the development of apparatuses facilitating ten distinct mechanics experiments utilizing cycloidal curves, aiming to enhance students' intuitive understanding of mechanics. The apparatuses are designed to be compact for easy use on a desk, allowing exploration of concepts such as momentum conservation, impulse, collisions, and safety mechanisms. They can be disassembled into two parts for convenient storage and have been adapted for simultaneous drop experiments. Additional experiments include comparing inclined planes, circular arcs, and cycloidal curves to verify the brachistochrone property, as well as exploring the isochronous nature of cycloidal pendulums, Galileo's inclined plane experiments, and inertia thought experiments. To improve observation and measurement accuracy, auxiliary devices have been developed to reduce errors when manually releasing marbles, and smartphone cameras can be utilized to clearly capture the rapid motion of the balls. This study aims to provide educational materials that apply cycloidal curves in practical lessons, facilitating effective mechanics experiments in high school integrated science, Physics I and II, and middle school science education. It seeks to connect scientific principles with real-life applications, encouraging thoughtful consideration and extending the meaning and value of these concepts. Through this research, it is anticipated that students will engage in hands-on experiments, creatively explore mechanics concepts, deepen their understanding, and connect scientific content with everyday life.

Session H03: Frontiers in Space Science and Astronomy

Location: Franklin/McPherson **Time:** 3–4 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Ann Schmiedekamp

H03-1: 3–3:24 p.m. Exploring the Universe with the James Webb Space Telescope

Invited – Kelly Lepo

The James Webb Space Telescope, NASA's latest flagship space observatory, released its first spectacular color images in July 2022. This summer marks three years of the telescope's science operations. In this presentation, I will take a deep dive into some of Webb's latest discoveries, including what we are learning about the early universe, how stars form and die, what planets around other stars are like, and our dynamic solar system. I will also present resources you can use to discuss JWST science with learners inside and outside of the classroom.

H03-2: 3:24–3:36 p.m. GeoGebra and Planetary Motion: Modelling the Duration of Our Days

Lawrence Whitfield

As a complement to the Sunrise, Sunset: Deriving the Duration of Our Days talk, I will present a series of GeoGebra simulations that teachers can readily use in the physics classroom to illustrate fundamental concepts in planetary motion. Guidance will be provided to enable both teachers and students to begin constructing their own GeoGebra models. This will be used to enhance students' mathematical understanding of the earth-sun system through multiple representations.   This could ultimately lead students to combine computer modeling, high school math, principles of physics and basic astronomy to make their own models for uses up to and including science fair submissions.

H03-3:   3:36–3:48 p.m. Learn about Heliophysics and Space Weather Events through NASA's Community Coordinated Modeling Center's (CCMC) Tools

Elana Resnick, NASA CCMC | ASRC Federal,
Masha Kuznetsova, Leila Mays, Yihua Zheng, Jia Yue, Chiu Wiegand, Richard Mullinix, Elon Olsson, Anders Lundkvist

Learn about heliophysics and how you can use the Community Coordinated Modeling Center's (CCMC's) tools to engage with heliophysics and the Sun's path towards solar maximum for solar cycle 25. Events such as the annular eclipse from October 2023, the total solar eclipse from April 8th, 2024, Parker Solar Probe's closest approach to the sun from December 24th, 2024 can be analyzed and viewed through CCMC's interactive tools. The CCMC has hands-on space weather modeling tools for formal and informal educators. The CCMC supports educational activities, such as heliophysics and space weather summer schools, contests, research visits and exchanges. We at the CCMC create and maintain a wide variety of tools for space weather simulations, analysis, forecasting, and visualization. This includes tools such as the Integrated Space Weather Analysis System (ISWA), Database Of Notifications, Knowledge, Information (DONKI), and OpenSpace 3D visualization project.

Session H04: PER: AI in the Classroom and Research: Part 2

Location: Wilson/Roosevelt   **Time:** 3–4 p.m.   **Date:** Tuesday, Aug. 5, 2025   **Moderator:** Qiaoyi Liu

H04-1:   3–3:12 p.m.   Comparing Different NLP Methods at Grading Open Ended Physics Problems

Sean Savage, Purdue University, Nikhil Borse, M.Sc., N. Sanjay Rebello

A limiting factor in examining student reasoning on conceptual assessments has been that such assessments are typically administered in a multiple-choice (MC) format. Thus limiting the options to analyze more elaborate data from students who may not fully understand a concept. Current tools such as Machine Learning (ML) and large language models (LLMs) offer a promising opportunity for assessing students' written responses in a fair and consistent way, offering a possible alternative to MC assessments.. Our study compares ML, LLM and humans at classifying students' written explanations (correct or incorrect) with respect to their correctness on MC questions. We compare the correctness of the written explanations with the ground truth (students' MC correctness), allowing us to verify the accuracy in Natural Language processing (NLP) techniques in grading written responses. Our preliminary findings show that MC results best align with human raters, though ML and LLM are not far behind.

H04-2: 3:12–3:24 p.m.   AI as a Research Partner: Enhancing PER Literature Analysis

Michael Mingyar, Montana State University, Shannon Willoughby

Understanding the evolution of a field of study is important for engaging with that field, yet tracking trends in Physics Education Research (PER) is increasingly challenging due to the expanding amount of relevant literature. Traditional literature reviews provide valuable insight but are slow and labor-intensive, limiting researchers' ability to track how concepts develop over time. To explore this challenge, we develop an automated approach for large-scale literature analysis using modern language models. By applying natural language processing techniques like sentiment analysis, we investigate the potential of machine learning to extract insights from PER publications. We focus on publications from The Physics Teacher, PER Conference Proceedings, American Journal of Physics, and Physical Review PER. While not a replacement for human analysis, this approach may help identify patterns in how ideas emerge, spread, or fade within PER literature.

H04-3: 3:24–3:36 p.m.   Physics Course Grade Prediction Using Bayesian Networks

John Pace, West Virginia University,
John Stewart, John Hansen

Bayesian networks trained on students' physics course performance data were used to analyze student progression through the curriculum and predict student performance in a set of upper-level undergraduate courses. An expert-elicited method of developing conditional dependency structures is explored and compared to standard Bayesian network structure learning algorithms. The course grade classification performance of a set of Bayesian network models is examined for modern physics, electricity and magnetism, and quantum mechanics courses. Adjustments to modeling procedures are explored to accommodate low record counts in the course performance datasets. Benefits of Bayesian networks, such as ease of interpretation and conditional probability querying, are discussed.

Session H05: Developing Scientific Reasoning and Decision-Making Abilities: Part 4

Location: Cabin John/Arlington   **Time:** 3–4 p.m.   **Date:** Tuesday, Aug. 5, 2025   **Moderator:** Kathy Shan

H05-1:   3–3:12 p.m.   Scientific Literacy in 2025: A Case for Constructivism in Teaching Physics

Diane Jammula, Rutgers University - Newark,
Sheehan Ahmed, Joshua Rutberg

News organizations and social media present alternative facts. Society is polarized as algorithms facilitate confirmation bias and cancel culture ruminates on both sides. The development of generative artificial intelligence outpaces policies and norms of use. The United States is undergoing rapid change from the federal administration, and nationalist movements abound worldwide. This is the society we are living in and preparing our students for. While few of our students will ever again need to calculate the final velocity of a cart after a collision, they will need to make decisions impacting their personal lives, the community, and society at large regarding science. In this talk we examine our current social and political climate; identify scientific abilities our students need; and suggest how to teach these abilities. We make a case for constructivist physics education, where students mirror the practices of physicists to build and test ideas through experimentation and collaboration. We show how we attempt to teach these abilities using the Investigative Science Learning Environment (ISLE) approach in our introductory physics courses at Rutgers - Newark. Our students have a say in their lives and society, and we seek to empower and equip them for the world they will lead.

H05-2: 3:12–3:24 p.m. TRIAGE: A Mnemonic-Based Problem-Solving Rubric for Introductory Physics

Jax Sanders, Marquette University, Melissa Vigil

The introductory physics with calculus sequence at Marquette uses free-response homework and exam problems, graded using a rubric emphasizing elements of expert-like problem solving. In the 2024-25 academic year, the course-wide rubric was revised to reflect and emphasize the TRIAGE (Translate, Represent, Identify, Assumptions, Generate, Evaluate) mnemonic devised by Melissa Vigil. The existing rubric was revised to explicitly reference this framework and applied across lecture activities, homework, exams, and lab assessments, such that all evaluations in the course use the same solution structure. This has resulted in quantitative improvements in exam scores and qualitative improvements in student attitudes and approach to problem solving.

H05-2: 3:24–3:36 p.m. Against Problem Solving Method: When Physical Intuition Succeeds

Mark Eichenlaub, Art of Problem Solving

Solving physics problems is hard. Even harder is watching your students struggling with problems to the point of frustration or defeat. To help, we often teach a method: a systematic way of breaking the solution process into the same steps, problem after problem. With a clear method to follow, students are more likely to stay organized, move from step to step fluidly, catch and fix their mistakes, and arrive at the number we wanted them to. In short, they're more likely to succeed. But I've found that when I scaffold success at finding the answer, I can wind up sacrificing chances for sense-making, intuition-building, creativity, and student agency. Unchecked, the tyranny of the right answer leads me to devalue what I claim to value the most. I'd like to illustrate this by example and share ideas on balancing method against freedom in a course with a strong sense-making culture.

Session H06: How Do You Teach about Women and Individuals from Minoritized Groups in Physics?

Location: Bulfinch/Renwick **Time:** 3–4 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Shannon Willoughby

H06-1: 3–3:12 p.m. "Meet the People Who Use Physics"—Creating a More Inclusive Introductory Physics Textbook

Roger Freedman, University of California, Santa Barbara

At the 2023 AAPT Winter Meeting, Xiang, Gray, and Hudgings presented their findings that textbooks "focus overwhelmingly on work attributed to White men of European, British, and North American descent" (1). In this talk I will describe how I have taken to heart the lessons of their presentation in preparing the new edition of our University Physics textbook (2). This edition will include 44 essays by a diverse group of scientists, engineers, and science communicators from five continents and 13 countries, all of whom use physics in their daily work. It will also highlight the contributions of many figures who have not traditionally been mentioned in introductory textbooks, including Émilie du Châtelet (France, 18th century), Eunice Newton Foote (USA, 19th century), Dorothy Hodgkin (UK, 20th century), Hideki Yukawa (Japan, 20th century), Maria Goeppert Mayer (Germany/USA, 20th century), Elmer S. Imes (USA, 20th century) and Cecilia Payne-Gaposchkin (UK/USA, 20th century).

H06-1: 3:12–3:24 p.m. Femme Futurities: Where Women are Finding Hope in Physics

Stephanie Williams,
Chandra Turpen, Leaf C. Kullgren

The famous book "Talking about Leaving" (1999) investigated why women leave the field of physics and identified a variety of structural, cultural, individual, and systemic factors that pushed women out of the field of physics. Twenty years later, "Talking about Leaving: Revisited" (2019) found that many of the factors pushing women out still remain. Yet, we see the number of women in physics is growing, if slowly. So what helps them stay? If many of the barriers to women's participation in undergraduate physics remain in place, where are they finding sources of resilience or hope, both in and outside of physics? Our pilot study investigates sources of hope in physics and narratives that students have for "talking about staying." We will present preliminary analyses of these interview transcripts and share preliminary insights.

Session H07: Creating Inclusive and Supportive Physics Communities: Part 2

Location: Penn Quarter AB **Time:** 3–4 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Ryen Burris

H07-1: 3–3:12 p.m. Leading a Student Design Team: Lessons from the C2C Project

Matthew W. Guthrie, University of Connecticut,
Theodore Bott, Xian Wu, Tanya Adams, Erin M. Scanlon, Daryl McPadden

The Courses to Careers (C2C) project is a dual-threaded, professional development (PD) initiative aimed at fostering meaningful faculty-student partnerships to address ableism in the professional physics field. A key component of this initiative is the student design team - a group of disabled physics students collaborating to support one another, develop workshops, publications, and career PD resources. In this talk, I will explore the impact of leading the design team, highlighting challenges, successes, and lessons learned in co-developing materials that bridge accessibility, PD, and education research. Additionally, I will discuss how this collaborative model has influenced broader project outcomes, including workshop design, faculty engagement, and student empowerment. Through this work, we demonstrate the potential for faculty-student partnerships to drive systemic change in physics communities.

H07-2: 3:12–3:24 p.m. The Access Assembly: Learning Together, Building Friendships, and Strengthening our Leadership Capacities

Chandra Turpen, University of Maryland - College Park,
Brianne Gutmann, Mackenzie Carlson, Joel C. Corbo, Rob Dalka, Gabrielle Jones-Hall, Megan Marshall-Smith, Devyn Shafer

Founded in 2014, the Access Network brings together nine student-centered, university-based programs that are pursuing systemic change towards a vision of a more diverse, equitable, inclusive, and accessible STEM community. Leaders at the Network-level and program-level are either current students (undergraduate or graduate) or young faculty and professional scientists, many of whom started out as student leaders in Access programs. Over the last 9 years, Access has brought people together (virtually or in-person) for an annual event called the "Assembly." Student leaders who attend the Assembly appreciate community-building and networking opportunities that help them build capacity for leading local site programming. Many participants report that the Assembly is a special place with a different feel than many other professional spaces. In this talk, we will share stories from past Assembly events to give you a feel for how this space operates differently. We also report on the results of a post-Assembly evaluation survey which illustrates that participants tend to feel included, make new friends, feel valued, and build confidence as leaders.

H07-3: 3:24–3:36 p.m. The Access Assembly: Sharing Ideas and Enabling Informed Adaptations

Brianne Gutmann, University Of Illinois - Urbana Champaign,
Chandra Turpen, Mackenzie Carlson, Joel C. Corbo, Rob Dalka, Gabrielle Jones-Hall, Megan Marshall-Smith, Devyn Shafer, The Access Network

Founded in 2014, the Access Network brings together nine student-centered, university-based programs that are pursuing systemic change towards a vision of a more diverse, equitable, inclusive, and accessible STEM community. Leaders at the Network-level and program-level are either current students (undergraduate or graduate) or young faculty and professional scientists, many of whom started out as student leaders in Access programs. Over the last 9 years, Access has brought people together (virtually or in-person) for an annual event called the "Assembly." In addition to supporting community and networking, the environment and structures at the Assembly enable the sharing of ideas, excite people to translate those ideas to their local programs, and create space for informed and deliberate adaptations. Drawing on post-Assembly survey data, we see that participants from various institutional positionalities report benefiting and/or learning from their experiences at the Assembly and having confidence to adapt these ideas to their local contexts. We briefly describe where ideas come from, where attendees are intending to apply them, and how session foci shape the ideas that gain traction with attendees.

H07-4: 3:36–3:48 p.m. Justice, Equity, Diversity, Inclusion in STEM: Utilizing Faculty Professional Development to Foster Culturally Responsive Teaching and Inclusive Excellence in Physics and other STEM Disciplines

Vanessa Preisler, University Of La Verne,
Karlita Warren, Christine Broussard

Racial and gender minority student representation in STEM fields continues to face significant disparities, exacerbated by systemic and programmatic barriers such as a lack of belonging, discrimination, isolation, stereotype threat, and insufficient mentorship or institutional support. These barriers contribute to high attrition rates and unequal graduation outcomes. To address these challenges, STEM faculty must be equipped to integrate justice, equity, diversity, and inclusion (JEDI) into their teaching to foster greater student success. This presentation will discuss the preliminary outcomes of The JEDI in STEM Project, an initiative at the University of La Verne, an Hispanic-Serving Institution (HSI), aimed at training faculty to incorporate JEDI principles into their courses. The project's professional development activities focused on improving faculty self-efficacy, promoting culturally sustaining practices (CSP), and increasing the use of inclusive teaching strategies within STEM classrooms. Over one academic year, faculty cohorts applied these concepts to revise curricula and integrate CSP into their courses, particularly focusing on gateway courses.

Session H08: PER: Conceptual Inventories: Part 2

Location: Constitution DE **Time:** 3–4 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** David Pritchard

H08-1: 3–3:12 p.m. PE-CAP: Redesigning Legacy Conceptual Inventories: Project Overview

Andrew F. Heckler, The Ohio State University,
Rachel Henderson, Dena Izadi, John Stewart, Gay Stewart

We provide an overview of Physics Evidence-Centered Assessment Project (PE-CAP): a large and long-term project, most recently funded by NSF award #2235518, to develop sets of valid, fair, transparent, and flexible assessments of conceptual understanding of university-level introductory physics topics. PE-CAP is intended to move beyond legacy instruments, such as the Force Concept Inventory, and use more robust and comprehensive methods to build valid and ever-improving assessments that can be productively used by educators and education researchers for a broad range of contexts and populations. In this talk, we briefly describe the big-picture ideas behind the project such as the evidence-centered design framework, physics community input and engagement, data collection from a diverse set of institutional contexts and populations, qualitative and quantitative data collection, extensive analysis on large data sets, transparency with data and arguments of validity, access and flexibility for researchers and educators, and continual improvement of items and assessment scales and subscales. Other PE-CAP talks during this AAPT conference will provide details on results from an assessment on kinematics, which is the first of the two assessments we are currently building.

H08-2: 3:12–3:24 p.m. PE-CAP: Redesigning Legacy Conceptual Inventories: Partnering with Introductory Physics Instructors to Develop Equitable and Flexible Assessments for Kinematics and Dynamics

Dena Izadi, Michigan State University,
Rachel Henderson, Andrew F. Heckler, John Stewart, Gay Stewart

Commonly used instruments like the Force Concept Inventory (FCI) and the Force and Motion Conceptual Evaluation (FMCE) have significant advanced Physics Education Research (PER). However, these assessments have revealed flaws, including psychometric issues that undermine their reliability and validity, as well as demographic biases affecting underrepresented student populations. To better align with modern teaching practices and the diverse backgrounds of students, it is crucial to redesign these tools. This collaborative effort aims to create a library of validated items organized into subscales, allowing instructors to customize assessments to meet their classroom needs. In this talk, we will present the goals and progress of our NSF-funded project, which focuses on creating a new assessment tool, the Kinematics and Dynamics Assessment (KDA), through a community-based approach. We will share preliminary data from instructors across the country, highlighting current assessment practices and emphasizing the importance of community feedback. Our data provides insights into developing formal assessment tools in addition to individual strategies to gauge real-time class understanding. Additionally, there's a focus on using these introductory classes to build professional skills through assessments and course design. We invite introductory physics instructors to actively participate in this study, sharing their insights and experiences to ensure the development of an equitable and flexible assessment tool. Engaging a diverse group of educators will be essential in enhancing physics education for all students. Acknowledgement- This work is supported by the National Science Foundation (DUE-2235518, DUE-2235595, and DUE-2235681).

H08-3: 3:24–3:36 p.m. PE-CAP: Redesigning Legacy Conceptual Inventories: Overview of Project Progress and the Validation Framework

John Stewart, West Virginia University

This talk is part of a project (NSF award #2235518) to develop a new generation of improved instruments measuring Newtonian kinematics and dynamics. These instruments would replace the now venerable Force Concept Inventory and the Force and Motion Conceptual Evaluation while providing improved measurement accuracy and flexibility. More than 120 items have been tested in 11 different instruments at 3 large research universities in the Spring 2024 through Spring 2025 semesters producing over 14,000 student responses. A 20-item one-dimensional kinematics inventory is in the final testing phase with a one-dimensional dynamics instrument in the initial testing phase. Both qualitative and quantitative validation is underway. This talk will discuss the validation framework and give an overview of the quantitative and qualitative validation results to date. Issues involving applying the same instrument in calculus and algebra-based class and as a pretest and post-test will also be explored.

H08-4: 3:36–3:48 p.m. PE-CAP: Redesigning Legacy Conceptual Inventories: Summarizing the Quantitative Validation Process

Brett Ballard, West Virginia University,
John Stewart

In the ongoing effort to develop a new concept inventory of Newtonian mechanics, context neutral 1-D kinematic and dynamic items were given to students at three R1 universities. Item parameters from Classical Test Theory (CTT) and Item Response Theory (IRT) have been collected on these items over the course of three semesters providing a rich, comprehensive overview of item performance in algebra-based and calculus-based introductory physics courses across pretest and post-test settings. The data shows a substantial difference in item performance between algebra and calculus-based courses suggesting the development and usage of a conceptual instrument should factor in these two populations. The projects' efforts to build subscales out of the tested items using multidimensional IRT, factor analysis, correlation graphs, cognitive diagnostic modeling (CDM), and regression techniques will be presented.

H08-5: 3:48–4 p.m. PE-CAP: Redesigning Legacy Conceptual Inventories: Qualitative Validity Evidence from Student Reasoning in Cognitive Interviews

Elaine Christman, West Virginia University,
Heather Mei, John Stewart

A project (NSF award #2235518) is underway to use evidence-centered design to create a replacement for the Force Concept Inventory (FCI) and Force and Motion Conceptual Evaluation (FMCE) comprising flexible subscales developed with input from the physics education community. We have used the three-step test interview process to collect extensive data on students' reasoning processes as they work problems from subscales on one-dimensional kinematics and dynamics. In this talk, we'll share how this rich data has been used in item development and revision and provide detailed validity evidence for sample items.

Session H09: PER: Diversity, Equity, and Inclusion

Location: Lafayette Park **Time:** 3–4 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Lucky Nonyelum

H09-1: 3–3:12 p.m. Bazinga!: How Portrayals of Physicists in Media Shape Student Perceptions of Physics Culture

Anusha Damle

Media's portrayal of science and scientists can play a formative role in how prospective and developing physicists' view the field, their role and/or fit within their field, and the role of physicists as related to others and society more broadly. In this study, we surveyed students about their perceptions of popular scientists in media, both real scientists and characters. We asked students how these portrayals informed their understanding of scientific culture and science identity, as well as how their experiences in science align or misalign with media messaging. Results from the survey, and potentially follow-up interviews will be shared.

H09-2: 3:12–3:24 p.m. The Relationship Between Instructor Beliefs and Practices about Inclusive Teaching

Md Sanyat Rabby, Charles Henderson

Inclusive teaching pedagogies have been shown to enhance the success and retention of women and racial minorities, thereby promoting diversity in STEM fields. However, many STEM instructors do not fully implement these practices. The Inclusive STEM Teaching Project is a six-week online professional development course designed to strengthen instructors' beliefs and practices related to inclusive teaching. To explore barriers to implementation, we conducted qualitative phenomenological interviews with 17 STEM instructors who completed the course. Our analysis examines the relationship between their beliefs about inclusive teaching and their actual classroom practices. In this talk, we will present the range of instructors' beliefs and the reasons they cite for discrepancies between their beliefs and practices. These findings offer insights into improving professional development programs and addressing structural and cultural barriers to inclusive STEM instruction.

H09-3: 3:24–3:36 p.m. Desired Belonging Amongst Upper Division Physics Students

Daniel Pacheco, Geoff Potvin

Prior research has identified sense of belonging as an overall positive contributor to students' academic success. Also, junior-level physics has previously been shown to be a critical period in students' undergraduate physics career. In earlier work, we identified a variety of cases in which students' expectations for belonging did not align cleanly with their course-taking and academic success which, in turn, can affect individuals' future physics intentions. Thus, we developed the concept of Desired Belonging to articulate the ways in which students seek or intend to belong to a specific community or communities. To explore this concept, we conducted a phenomenological study by collecting interview data from upper division physics students to probe their social networks, academic experiences, experiences in the university physics community (including peer and faculty relationships), and their desired belonging. In this talk, we will present the emergent findings of this study to examine how students' experiences affect (or not) their desired belonging during their upper division years, and the implications of this work for supporting students.

H09-4: 3:36–3:48 p.m. From Courses to Careers: Impact of Workshop Design on Students' Professional Development

Mason D. Moenter, Texas A&M University, Michigan State University,
Erin Syerson, Bella Tuffias-Mora, Jayden Butler, David Cassens, Tanya Adams, Theodore Bott, Erin M. Scanlon, Matthew W. Guthrie, Daryl McPadden

Recently, there have been many efforts to broaden participation in STEM to empower a diverse and knowledgeable workforce, which has been reflected in the 2022-2026 National Science Foundation's (NSF) Strategic Plan. As a part of these goals, efforts to create a more inclusive, accommodating, and accessible community are crucial for supporting disabled students, who make up 20% of undergraduate science & engineering students. The Courses 2 Careers (C2C) project aims to improve accessibility and inclusion in physics through a week-long workshop that facilitates mutually beneficial partnerships between disabled post-secondary physics students and faculty across multiple institutions. Throughout the development of the workshop, student members have been an active part of the design team, including working on activities for the workshop, serving on panels at conferences, co-facilitating the workshop, and writing a series of articles for the Just Physics? column of The Physics Teacher. By participating in this work, student design team members have gained valuable professional skills, which they have then translated into the professional development component of the C2C workshop. This contribution highlights the benefits of the collaboration between students and faculty as a part of the design and delivery of the workshop.

Session H10: Celebrating 20 Years of Physical Review Physics Education Research– Part 2

Location: Farragut Square **Time:** 3–4 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Mila Kryjevskaia

H10-1: 3 p.m. Future Directions of Physical Review Physics Education Research

Invited – Eric Brewe, Drexel University,
Charles Henderson, Noah Finkelstein

Over the past two decades, PRPER has played a pivotal role in establishing Physics Education Research (PER) as a robust field within physics. As we look ahead, our focus turns to sustaining growth and enhancing impact. In this interactive session, we will commemorate the milestones that have shaped PRPER into the premier journal for PER and look forward to new challenges and opportunities. We invite you to join us in a dialogue about the future directions of the journal, aiming to align its evolution with the aspirations of the PER community. And finally we invite you to celebrate the 20th anniversary of PRPER with us in this session.

Session H11: The Living Physics Portal

Location: Salon E (Washington at Metro Center) **Time:** 3–4 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Nancy Beverly

H11–1: 3 p.m. A Multiple Representation Exploration of the Ideal Gas Law

Panel – Mayuri Gilhooly, University of New England

Insights from a semester long project on submitting "A multiple representation exploration of the ideal gas law" onto Living Physics Portal and then on to Course Source for publication will be shared. This is a unit from a studio-style, modeling-based introductory physics course designed for life science students in a pre-health sequence at the University of New England. This content is designed for students to explore ideal gas law (PV = NkBT) through hands-on experiments and represent their findings using graphical, mathematical, diagrammatic and verbal models. The curriculum contains reading material, instructor notes, and worksheet problems to assess student learning with solutions.

H11–2: 3 p.m. Applying Course Source with the Living Physics Portal to Present a 3-term set of 24 Human-Centered IPLS Laboratories: Design, Implementation, Assessment, and Publication for Diverse Classroom Settings.

Panel – Elizabeth Mills, University of San Diego, Katsushi Arisaka

The first part of this panel discussion presentation reflects on the pre-pandemic design, implementation, and assessment of UCLA's Introductory Physics for Life Sciences Laboratory Revisions, which were taught from 2017-2020 across all IPLS laboratory sections. In this time, thousands of undergraduate students were able to make their own scientific questions around human-centered problems and test their predictions by performing in real world physics activities. E-CLASS assessment data showed an increase in students' reflection in asking their own scientific questions, which was a marked improvement over pre-revision laboratory survey data. Now, post pandemic, these laboratories are available to all who would like to create group-based, human-centered scientific inquiry for their students. The second part of this panel discussion communicates how this curriculum has been generalized as a pedagogical tool via Course Source. Through the Living Physics Portal, organized and editable information about background materials, student worksheets, equipment lists and instructor manuals/solution sets are available to all educators. The addition of the Course Source publication communicates additional background literature reviews, pedagogical frameworks, learning outcomes and detailed lesson plans to support the bigger picture behind how and why this curriculum was developed. The combination of Course Source publication with the Living Physics Portal library allows for this curriculum to be made accessible for diverse educational settings using evidence-based framework and pedagogy. Various methods of implementation are discussed, so that this curriculum is made accessible for your classroom!

H11–2: 3 p.m. Sharing Life-Science Based Curricula on the Online Platforms of Living Physics Portal (LPP) and CourseSource

Panel – Priya Jamkhedkar, PhD, Portland State University

In this panel discussion, I share my experiences about uploading my curriculum to the Living Physics Portal (LPP) and CourseSource. I developed curriculum for an algebra-based introductory physics course for life-sciences majors, which I taught at Portland State University. I wrote a series of articles for this course spanning topics such as balance and base of support, circular motion, elasticity, and rigidity with examples illustrating the elastic properties of bones, teeth, tendons, and blood vessels, energy expenditure in humans, physics of impulse using biomechanical movements, physics of orthodontic movements, and the physics of vertical jumps in mechanics; electric activity of the heart, electroreception in animals, conduction of electrical signals in nerves, use of high energy charged particles and radiation in radiation therapy and medical imaging, and the use of RC circuits as timers in electromagnetism; working of the harmonic scalpel and ultrasound in oscillations and waves, LASIK surgery and optical fibers in endoscopes in optics; and body temperature measurement and thermoregulation in humans in thermodynamics. To share my materials with other instructors, I chose to upload these articles to LPP and CourseSource, where other instructors can download them. As a part of a workshop, I learned how to upload material on both platforms. I will discuss the process of uploading material to both the community library and the vetted library in LPP. I also prepared an article for CourseSource, "Conduction of Electric Signals by Nerves" and will describe the requirements for publication in CourseSource. I will also talk about the ease with which other instructors can download these materials for use in their classes.

Session H12: Rethinking the Undergraduate Physics Curriculum

Location: Salon A/B (Washington at Metro Center) **Time:** 3–4 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** Ernest Behringer

Through surveys, online and in-person discussion groups, the AAPT REV-UP Working Group has gathered input from the community regarding concerns about the undergraduate physics curriculum and suggestions for changes. The input received to date will be reported followed by small group discussions by attendees to comment on prior input or to provide new ideas and concerns.

Session H13: Using Manim to Create High-Quality Mathematical Animations

Location: Salon C/D (Washington at Metro Center) **Time:** 3–4 p.m. **Date:** Tuesday, Aug. 5, 2025 **Moderator:** David Jackson

Manim is a Python library for creating high-quality mathematical animations. It was developed by Grant Sanderson for the animations in the venerable YouTube channel 3Blue1Brown and has been made freely available. An example of how this library can be used in physics videos can be found on the YouTube channel All Things Physics. This session will provide a short tutorial on how to create some simple animations using Manim. People interested in trying out these animations at the session should arrive with the community version of manim already installed on their computers (see https://www.manim.community/).

Session I01: Teaching the Introductory Physics for the Life Sciences (IPLS) Course: Part 3

Location: Declaration A **Time:** 10–11 a.m. **Date:** Wednesday, Aug. 6, 2025 **Moderator:** Priya Jamkhedkar, PhD

I01-1: 10–10:12 a.m. Data-Driven Introductory Student Activities Framed to Address Life Context Inquiries

Nancy Beverly, Mercy University

In the introductory physics sequence taken by students preparing for futures in health professions or biological sciences at Mercy University students learn basic physics through life-context activities, primarily based on data the students have taken on their own bodies or from published research. Results using this data are used to make judgments about or provide insight into the life phenomena. Examples will be shared. Many of the activities can be found in the Community library of the Living Physics Portal dynamic repository https://www.livingphysicsportal.org/

I01-2: 10:12–10:24 a.m. Looking for Life in Space: A Heliophysics-centric Exploration

Rebecca Vieyra, University of Colorado - Boulder,
Ramon E. Lopez, Darsa Donelan, Ximena Cid, Bradley Ambrose, Shannon Willouoghby

Heliophysics is an exciting context for teaching many foundational physics ideas that are related to the search for life in space. Using our Sun and solar system as a case study, educators can teach about spectral analysis of stars and planetary atmospheres, thermal radiation, and planetary magnetism, and extend these understandings in our search for exoplanets. Learn about relevant learning sequences and resources from the AAPT's NASA Heliophysics Education Activation Team (HEAT) web page: https://aapt.org/Resources/NASA_HEAT.cfm.

I01-3: 10:24–10:36 a.m. Transforming Algebra-Based Introductory Physics Courses with Personalized Adaptive Learning to Enhance Student Engagement and Success

Archana Dubey, University of Central Florida,
Baiyun Chen, William Kaden, Alfons Schulte

The algebra-based physics sequence at the University of Central Florida has been a bottleneck for non-Physics STEM majors, affecting retention and time-to-degree completion. To address this, College Physics I (PHY2053) and II (PHY2054) courses have been redesigned with Personalized Adaptive Learning (PAL) technology, which tailors content and problem-solving paths to each student's unique skills, learning preferences, and performance. PAL has provided students with flexible, interactive learning experiences, allowing them to engage with material before lectures and practice problem-solving at their own pace. Adaptive assignments present dynamically generated questions picked from instructor-designed question banks, track student progress, and facilitate instructor intervention through a just-in-time dashboard. The timely instructor support enhances the learning experience by addressing the challenges as they arise. This presentation will cover insights from the course redesign, student learning gains, learner feedback, and strategies for implementing adaptive learning in physics to enhance student engagement and success.

I01-4: 10:36–10:48 a.m. Is It Possible to Get Good Evaluations and Still Sleep Well at Night?

Maxim Bychkov, Ph. D., University Of Virginia, Elizabeth Larson

At the college level, introductory physics laboratory courses for non-majors present an interesting set of pedagogical challenges. With such large enrollment courses, the administrative load on the instructor is high, the motivation of the students is often low, and the scientific and mathematical background levels vary widely from student to student. Misunderstandings are also bound to arise; due to the large number of sections, instructions often cannot be delivered by the instructor of record and are filtered through Teaching Assistants. Since returning to in-person classes in the Fall of 2021 at the University of Virginia Physics Department, my introductory laboratory courses have seen a continuous decline in all student satisfaction markers used to evaluate the quality of instruction. This trend prompted me to re-evaluate the courses and look for ways to address the challenges highlighted above. I started by analyzing students' evaluations to find the most disliked aspects of the course. Group report writing and the perceived arbitrariness of report grading were at the top of the list. In response to this feedback, I converted all lab reports into an automatically graded series of assignments using WebAssign. To do this, I wrote a relatively complicated Pearl code that allows students to enter their individual experimental data, which is checked by the system for consistency. The subsequent questions (multiple choice, symbolic, numerical, etc.) are graded on correctness, with values that depend on students' entered data. In this new system, students complete all out-of-class assignments independently, and all grading is automatic and transparent. In this talk I will give a brief overview of the course's past and current structures, will show several examples of the new auto-graded smart assignments, and will show plots that demonstrate the improvement in students' attitude towards the course -- improvements that were achieved by streamlining the flow of the course for both students and instructors.

Session I02: Labs

Location: Declaration B **Time:** 10–11 a.m. **Date:** Wednesday, Aug. 6, 2025 **Moderator:** Nathan Tompkins

I02-1: 10–10:12 a.m. Teaching the Experimental Design Process in High School Physics

Jeff Bigler, Lynn English High School / Lynn Public Schools

Most students' experience with high school experiments involves either following a predetermined procedure or trying ideas haphazardly until a working procedure is found, neither of which is effective in teaching the experimental design process. By following a process that connects equations and experimental conditions with each other, students will be able to systematically determine the necessary measurements and experimental conditions. The process of connecting the equations creates the list of quantities to be measured, constants to be looked up, and some of the necessary experimental conditions. This list of quantities, in turn, determines the flow chart from which the detailed experimental procedure can be created. The list of equations in the order that they were found determines (in reverse) the equations needed for calculations and the order in which to perform them. This presentation describes the process, leads participants through some sample experiments, and gives them a form that their students can use for the process in their classrooms. While this presentation is geared toward high school physics experiments, the technique could also be applicable to some undergraduate experiments.

I02-2: 10:12–10:24 a.m. Development of New ISLE-based labs for the reformed introductory physics course

Gorazd Planinsic, Ph.D., University of Ljubljana,
Nastja Mahne, Ph.D. in Physics, Sergej Faletic, Ph.D. in Physics, Andreja Šarlah, Aleš Mohoric

A key objective of ISLE-based labs is to engage students in designing experiments. Unlike other lab approaches where students create their own experiments, ISLE-based labs not only emphasize authentic experimentation and the development of scientific abilities but also play a crucial role in helping students construct and test fundamental physics concepts that they will learn or have learned in lessons and problem solving sessions. I will present our experience with the development and implementation of weekly ISLE-based labs for a two-year introductory physics course that was recently reformed using the ISLE approach. I will present examples of tested low-cost new ISLE-based labs and share our experience with training TAs in the design and production of such labs. We acknowldge financial support by ARIS P1-0060 program and NOO ULTRA project.

I02-3: 10:24–10:36 a.m. Revisions to a Physics Lab for Life Science Majors

M. Jeannette Lawler, PhD, Brigham Young University,
Adam Bennion, Nathan D. Powers, Kethry Walton

This presentation discusses the results of modifications made to a one-credit, stand-alone laboratory course for life science majors. The course, which can be taken alongside or after an algebra-based Newtonian physics course, includes activities on translational, rotational, and harmonic motion. Students are also asked to complete a longer project applying models developed in their earlier labs to a biomechanical system. Recently, the course was updated to emphasize modeling and experimental design, shifting from its previous focus on reinforcing conceptual understanding. We are evaluating the impact of these changes on students' modeling skills and attitudes about the course. Our findings, which highlight the effectiveness of the new course design, will be presented.

I02-4: 10:36–10:48 a.m. An Inquiry-Based Undergraduate Physics Lab Transformation: Structure, Learning Goals, and Student Perceptions

Julian D. Gifford, Ph.D.

Laboratory courses are an integral part of the introductory physics experience at most universities, but the format, learning goals, and implementation of these courses vary dramatically across institutions and programs. Recently there has been a call to refocus the learning goals of introductory lab courses to move away from content-validation companions to lecture and towards more authentic experimental experiences that highlight practical lab skills including data analysis, experimental design, and experimental modeling. At the University of Colorado - Denver we have taken up this call, rebuilding our introductory physics labs to be stand-alone courses in experimental physics that are completely disconnected from lecture and built on an instructional model of guided inquiry. As part of a larger project analyzing these lab transformations, here I present the structure and learning goals of these transformed courses, and give examples of the types of lab activities and measures of student learning outcomes. Additionally, I'll discuss shifts in student perceptions of these lab courses, as measured both by responses to course feedback surveys and end of semester course evaluations.

I02-5: 10:48–11 a.m. Measuring and Analyzing Teaching Assistant Comfort and Content Preparation in an Introductory Physics Laboratory Course

Melissa L. Barru, BS, University of Colorado Denver,
Julian D. Gifford, Ph.D.

Across the United States, Introductory Physics Lab courses are typically broken into multiple sections taught by Teaching Assistants, often graduate TAs. At CU Denver (an Hispanic serving, primarily undergraduate urban university) our Introductory Physics Labs are built on a model of guided-inquiry, and the Teaching Assistant team consists of mostly undergraduate physics majors. As part of a broader project studying the transformation and efficacy of these labs, we seek to better understand how our undergraduate TAs prepare for their roles, and specifically their comfort level with the material. To that end, we have designed weekly surveys for our TAs and implemented them over multiple semesters. These surveys involved both Likert style and free-response questions and were designed to probe the progression of TA comfort levels throughout the week, specifically (1) before the preparatory meetings (2) after the preparatory meetings but before teaching, and (3) after teaching. We present a preliminary analysis of these survey results looking at TA comfort over the course of one semester and one academic year. Early analysis results indicate that TA comfort with the material after the weekly preparatory meetings increased throughout the semester. Alongside these results, the amount of time TAs spent preparing content on their own was stable with a small increase over time; however, a larger number of TAs engaged in content preparation before the preparatory meetings at the end of the semester compared to the beginning of the semester.

Session I03: Sense-Making Across Different Domains: Part 1

Location: **Franklin/McPherson** **Time:** 10–11 a.m. **Date:** Wednesday, Aug. 6, 2025 **Moderator:** Apekshya Ghimire

I03-1: 10–10:24 a.m. Understanding Student Sensemaking While Solving Physics Problems

Jaya Shivangani Kashyap, PhD, University of Pittsburgh,
Chandralekha Singh

Understanding student sensemaking in physics problem solving can play an important role in developing effective scaffolding support and designing curricula and pedagogies. Few prior studies have focused on advanced students' sensemaking. This study investigates how advanced students navigate the problem-solving process in upper-level electricity and magnetism course using the epistemic game framework proposed by Tuminaro and Redish. We conducted interviews with upper-level undergraduate and graduate students and observed their sensemaking and reasonings while they solved physics problems. The analysis reveals how students approach physics problems, and what resources were activated while sensemaking. Our research can be valuable for instructors and researchers to understand how advanced students do sensemaking while solving advanced physics problems in the context of electricity and magnetism.

Session I04: PICUP: Teaching about Quantum Computing and Quantum Mechanics

Location: Wilson/Roosevelt **Time:** 10–11 a.m. **Date:** Wednesday, Aug. 6, 2025 **Moderator:** Marie Lopez Del Puerto

I04-1: 10–10:24 a.m. Computation in a Quantum Computing Course

Invited – Robert Hilborn, AAPT

With the rapid rise in interest in quantum computing and quantum information science, many physics departments are now offering introductions to those fields for physics, computer science, and mathematics majors. For the foreseeable future, classical computing will play an important role in interacting with a quantum computer and in analyzing the results of quantum algorithms. In this talk, I will describe how classical computing and quantum computing worked synergistically in such a course for computer science, computer engineering, and mathematics majors at a major research university. The mode should work well in almost any undergraduate physics program.

I04-2: 10:24–10:48 a.m. Teaching Quantum Computing with Augmented Reality

Invited – Michele McColgan, Siena College,
Leo T. Vanderlofske

The MARVLS Augmented Reality (AR) Apps are designed to allow students to visualize abstract 3D physics concepts, link 2D representations to 3D models, and link variables in equations to physical objects in the 3D models. The MARVLS Apps use the camera on the phone or tablet to place the digital model visually onto the Merge cube and then change the orientation of the AR model in response to the user rotating the Merge cube. The AR scenes are developed in the Unity development platform that includes drag and drop functionality, animations, and C# coding. Many of the AR scenes in the Apps were developed through a collaboration of faculty and students through an undergraduate summer research program that provides paid experiences for students to participate in research. The faculty members identify different physics concepts that students have difficulty visualizing and together with the student researchers, the AR scenes are designed. Coding is often used to manipulate the digital objects defined in the design criteria. Students learn the C# programming language through the Unity Learn system, youtube videos, and AI resources. They implement the code and make modifications as necessary to meet the design criteria. The MARVLS: Quantum Computing App was developed for the American Physical Society to be included in their 2025 PhysicsQuest lessons. An undergraduate student participated in the design and development of the AR scenes, the game objects, animations, scripting, and the user interactions. This talk will describe the process of creating the Apps through the Unity development platform and illustrate some examples of the coding needed to meet the design criteria of the AR scenes.

Session I05: Cultivating Physics Educators: Pathways, Practices, and Professional Growth: Part 1

Location: Cabin John/Arlington **Time:** 10–11 a.m. **Date:** Wednesday, Aug. 6, 2025 **Moderator:** Adam Love

I05-1: 10–10:12 a.m. Learning Assistants' Pathways to Becoming Physics Teachers

Benjamin Dreyfus, George Mason Univ,
Erin Peters-Burton, Jessica L. Rosenberg

We present preliminary interview data from former Learning Assistants (LAs) who went on to be physics teachers. In these case studies, we look at the influences that brought these teachers along this path, and discuss implications for the LA program and for physics teacher recruitment.

I05-2: 10:12–10:24 a.m. Exploring the Interplay Between AI literacy of Pre-service Teachers and their Attitudes About Physics in the Development of Physics-Based Assessment Objectives

Razan Hamed, Purdue Univ,
Amogh Sirnoorkar, N. Sanjay Rebello

The impressive capabilities of Generative Artificial Intelligence (AI) have promised a huge potential to transform classroom practices, particularly assessments. This talk investigates how pre-service elementary teachers develop and refine their practice-oriented physics assessment objectives (AO) using AI. We further investigate their approaches towards engaging with AOs with respect to their attitudes about physics and their knowledge of AI. The study employs multiple surveys to assess teachers' attitudes about physics and their current understanding of AI, exploring how these elements shape their skills and abilities in prompting AI models effectively. Furthermore, this work analyzes the capabilities and constraints teachers face when developing practice-oriented assessment objectives and their perceived differences between self-generated and AI-generated objectives. This work contributes to the existing efforts in equipping future teachers to effectively leverage emerging technologies in teaching science.

I05-3: 10:24–10:36 a.m. Teaching Secondary Physics: A Course for Classical Education Minors

Paul Hosmer, PhD in Physics, Hillsdale College

A course on Teaching Secondary Physics was redesigned to be accepted as an elective in the Classical Education minor program at Hillsdale College. The course, directed toward future physics teachers in a classical school setting, specifically confronts similarities and differences in the ways that physics in particular and science in general are addressed inside versus outside the modern classical education movement. Examination of relevant Physics Education Research (PER) for the various topics is a central component of each class session. The course has now been implemented successfully for three semesters. This talk reports on the design of the course, its reception, success and failures, lessons learned so far, and future outlook.

I05-4: 10:36–10:48 a.m. An Inquiry into Middle School Science Teacher Professional Development Practices

Debbie Andres, Paramus High School

The underrepresentation of marginalized identities in the U.S. STEM workforce persists, highlighting the critical role of middle school science classrooms in early STEM development. While these classrooms offer rich opportunities to develop inclusive pedagogical practices, recent efforts have largely focused on student interventions, neglecting the central role of teachers. Many existing pedagogies prioritize standards and accountability: hindering students' critical thinking and lacking contextual relevance to science. This study examined the effects of a teacher intervention program based on the Humanizing Pedagogy for Critical Science Education (HPCSE) framework. HPCSE emphasizes: (1) challenging status quo knowledge, (2) centering content on students' authentic lived experiences, and (3) helping students experience success by utilizing their class contributions. A mixed methods intervention design was employed to assess changes in middle school science teachers' HPCSE practices and beliefs. Key findings revealed that the professional development experience fostered a collaborative culture of inquiry, enhanced teachers' understanding and application of the HPCSE framework, and increased awareness of the need for deeper introspection on diversity, equity, and inclusion within science education. The study provides valuable insights into teachers' learning processes and the obstacles they face when engaging with professional development materials. The findings underscore the ongoing need for advancements in implementing humanizing pedagogies in K-12 science classrooms and K-12 science teacher professional development.

Session I06: PER: Assessment

Location: Bulfinch/Renwick **Time:** 10–11 a.m. **Date:** Wednesday, Aug. 6, 2025 **Moderator:** Diane Jammula

I06-1: 10–10:12 a.m. Does Presentation Matter? Show-Work Presentation Quality Correlates with Student Performance in Introductory Physics

Heather Mei, The Ohio State University,
Qiaoyi Liu, Andrew F. Heckler

Traditional physics exams often prioritize accuracy without considering how layout and neatness of show-work problem solutions might impact grading outcomes. To investigate this, we first developed a 7-indicator coding rubric to quantify "Show-Work Presentation" and used factor analysis to reduce the indicators to two distinct, uncorrelated factors: Form (layout, neatness) and Annotation (completeness, detail). We then analyzed the relationships between several factors including Show-Work Presentation, question performance, exam and course performance, and conscientiousness, in a calculus-based introductory physics course at a large public research university. Results indicate that even while controlling for ACT math and conscientiousness, Form is a significant predictor for all show-work question scores but not for multiple choice question scores. This result suggests that some aspects of Show-Work Presentation may play a role in exam performance beyond prior preparation and conscientiousness. We also find that women tend to score equally or higher on Show-Work Presentation scores than men, which may partially mediate observed differences in exam scores.

I06-2: 10:12–10:24 a.m. Some Physics Students Express Concern About their Speed on Tasks Compared to Peers. How Does this Relate to their Course Grades?

Harish Moni Prakash, The Ohio State University, Andrew F. Heckler

We have previously found that in introductory physics courses, among students with the same accuracy on math skills, students who are faster on math earn higher grades on physics exams. Cognitive (e.g. skill fluency) and non-cognitive (e.g. psychological) mechanisms may play a role in explaining this finding. To investigate some potential non-cognitive mechanisms, we surveyed N~500 algebra-based intro physics students on psychological factors including Self-Efficacy (SE), concern about speed compared to peers ('Speed Comparison Concern' (SCC)), and concern about accuracy compared to peers ('Accuracy Comparison Concern' (ACC)). Though all three of these factors are correlated with each other and with physics exam grades, only SCC is associated with student speed on math skills after controlling for accuracy on math. Mediation models support the argument that SCC plays a role in explaining why faster students on math do better on physics exams. Open responses from students improve the validity of the SCC construct, particularly discriminate validity compared to ACC and SE. Further, these responses provide potential reasons for why students are concerned about their speed, how it may affect their exam performance, and possible instructional strategies to mitigate this concern.

I06-3: 10:24–10:36 a.m. An Overview of the Research Landscape on Alternative Grading Practices in Undergraduate STEM

John Buncher, North Dakota State University, Emily Hackerson, Tara Slominski, Nekeisha Johnson, Safana Ismael, Lauren Singelmann, Alexey Leontyev, Alexander G. Knopps, Ariana McDarby, Jonathan J. Nguyen, Danielle L. J. Condry, James M. Nyachwaya, Kathryn T. Wissman, William Falkner, Krystal Grieger, Lisa Montplaisir, Angela Hodgson, Jennifer L. Momsen

Alternative grading strategies are increasingly popular in higher education, but research into the outcomes of these strategies is limited. NDSU's interdisciplinary DBER group recently published a scoping review which aims to provide an overview of the relevant research regarding alternative grading strategies in undergraduate STEM and identify gaps in the literature to inform future research. In this talk we'll discuss the tools being used to measure the effects of alternative grading, and citation analysis which show that research into alternative grading methods tends to occur in both disciplinary and practice-based silos. We will end with suggestions for authors of future publications in this area.

I06-4: 10:36–10:48 a.m. Keeping Conceptual Mastery Consistent: The Importance of Fidelity Between Course Elements

Ryen Burris, University of Maryland - College Park, Andrew Elby

Our talk compares student responses to different implementations of the same conceptual mastery system in two undergraduate engineering physics classes. The Supported Mastery Assessment using Repeated Testing (SMART) system aims to incentivize conceptual learning by adding retake exams and removing partial-credit for correct equations/facts embedded within conceptually incorrect approaches. However, SMART does not dictate how other parts of the course, such as homework or the relative weighting of exams, should be approached, leaving individual instructors to make these choices. Using interview data, we argue that not all choices are equal because students preferred the class with high fidelity between course elements; that is, student satisfaction with SMART (and the course overall) was higher when students perceived exams, class time, homework, and class policies as all contributing towards conceptual mastery. We offer valuable contributions to both researchers and practitioners: for researchers, we present a novel view on how students react to alternative assessment systems and course structures; for instructors, we provide illustrative examples of creating cohesive courses that support conceptual mastery and improve student buy-in. This work was funded by NSF Award DUE-2013268.

I06-5: 10:48–11 a.m. Effects of Two-Stage Exams on Korean Students' Learning Motivation and Assessment Perception: A Mixed-Methods Study

Hyewon Jang, Sejong University

Two-stage exams have been utilized in physics education to enhance students' academic abilities, but there are few cases of their application in South Korea. This study quantitatively and qualitatively investigated the effects of two-stage exams on learning motivation and assessment perception when applied to Korean students for the first time. For this purpose, two-stage exams were implemented in four different subject courses over one semester, and

a total of 28 items measuring self-efficacy, goal orientation, test anxiety, and perception of assessment (emotional and social aspects) were administered as pre-post tests, along with semi-structured interviews. First, survey results showed that the group that received two-stage exams experienced significant increases in self-efficacy and learning motivation, and perceived assessment as promoting collaboration and being an enjoyable experience. Second, the semi-structured interviews revealed that Korean students had positive perceptions of two-stage exams and suggested improvements for effective implementation. This study provides implications not only for physics education but also for educators based in competitive educational cultures.

Session I07: PER: Student Reasoning, Learning, and Behavior: Part 1

Location: Penn Quarter AB **Time:** 10–11 a.m. **Date:** Wednesday, Aug. 6, 2025 **Moderator:** Meghan DiBacco

I07-1: 10–10:12 a.m. Perception vs. Reality: Assessing Student Understanding of Physics Through System Diagnostics and Self-Reported Confidence

Kathy Shan, University of Toledo

I compared system diagnostics of student understanding and performance on reading/pre-lecture assignments using the McGraw Hill Connect system throughout the semester to student comments on their understanding of those assignments in an introductory two semester physics course. I find that students don't always have an accurate perception of their understanding of physics concepts, based on how difficult they find the assignments to be.

I07-2: 10:12–10:24 a.m. Exploring Integrative Thinking in Student-Created Engineering-Design Projects

Ravishankar Chatta Subramaniam, Purdue University,
Jason W. Morphew, N. Sanjay Rebello, Carina M. Rebello

Building on our multi-part series on the Ways of Thinking for Engineering Design-based Physics (WoT4EDP) framework, this exploratory study investigates how Integrative Thinking emerges as student groups solve self-generated Engineering Design (ED) problems. We explore the foundational question: What is Integrative Thinking? Although no frameworks currently define it, this study aims to contribute to its development, using the definition of Integrative STEM as a guide. In this preliminary study, we apply the framework by Sneider et al. to explore the integration of computational and mathematical thinking. The study took place in an ED-based, calculus-based physics lab course for future engineers. Fourteen student groups framed their own design problems and worked toward solutions over five weeks. We present guiding questions from our research and share preliminary findings from the analysis of the students' written reports.

I07-3: 10:24–10:36 a.m. Encouraging Contributions in Early Physics Research Experiences for STEM Motivation

Anne E. Leak, Center for Science and Engineering Partnerships at UC Santa Barbara,
Jyllian R. Herman, Peter Chung, Christian Vaca

Students participating in undergraduate research experiences learn to contribute in many impactful ways (e.g., collecting data, asking questions, coming up with ideas) that in turn foster their motivation to pursue STEM, especially by improving their confidence as a researcher and how others recognize their science accomplishments. The TRAINS program explores community college students in their first physics research experiences, bridging the gap in-between classroom physics and active research participation that can be especially challenging for community college students. This study focuses on 15 community college TRAINS Scholars who participated in a mentored biophysics research experience. Data analysis includes qualitative coding of focus group interviews and open-ended journal prompts about making contributions, asking questions, and STEM motivation and interests as well as quantitative analysis of additional context questions. Findings provide insights into the specific ways that undergraduate students learn to contribute to authentic physics research. By understanding the key ways that students learn to contribute to physics research in their first undergraduate research experiences, we can make the support for these contributions a more explicit and transparent part of undergraduate research programs.

I07-4: 10:36–10:48 a.m. A Complex Systems Approach to Student Collaboration Avoidance

Alexander Conte, University of Maryland,
Erin Sohr, Jennifer Radoff, Andrew Elby

Student collaboration has become a focal point of physics and engineering education as institutions strive to prepare STEM students for the workforce. Student collaboration also brings many educational benefits that enhance learning. In spite of many interventions instructors and programs use to encourage collaboration, students often choose not to work with their peers. Research studying this problem tends to offer one or two potential explanatory factors, like personal preferences or engineering culture. This limited explanatory focus prevents the construction of a complex systems account of student behavior that emphasizes how multiple factors contributing to student decision making can influence each other or overlap. As part of an ongoing study to understand how students navigate dilemmas in their coursework, we found a common phenomenon of collaboration avoidance, which was not well explained by any one factor. We analyze interview data from two students, Ashley and Sypha, whose decisions about whether or not to collaborate with their peers emerged from a confluence of factors, such as engineering culture, course structures, social norms, and personal preferences. This research can inform instructional interventions aimed at supporting student collaborations. Supported by NSF award #2142461

Session I08: Advanced Labs by Undergrads

Location: Constitution DE **Time:** 10–11 a.m. **Date:** Wednesday, Aug. 6, 2025 **Moderator:** TBA

I08-1: 10–10:48 a.m. Designing a Cost-Effective Wind Tunnel to Explore Aerodynamics in an Undergraduate Laboratory

Invited – Alison Koval, Lycoming College

Aerodynamic principles and fluid dynamics are integral to undergraduate physics education, yet they are rarely accompanied by hands-on experimentation. As a result, students are often left to grapple with abstract theoretical concepts disconnected from physical intuition. To address this, we designed and constructed a wind tunnel for approximately $150 using readily available mate rials. This accessible apparatus enables direct visualization of flow patterns around bluff bodies and immerses students in the study of aerodynamic phenomena, including laminar-to-turbulent transitions, Reynolds number effects, and vortex shedding.
The first half of this presentation will detail the development and design of the wind tunnel, highlighting material selection, construction methods, experimental setup, and key design deci sions. The second half will focus on the broader benefits and long-term potential of the project, demonstrating how the wind tunnel can

be adapted for diverse experiments, integrated across multiple courses, and serve as an introduction to advanced techniques such as computational fluid dynamics (CFD). Beyond its immediate instructional value, the project fosters meaningful student participation in all stages of design and analysis, supporting independent inquiry and experiential learning in undergraduate physics.

Session I09: PER: Outreach and Informal Physics

Location: Lafayette Park **Time:** 10–11 a.m. **Date:** Wednesday, Aug. 6, 2025 **Moderator:** Andrew Pawl

I09-1: 10–10:12 a.m. Impact of Outreach on Physics Students: Quantitative Results from a National Survey

Jonathan Perry, University of Texas - Austin, Tatiana L. Erukhimova, Toni Sauncy, Susan White, John Tyler, Rachel Ivie

Each year physics students around the country engage in opportunities to take their passion for the field outside their classrooms, engaging with the public through informal outreach programs. Research on the impacts of these activities, often conducted at single institutions, has shown that students working to facilitate outreach experienced improved measures of identity, belonging, and career skill development. Here we present results from the first nationwide survey examining the impact of physics outreach experiences on university physics students. This newly developed instrument incorporated both closed- and open-ended questions and was distributed to students through the national Society of Physics Students network. The goals of the survey were to sample student perceptions of their physics identity, sense of belonging, mindset, self-efficacy, and career skill readiness. This talk focuses on the quantitative analysis of the closed-ended survey responses. Through regression analysis a positive relationship between participating in informal physics outreach was observed with both growth mindset and sense of belonging. Analysis also showed that participation in outreach was no more or less likely for students based on a variety of demographic factors, except for being a freshman.

I09-2: 10:12–10:24 a.m. Discovering Physics in Informal Settings: How Bike Repair and Community Cycling Provide Rich Contexts for Learning Physics

Stacy M. Scheuneman, University At Buffalo, Noemi Waight, Ryan M. Rish, Jennifer Tripp, Fatemeh Mozaffari, Finn Goehrig, David W. Jackson

Preliminary results investigating bike-mediated and place-based physics learning that emerged in the first two years of the STEMcyclists research program, which draws on community partnerships in providing a STEM-focused summer experience for high school youth through bike repair and community cycling, are presented and discussed. This presentation will also consider implications for physics learning in formal classroom settings, and provide an opportunity to explore pieces of a bike-centric rotational motion unit and stand-alone activities appropriate for a variety of levels of physics learners. This material is based upon work supported by the National Science Foundation under Grant No. 2314260. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

I09-3: 10:24–10:36 a.m. Development of Student Growth Mindset through Informal Learning

Isabella Oaks, Texas A&M University, Jonathan Perry, Tatiana L. Erukhimova, James K. Hirons, Toni Sauncy

Through research, a connection between student facilitation of physics outreach and identity, resilience, and career development has been found. Previously, studies have been limited to individual institutions with a limited number of participants. In this study, a national survey was distributed to the Society of Physics Students chapters, collecting self-reported data on individual experiences in facilitating physics outreach. We gathered responses to three open-ended questions posed to survey respondents who had participated in informal physics outreach programs. These responses were then analyzed, focusing on themes surrounding growth/fixed mindset. A thematic analysis was conducted, identifying three main themes related to students' growth mindset: realization of understanding, recognition of there being more to learn, and confidence in their ability/knowledge. Specifically, we examined responses that highlighted the directionality of mindset, where students shared whether outreach influenced their mindset in the discipline or they carried their mindset from the discipline to their outreach activities. The results indicate that students who participated in outreach were likely to develop a growth mindset through informal learning. In addition, data from a prior local study were analyzed with similar results being found. This local and national data will be discussed in detail.

I09-4: 10:36–10:48 a.m. Impact of Outreach on Physics Students: Qualitative Results from a National Survey

Tatiana L. Erukhimova, Texas A&M University, Jonathan Perry, Toni Sauncy, Carlee Garrett, Jonan Donaldson, Susan White, John Tyler, Rachel Ivie

Physics departments across the country strive to enrich the educational experience of physics majors and prepare them for their careers. While coursework and labs are central, impactful experiences like physics outreach enhance learning beyond the classroom. We present the results of the first nationwide study examining university students' experiences with physics outreach. A newly developed survey instrument, incorporating both closed- and open-ended questions, was distributed to individual physics majors through the national network of the Society of Physics Students. The survey aimed to assess students' perceptions of their physics identity, sense of belonging, mindset, and career skill readiness. This talk focuses on the qualitative analysis of the open-ended survey responses. Network analysis revealed that student experiences clustered into key themes, including resilience, self-perception, disciplinary development and connectedness, audience engagement, and personal transformation. These findings may be valuable for physics departments looking to enhance and expand students' learning experiences.

Session I10: Advocacy in Physics Education: Part 1 – Sponsored by AIP

Location: Farragut Square **Time:** 10–11 a.m. **Date:** Wednesday, Aug. 6, 2025 **Moderator:** Gabe Spalding

This session will focus on the major issues facing science and science education with the new administration. Topics such as the FY26 Federal research and development budget and the Department of Education will be discussed. The panel will delve into practical strategies for interacting with state and national legislators, issues coming up in the next year, resources to stay informed and actively advocating, etc. This is an opportunity for attendees to have questions answered and get more insight into the policy and funding issues that the science and education community is facing. This panel is sponsored by the American Institute of Physics.

SPEAKERS:
Charlotte Selton
David Crowley
Roohi Dalal
Della Cronin
Matthew Jepsen, SPIE

Session I11: Women in Quantum Research

Location: Salon E (Washington at Metro Center) **Time:** 10–11 a.m. **Date:** Wednesday, Aug. 6, 2025 **Moderator:** Vanessa Preisler

I11: 10–10:24 a.m. Building Quantum Education and Workforce Development from Elementary School to the Workforce

Invited – Jessica L. Rosenberg, George Mason University

New quantum technologies are emerging and industry leaders are expressing concerns about the need to grow a skilled workforce in this area. Despite its importance and cross-disciplinary applications, student knowledge of quantum information science remains limited, and interest is primarily confined to those in the physical sciences and engineering disciplines. As the field moves forward, it is essential that we engage a more diverse pool of students so that we have enough talent to fill the growing need. We will discuss our efforts to develop education and workforce development programs for students and teachers from elementary through graduate school.

Session I12: Honoring the Legacy and Impact of Joe Redish

Location: Salon A/B (Washington at Metro Center) **Time:** 10–11 a.m. **Date:** Wednesday, Aug. 6, 2025 **Moderator:** Mel Sabella

Join us to honor the legacy of E.F. "Joe" Redish. We will celebrate the impact Joe has had on so many, through a series of brief professional and personal remembrances by members of the physics education community that were close to him. Attendees at the session will have an opportunity to share their own stories to collectively reflect on the influence Joe has had on members of our community. In addition to participant remembrances, we will hear from the following scheduled presenters: Andy Elby, Apriel Hodari, Bob Hilborn, Chandra Turpen, David Hammer, Eric Kuo, Gary White, Jeff Saul, Lei Bao, Mel Sabella, Michael Wittmann, Paula Heron, Sam McKagan.

Session J01: Teaching the Introductory Physics for the Life Sciences (IPLS) Course: Part 4

Location: Declaration A **Time:** 11 a.m.–12 p.m. **Date:** Wednesday, Aug. 6, 2025 **Moderator:** Jonathan W. Alfson

J01-1: 11–11:12 a.m. Determining How Context Matters Using a Dual Process Theory of Reasoning Framework

Tyler Garcia, North Dakota State University,
Mila Kryjevskaia

Dual-Process Theory of Reasoning (DPToR) is one of the theoretical frameworks used to examine student reasoning in physics. To date, the framework has mostly been used to analyze student reasoning in introductory calculus-based physics courses. In this study, we use the framework and accompanying methodology of screening-target question pairs to probe student reasoning in algebra-based courses taken by life science majors. In addition, we redesigned some screening-target question pairs to examine whether offering these questions in a context more relevant to the life sciences students will improve their performance. Both original and modified sequences of questions require the same physics knowledge and skills but differ in context. Half the students in the course received the original pairs in a traditional physics context, while the other half of the class was served with the modified versions. We report on the differences in performance and discuss implications for research and instruction.

J01-2: 11:12–11:24 a.m. Teaching about Torques and Composite Movements through Examples in Orthodontics

Priya Jamkhedkar, PhD, Portland State University,
Lewis Hicks, Annelise Cummings, Travis Kregear, Ralf Widenhorn

Many life-sciences majors hope to pursue careers in dentistry. Introductory physics classes, including those designed for life-sciences majors, often lack curricular material with examples based on orthodontics, a branch of dentistry that deals with movement and alignment of teeth. A good understanding of forces and torques is important in orthodontics. A combination of different movements such as translation and rotations about the center-of-resistance (a concept equivalent to center-of-mass for constrained objects) is required to achieve the desired orthodontic results. To connect orthodontics to physics concepts, we developed curriculum discussing different orthodontic movements in the context of torques and forces, incorporating the physiological processes underlying orthodontic treatment. We developed interactive simulations for students to explore the main concepts associated with torque, such as the moment arm and line of action of forces. Students worked on visualizing the motion of teeth as a combination of translation and rotation. We also produced videos of interviews with an orthodontist discussing current orthodontic technology. This curriculum can be used as a model to integrate physics and health sciences concepts, thereby increasing class engagement by pre-health students.

J01-3: 11:24–11:36 a.m. Building a Sustainable Community in Life Science Physics Courses by Leveraging Student Course-Alumni Assistants

Jason Puchalla, Princeton University,
Monica Skoge

Introductory physics classes aimed at engineering and physics majors typically benefit from a student cohort that is closely aligned with the course materials and the scientific approach. Many of these students may have already interacted with or even met their instructors prior to enrolling. In contrast, introductory physics for the life sciences (IPLS) courses often serve students from a wide range of independent departments, who are generally unfamiliar with the class techniques and instructors. This lack of a cohesive community can impact class participation, make it harder for students to find peer support, and contribute to preconceptions about the subject's utility and learnability. Since enrollment in IPLS courses is primarily made up of juniors and seniors who often are more focused on building connections within their major, building a sense of community around a physics class may be even more challenging. To address this, we have implemented an undergraduate course-alumni assistant (UCA) program, which offers alumni of the course the opportunity to assist with class instruction the following year. A few months before the class begins, students from the previous enrollment cycle are contacted to gauge their interest in becoming UCAs for the next class. UCAs can sign up for paid work as graders of in-class participation assignments, serve as peer guides for study halls, or host study break events. The course instructors oversee and monitor the UCA program, but importantly, UCAs are considered part of the course instruction team and are presented as such to new students. Here, we describe the structure and details of the UCA program in our Princeton IPLS class and how it has evolved into a self-sustaining community within the life science departments. We believe that many elements of this model could also be beneficial if adopted in standard engineering and physics courses.

J01-4: 11:36–11:48 a.m. How COVID-19 Shaped Biological Physics Teaching at Georgetown University

Rhonda Dzakpasu, Georgetown University

Like many academic institutions, Georgetown University abruptly pivoted to virtual instruction in March 2020. During the course of those spring and summer semesters, faculty were given access to "how to teach online" courses and workshops at institutions with deep virtual learning experience as well as at Georgetown. The important factor for a successful transition was the maintenance of cohesion and community. This can be a challenge in a traditional setting; in the online space, it felt quite daunting. Add to this the teaching of biological physics to very different cohorts of students and success seemed insurmountable. I will report on how significant changes made during COVID to our introductory biological physics course - which is taken after the introductory physics sequence - resulted in a doubling of the course enrollment. Importantly, these changes translated quite nicely once in-person teaching restrictions were lifted.

Session J02: Assessing Lab Strategies and Outcomes

Location: Declaration B **Time:** 11 a.m.–12 p.m. **Date:** Wednesday, Aug. 6, 2025 **Moderator:** Josh Rutberg

J02-1: 11–11:12 a.m. Comparing Online Labs and Video Lectures as Pre-Lecture Activities for Interactive Calculus-Based Physics Classes

Amin Bayat Barooni, Georgia State University

Problem: In my calculus-based physics lecture classes where labs are not fully integrated, students struggle to grasp concepts as labs are designed to complement lectures. Feedback from my student surveys reveals difficulties in comprehending concepts that they learned through pre-class readings or interactive videos, showing a need for a more robust pedagogical approach. Drawing from my positive experience with an integrated lab and lecture format in algebra-based classes using the Investigative Science Learning Environments (ISLE) [1] pedagogy that students learn by starting with doing experiments, I propose a solution to enhance my students' learning in the calculus-based physics lecture classes. Proposed Solution: To address these challenges, I propose using online lab platforms such as Pivot Interactive [2]. This platform would enable students to conduct observational experiments remotely before each class. This approach may enhance student preparation for in-class activities, including Think-Pair-Share [3], which can enhance their learning. Methods and Research Question: My primary research question is: Can mini-interactive online labs improve students' understanding of physics concepts and beliefs about physics courses compared to interactive video lectures? During the Spring 2025 semester, one class will use mini-interactive online labs and a small percentage of interactive video lectures, while the other will rely on interactive video lectures. Student responses will be analyzed, and feedback will be provided before each class session.

J02-2: 11:12–11:24 a.m. Using Simulations to Support Student Learning Outcomes in Interactive and Engaging Lab Experiences

Manher Jariwala, Boston University,
Andrew Duffy, Emily C. Allen

Learning in both the classroom and the lab requires a social construction of knowledge to develop both content and scientific skill mastery. One challenge, however, is the disconnect that has been seen between students' understanding of abstract concepts taught in the classroom with the real-world experiences in the lab. Our research on students' use of simulations in concert with hands-on equipment demonstrates similar learning outcomes as with hands-on equipment alone. These results suggest a strategy for providing students more modes of interaction and engagement with the material. In doing so, the hope is to provide effective learning tools for an increasing range of diverse student backgrounds. Existing simulations and activities created by our Boston University PER group and others will be shared as examples and models for the developed work.

J02-3: 11:24–11:36 a.m. Student Reasoning about Measurement Uncertainty while Working with the Projectile Data Lab PhET Simulation

Qiaoyi Liu, University of Colorado Boulder,
Matthew Blackman, Katherine Perkins, Heather J. Lewandowski

Understanding concepts of measurement uncertainty is a core competency of physicists and engineers, and many physics lab courses aim to have students learn these ideas. However, there is strong evidence that this goal is often not met. To address the challenge of improving students' conceptual knowledge of measurement uncertainty, we developed a new, noise-enhanced PhET simulation named Projectile Data Lab by incorporating statistical noise into the Projectile Motion simulation. Additionally, the data from the simulation can be sent to the Common Online Data Analysis Platform (CODAP), creating an instructional platform. Finally, we developed relevant activities for instructors to use the simulations in their lab courses. The combination of the PhET simulation, its CODAP-integrated instructional platform, the associated lab activities, and the instructor facilitation forms a new learning environment that aims to enhance student reasoning about measurement uncertainty. To investigate the effectiveness of this learning environment, we conducted think-aloud interviews where students worked through the lab activities with the simulations. We will describe the design of the new learning environment, and report the results from the student think-aloud interviews.

J02-4: 11:36–11:48 a.m. Enhancing Collaboration and Learning in Physics Lab Courses Through the POE-D Framework

Umesh Silwal, University of North Carolina At Charlotte,
Richard A. Dudley

Physics lab courses are an integral part of undergraduate education, where students learn to set up lab equipment, collect data, interpret results, draw conclusions, and perceive science as a structured discipline rather than mere magic. However, despite working in small groups for lab experiments, we noticed that students often do not collaborate effectively, limiting learning outcomes and professional development. To address this, we introduced an additional lab component, 'Discussion', within our existing Predict, Observe, and Explain (POE) framework, creating POE-D. After completing the lab work and individually filling out worksheets/lab reports, students discuss their findings with their lab partners at the end of the session, clarify misconceptions, and revise their responses accordingly. To help foster the discussions, students submit worksheets/lab reports in two separate stacks, with the TA randomly grading one per group and assigning the same score to all group members. This talk will present measures of the effectiveness of this new approach in strengthening collaboration, critical thinking, and problem-solving skills while fostering a more effective and engaging lab learning experience.

J02-5: 11:48 a.m.–12 p.m. Exploring the Effectiveness of Inquiry-Based Physics Labs in Boosting Students' Interest in Physics

Keshab R. Pokharel, UAF, Michael M. Hull

This study investigates the impact of an inquiry-based radioactivity lab on undergraduate students' interest in physics, comparing it to a traditional, scripted lab. The inquiry-based approach begins with students constructing a cloud chamber, which they can use as a research tool. Students independently design methods to implement in the lab, fostering a sense of ownership and engagement in their learning. To evaluate the effectiveness of this approach, we collected data through pre- and post-lab surveys, in-class video recordings, and student interviews, along with preliminary insights from teaching assistants. In this presentation, we will address the following key research questions: a. How does an inquiry-based radioactivity lab influence student interest in radioactivity and physics? b. How do interest levels in learning about radioactivity and radiation vary by gender before and after an inquiry-based lab? Our findings contribute not only to improving radioactivity education but also to physics lab instruction more broadly. Building on this work, we are implementing and assessing additional guided inquiry-based labs, including a pendulum lab in mechanics and a circuits lab in electricity. Preliminary results from these labs will also be discussed.

Session J03: Sense-Making Across Different Domains: Part 2

Location: Franklin/McPherson **Time:** 11 a.m.–12 p.m. **Date:** Wednesday, Aug. 6, 2025 **Moderator:** Miguel Vasquez-Vega

J03-1: 11–11:24 a.m. Sensemaking & Self-Efficacy in Upper Division Undergraduate Physics

Invited – Elizabeth Gire, Oregon State University,
Yangqiuting Li, Lupe MacIntosh

Evaluative sensemaking strategies are used to interrogate the plausibility of an answer to a problem. In physics, some of these strategies are checking units/dimensions, checking types of mathematical entities, considering limiting & special cases, and examining covariational relationships. One reason we teach these disciplinary strategies is to empower students as physics problem solvers. If students have agency in evaluating their own answers effectively, do they become more independent practitioners and build confidence in their own physics abilities? In our recent work, we have been exploring the relationship between instructional emphasis on evaluative sensemaking, students' sensemaking practices, and students' self-efficacy in advanced undergraduate physics courses. In this talk, we will share some preliminary mixed-methods analysis from homework and interview data.

J03-2: 11:24–11:36 a.m. Does "Ungrading" support Sensemaking? A preliminary comparison of Scored vs Unscored physics courses

Invited – Miguel Vasquez-Vega, Tufts University, David Hammer

We have developed a method to identify and code for evidence of students' Sensemaking in written work. Using this framework, we are analyzing data from active learning introductory undergraduate physics courses (Newtonian Mechanics, calculus-based) taught across two consecutive terms with a key difference: In the first term, no scores or grades were provided for any assessments— we refer to this as "Unscoring" (a practice sometimes called "Ungrading" in recent literature, though with additional nuance). In the second term, numerical scores were assigned, and students could receive partial or full credit for earnest engagement with confusion, even if their answers were not canonically correct— we refer to this as "Scoring." In both courses, feedback was carefully provided to address the substance of students' work, encourage reflection on physical coherence, and support Sensemaking. In this contribution, we present our methodology and preliminary findings from our analysis, comparing the evidence of students' sensemaking in each grading context.

J03-3: 11:36–11:48 a.m. What Is Needed for Success in Physics: Number/Symbol Sense or Prior Math Coursework?

Invited – Robert Cohen, Ph.D., East Stroudsburg Univ

Surprisingly, success in our first-semester algebra-based physics class is predicted by number and symbol sense (over rote algorithmic problem solving) more than anything else (including previous math coursework). I'll discuss how we know, why such sense-making is important, implications for physics and math education, and possible solutions.

Session J04: Educational Technology for Active Engagement and Assessment

Location: Wilson/Roosevelt **Time:** 11 a.m.–12 p.m. **Date:** Wednesday, Aug. 6, 2025 **Moderator:** Hyewon Jang

J04-1: 11–11:12 a.m. Seeing Virtually: Teaching Electricty and Magnetism in Virtual Reality

Matt Anderson, San Diego State University,
Elizabeth Flynn, Adrian Larios, Janet Bowers, Dustin Thoman, India Wishart, Luke Anderson, Beau Green

In this talk I will present our recent exploration into teaching E&M with augmented reality. A short demo will also be presented. Background: Augmented reality (AR) applications in STEM education have grown exponentially, yet questions remain about effective design principles. While cognitive approaches emphasize reducing complexity, social learning perspectives suggest value in promoting increasingly sophisticated engagement practices. Methods: We analyzed 91 first- and second-year physics students' interactions with AR representations of electric fields using purposive sampling. Students worked predominantly in pairs exploring 3D visualizations of field properties through an iPad-based AR environment. Results: Analysis revealed three key engagement patterns: (1) Perspective shifting: Students physically explored visualizations to develop spatial understanding; (2) Language shifting: Students progressively connected familiar terminology with formal physics concepts; (3) Role shifting: Students evolved from task completion to physics-based reasoning. Conclusions: Findings suggest AR's effectiveness stems from supporting students' evolution from peripheral to more central learning that involves the integration of social and linguistic emergence in the environment. Design implications include maintaining representational fidelity with traditional physics models and incorporating structured language scaffolds to promote sophisticated engagement practices.

J04-2: 11:12–11:24 a.m. Introducing PhET Studio: Customize PhET Sims for your Classroom

Linda Stegemann, BA, Chemistry; MS, Chemistry, PhET Interactive Simulations, University of Colorado Boulder,
Matthew Blackman, Kathy Perkins, PhET Team

PhET's library of interactive simulations ("sims") has revolutionized physics education, empowering teachers and enabling students to visualize and experiment with complex concepts. To further empower educators, PhET Interactive Simulations at the University of Colorado Boulder has developed PhET Studio, a platform designed for customization and lesson creation. In this session, we will introduce the core capabilities of PhET Studio, showcasing how instructors can leverage these capabilities to 1) adapt simulations to match their learning objectives, 2) eliminate the need for lengthy instructions, and 3) save instructional time. Instructors will learn how to create, save, and share customized simulation presets through simple URLs. We will conclude the session by sharing our roadmap for future PhET Studio capabilities and how PhET Studio will not only empower educators but also serve a critical role in securing and fueling PhET's work for years to come.

J04-3: 11:24–11:36 a.m. Asynchronous Synthetic Groupwork-based Tutorials: Conceptual Gains with the Newton's Third Law Open Source Tutorial

Michael M. Hull, University of Alaska Fairbanks,
Keshab R. Pokharel

Many students in the United States learn physics asynchronously online, and the number is forecasted to grow. Asynchronous education enables learning of non-conventional students who would otherwise find it prohibitive to learn physics. At the University of Alaska Fairbanks, for example, students taking our asynchronous introductory physics courses include parents, full-time employees, military personnel, and learners in rural communities. However, much research-based curriculum revolves around groupwork to enhance student learning, with both theoretical and empirical justification. We have been experimenting with an idea we are calling "Synthetic Groupwork-based Tutorials (SynG-Tuts)", where an individual learner interacts with a pre-recorded video of a group of fictitious classmates discussing their physics ideas (for example, in response to prompts on a guided worksheet-based Tutorial). At each prompt, the video pauses, and the learner is prompted to answer the prompt, potentially agreeing or disagreeing with the synthetic classmates. At key points, the free response prompt is followed by a multiple choice prompt asking the student to select which option best represents what they just typed. The video then jumps to a point appropriate for that multiple choice selection, such that synthetic groupmates respond to the learner's ideas. At previous AAPT meetings, we have presented our modifications of the Inquiry into Radioactivity (IiR) curriculum for use as a synthetic-groupwork based tutorial (SynG-IiR). This time, we will discuss our latest SynG-Tut, an asynchronous version of the Newton's Third Law Open Source Tutorial. Via pre/post-testing on conceptual understanding of Newton's Third Law, we will compare learning gains with what has been previously published using the original in-person Tutorial.

J04-4: 11:36–11:48 a.m. Giving Physics Exams in a Centralized Computer-Based Testing Lab

Andrew Gavrin, Indiana University - Indianapolis

I will describe the use of a computer-based testing center in teaching introductory physics at an urban public university. The center is maintained by the university's IT services and is open to all departments, though use is heaviest in mathematics and the natural sciences. At present, approximately 130 students can take exams concurrently, and the center is open 55 hours/week. Exams are scheduled, administered, and graded through the learning management system (Canvas at present). Faculty have substantial flexibility in setting exam durations and rules regarding notes, calculators, etc. This talk will describe the creation and maintenance of the center but will focus on the substantial pedagogical and logistical benefits of the system, including improved exam security, and scheduling flexibility. It will also note some drawbacks and potential improvements.

Session J05: Cultivating Physics Educators: Pathways, Practices, and Professional Growth: Part 2

Location: Cabin John/Arlington **Time:** 11 a.m.–12 p.m. **Date:** Wednesday, Aug. 6, 2025 **Moderator:** Rebecca Vieyra

J05-1: 11–11:12 a.m. Reflection on Developing a STEP UP Professional Learning Community

Bree Barnett Dreyfuss, Amador Valley High School

While teachers are accustomed to gathering, modifying, and writing lessons for their students they do not always have experience developing instructional materials for fellow teachers. This talk will include reflections from three high school teachers who developed Professional Learning Community materials for current and future high school physics teachers from across the country. As part of a new STEP UP program focused on the Everyday Actions Guide, a collection of strategies for an inclusive classroom community, the first PLC began in July 2025 and will continue through the 2025-2026 school year. Come hear about the experience of developing reflective activities for teachers with varying levels of experience and backgrounds, how the experience so far has affected our plans for the PLC and how you can join this national effort to bring physics teachers together to reflect on our teaching.

J05-2: 11:12–11:24 a.m. Exploring the Relationship between Teacher Networks and Adopting Equity-based teaching strategies

Pooneh Sabouri, Christopher Irwin, Nicole Schrode

Research shows that belonging to teacher networks plays a crucial role in professional learning as they facilitate knowledge sharing, collaboration, and support. Teacher networks can become a social infrastructure that strengthens and sustains teachers' commitment to adopting new pedagogical approaches. In particular, teacher networks offer teachers a sense of community, overcoming the feelings of isolation that sometimes accompany the challenging work of promoting equity. While existing research provides insights into the role of teacher networks in promoting equity, there is a need to measure the impact more specifically. In this study, we address this need and explore the effects of teacher networks on teachers' adoption of research-driven lessons designed to encourage students, in particular women, to pursue undergraduate physics majors. Our study participants are 80 high school physics teachers who received the lessons through a one-day professional development program in summer 2024. Throughout the school year, teacher participants had opportunities to interact with one another and with regional teacher leaders recruited and trained to implement the program. The data for the study is from teachers' responses to surveys administered before the summer program and at the end of the school year asking about participants' network before and after they join the program (e.g., who they know in the program), and whether they implemented the interventions. We define facilitators as the network nodes in each region and the number of connections each participant has with the facilitator (e.g., they know the facilitator) as the strength of their network. We used logistic regression to model the likelihood of implementing the lessons, using network strength as a predictor variable. The results can contribute to understanding the effect of teacher networks on sustaining the impact of PDs and possible ways of measuring it.

J05-3: 11:24–11:36 a.m. K-12 Articulation of Physics Curriculum: Teacher collaboration in K-12 is as important as student collaboration. In district wide programs, K-12 teachers explore vertical articulation of physics concepts

Arthur Eisenkraft, PhD, University of Massachusetts - Boston

Physics should be taught throughout grades K-12. We need physics teacher leaders within school districts and across all grades who understand how physics principles are articulated across all grades. Teacher leadership is an important aspect of strong schools and school districts and has been shown to be an important factor in teacher retention, teacher development, and student growth. For over a decade, the Center of Science and Mathematics in Context (COSMIC) at the University of Massachusetts – Boston has been refining and deploying a professional development program to build science teacher leadership capacity in high needs school districts. The program has been successfully deployed in 35 school districts in seven states around the country. The program is a two-year professional development for STEM teachers across K-12 grades. The first year is dedicated to thinking about teaching and examining teaching practice. This includes vertical articulation of curriculum as well as in-depth look at science and engineering practices. The second year of the program is dedicated to developing teacher leadership skills. At the completion of the program, school districts have a critical mass of science teacher leaders who can support district initiatives while remaining in the classroom.

Session J06: Demystifying Quantum: From Student Reasoning to Teacher Preparation

Location: Bulfinch/Renwick **Time:** 11 a.m.–12 p.m. **Date:** Wednesday, Aug. 6, 2025 **Moderator:** Jose Soto

J06-1: 11:–11:12 a.m. Student Reasoning about Quantum Teleportation While Working with Diagrammatic Exercises

Sebastian Kilde Westberg, University of Gothenburg,
Andreas Johansson, Jonas Enger

Our current technological development heavily relies on quantum physics, and there is an increasing demand for a qualified quantum workforce. In many European high school curricula, quantum physics is introduced through a semi-historical approach, a context that, while conveying some key ideas about fundamental shifts in understanding the world, may leave students with little understanding of contemporary quantum technologies and challenges. The current study explores a novel way of introducing the concept of quantum teleportation in Swedish high school physics using a simplified version of ZX-calculus, a diagrammatic formalism to describe quantum theory. We have developed a two-lesson module where students are first introduced to the mathematical formalism of boxes and wires following the structure presented in the textbook Quantum in Pictures. During the second lesson, students are shown how a simplified version of ZX-calculus can be used to describe some quantum phenomena, after which they work on exercises on quantum teleportation in groups. We collect pre- and post-tests, written responses, notes from questions asked during lessons, and video recordings of group discussions to analyze how students comprehend quantum teleportation using diagrammatic formalism. From this analysis, we aim to understand how their understanding of the nature of quantum physics develops throughout the intervention, using the theoretical framework of the variation theory of learning.

J06-2: 11:12–11:24 a.m. SUPER-Tech SHIP: Paving Pathways into Physics for Diverse High School Student

Melanie Pelcher, Syracuse City School District

The SUPER-Tech SHIP (Syracuse University Physics Emerging Research Technologies Summer High School Internship Program) is an initiative designed to create a paid summer research internship for high school students in the city of Syracuse. This program specifically targets a diverse population, with a focus on recruiting Black, Latino, Indigenous, and women students to enhance representation in the science, technology, engineering, and mathematics (STEM) workforce. The primary goal of SUPER-Tech SHIP is to expose students to emergent technologies in fields such as biotechnology, quantum information, and semiconductor detectors, thereby establishing a pipeline into Physics and other STEM careers. This presentation will highlight innovative methods utilized to engage historically excluded groups in physics through hands-on research experiences. The program consists of a 6-week experiential learning framework that features boot camps, research projects, and mentorship from faculty and near-peer mentors, allowing students to participate in immersive activities that enhance both their technical and professional skills. This work was supported by NSF grant # ITE-2347076, “Explorations: Syracuse University Physics Emerging Research Technologies Summer High school Internship Program (SUPER-Tech SHIP)” to Jennifer Ross and Mitchell Soderberg at Syracuse University in collaboration with Syracuse City School District.

J06-3: 11:24–11:36 a.m. The Impact of the Pathways to Quantum Immersion Program and College Trajectories and Career Conceptualization

Jessica L. Rosenberg, George Mason University,
Nancy Holincheck, Benjamin Dreyfus, Jennifer Simons, Laura M. Akesson

The Pathways to Quantum Summer Immersion Program introduces high school students to key quantum concepts and the jobs in quantum. The program has run each summer since 2022. The program includes: (1) a two-week virtual program focused on helping students understand basic quantum concepts, (2) a one-week in-person experience in which students build on their understanding of the quantum key concepts and visit research labs, companies engaged in quantum, and an organization focused on quantum policy, (3) an optional follow-up in which students create a poster on their vision of future uses for quantum, and (4) an optional (application required) extended research experience in quantum. We will present preliminary results from interviews with students who were part of the first 2 cohorts and are at least six months beyond their high school graduation. These interviews aim to understand how the program impacted their college trajectories and their thoughts about future career paths.

J06-4: 11:36–11:48 a.m. Investigating High School and Pre-high School Teachers’ Perceptions and Experiences of Teaching Quantum Concepts

Apekshya Ghimire, PhD in Physics, University of Pittsburgh,
Jaya Shivangani Kashyap, PhD, Emily Edwards, Chandralekha Singh

This study examines the effectiveness of QuanTime activities [1] in promoting quantum literacy and introducing foundational quantum concepts to K-12 students, aiming to prepare a diverse future quantum workforce. Teachers were divided into pre-high school (grades ≤8) and high school (grades 9-12) groups. A survey with 12 Likert scale questions and 14 open-ended questions were developed to learn about their perceptions and engagement. Open-ended feedback emphasized the ease of integrating these activities with minimal preparation. The positive response across both groups suggests QuanTime activities can be valuable to introduce quantum concepts early, fostering interest and foundational understanding. By engaging students from a young age, these activities can inspire diverse learners and prepare them for future opportunities in quantum technology. We thank the National Science Foundation for support. [1] https://q12education.org/quantime/quantime-activities

Session J07: PER: Student Reasoning, Learning, and Behavior: Part 2

Location: Penn Quarter AB **Time:** 11 a.m.–12 p.m. **Date:** Wednesday, Aug. 6, 2025 **Moderator:** Paul Miller

J07–1: 11–11:12 a.m. Student Use and Conceptions of Calculus Topics in Calc-Based Intro Physics

Idris Malik, North Dakota State University,
Warren M. Christensen

Prior Physics Education Research (PER) literature has exposed a surprising lack of Calculus topics in Calc-Based Intro Physics courses. We explore how the ideas of Derivatives and Integrals are present in a course, and how students think about these operations when working on problems. Electronic field notes were captured in selected class periods throughout the semester. Field notes document instances where students worked in small groups (where we captured audio and video recordings) and when the class responded to ideas posed by the instructor. We also conducted two Semi-structured one-on-one student interviews to have students work on questions from observed class periods and new questions about integrals and derivatives. We synthesize these data sets to encapsulate how students in this course thought about derivatives and integrals in a physics context. Material based on work supported by NSF PHY 2336911. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of NSF.

J07–2: 11:12–11:24 a.m. How Students Represent Physics Knowledge Through Recall

Anna C. Mederer, Worcester Polytechnic Institute,
Chad Nguyen, Stacy T. Shaw, Benjamin Pollard

Instructors use multiple representations such as equations, definitions, and graphs to convey the principles of physics to students. Previous studies have assessed how students solve physics problems presented using different representations. These studies have also shown the importance of understanding how students naturally construct and convey their physics knowledge through different representations. Recall activities, where students write down as much information as they remember from a previous lecture or topic, are a straightforward way for students to express what they have learned. Examining how students may use different representations in recall activities and the extent that representation use varies by person or topic has yet to be fully investigated. The goal of this study is to investigate the quantity and types of representations students recall in an introductory undergraduate physics course to better understand how students build their physics knowledge. Students were given five minutes at the beginning of each lecture within one week to write down as much information as they could remember from the previous lecture. We will discuss the results of this study as well as the implications for integrating recall activities into the classroom.

J07–3: 11:24–11:36 a.m. How Do Students Use Online Homework Solutions?

Andrew Elby, University of Maryland – College Park,
Alexander Conte, Erin Sohr, Jennifer Radoff

Instructors often assume that, when a student accesses online homework solutions from sites such as Chegg, the student intends to copy answers. To investigate how students use online homework solutions, we interviewed students and invited them to write or audiorecord "think aloud" journals as they worked on homework. With permission from the university's academic integrity office, we informed students that their responses would not be shared with that office. We found that students used online solutions in a variety of ways, many of them potentially helpful for their learning. For instance, some students solved the homework problem and then used an online solution to check their reasoning and/or answer. Some students used online solutions to get themselves "unstuck" when they couldn't figure out a step in the problem-solving process. In many cases, a given student might use a mix of these and other strategies, some aimed at helping them understand the underlying physics and others at helping them get the homework done under time constraints. These results suggest that instructors should not assume that students are simply copying when they use online solutions.1

J07–4: 11:36–11:48 a.m. Student Misconceptions about Tangential Acceleration in Curved Motion

Arlinda Hill, Ph.D., Arizona State University - Main Campus

Understanding acceleration in curved motion is critical for mastering introductory physics concepts, yet persistent misconceptions remain. In this study, we investigate University Physics I students' conceptual difficulties with tangential acceleration in non-uniform circular motion. When presented with a problem involving a car moving along a circular path with decreasing speed, a majority of students successfully calculated the magnitude of the total acceleration, correctly combining radial and tangential components. However, when asked to represent the direction of the acceleration vector, many students incorrectly identified the acceleration as pointing solely toward the center of the circle, neglecting the tangential component entirely. Analysis of written responses suggests that students often associate "acceleration in a curve" exclusively with radial acceleration, failing to recognize the role of changing speed along the path. Possible cognitive sources of this misunderstanding and suggestions on instructional strategies to better support student reasoning about multi-component acceleration vectors in two-dimensional motion are discussed.

Session J08: PER: Mathematical Reasoning and Problem Solving

Location: Constitution DE **Time:** 11 a.m.–12 p.m. **Date:** Wednesday, Aug. 6, 2025 **Moderator:** Raymond Zich

J08–1: 11–11:12 a.m. How Students Use Mathematical and Experimental Reasoning to Understand Quantum Experiments

Jason Tran, Georgetown University, Jim Freericks, Leanne Doughty

In quantum classes, it is important to discuss real, not contrived experiments. In the upper-division quantum course at Georgetown University, we discuss several quantum experiments and introduce mathematical tools based on quantum optics and techniques such as a simplified Feynman path integral to analyze these experiments and predict their outcomes. We assess students' fluency with this approach by conducting interviews where students answered conceptual questions, calculated probabilities, and provided step-by-step explanations of three experiments: single photons through a beam splitter, the Mach-Zehnder interferometer, and the Franson interferometer; the first two taught in instruction, the third not covered. This talk presents our results of the analysis of these student interviews.

J08–2: 11:12–11:24 a.m. Development and Validation of an Interactive Learning Tutorial on Quantum Key Distribution Involving Entanglement

Liam Doyle, University of Pittsburgh, Chandralekha Singh

We are amid the second quantum revolution due to our ability to coherently control quantum states. Helping students learn foundational concepts relevant for the second quantum revolution is important for preparing them to be leaders of the quantum information revolution. We describe the development, validation and evaluation of a Quantum Interactive Learning Tutorial (QuILT) on quantum key distribution involving entanglement. The protocol used in the QuILT uses entanglement as a resource for quantum key distribution. The QuILT strives to help undergraduate students learn about an exciting application relevant for the second quantum revolution. It actively engages students in the learning process and helps them build links between the formalism and the conceptual aspects of quantum physics without compromising the technical content. The evaluation suggests that the validated QuILT is helpful in improving students' understanding of relevant concepts. We thank the National Science Foundation for support.

J08–3: 11:24–11:36 a.m. Explicit Implementation of Problem-Solving Frameworks in Tutorials and a Comparison to the Conventional Approach of Designing Tutorials

James C. Hecht, Brigham Young University,
Andrew J. Mason, Matthew Rundquist, Seth Read, John S. Colton, David Neilsen

As part of a more comprehensive study on tutorials in upper-division physics, we study the effects of explicitly structuring tutorials around problem-frameworks compared to existing approaches of designing tutorials. During the Fall 2024 semester, we tested two sets of tutorials in a first-semester upper-division course on electromagnetism, one which was structured explicitly on a problem-solving framework based on the Minnesota model for introductory physics,* and another informed by existing literature on a more conventional tutorial approach. Throughout the semester, data was taken from a sample of 24 students through surveys, interviews, post-tutorial self-assessments, students' work on tutorials and on exams, and observing students while they solved problems related to tutorial topics. It seems that when students use such a tutorial, the change in format of tutorial seems to have little effect on exam scores, but that students are thinking more consciously about aspects of physics problems other than simply arriving at a correct answer. A larger sample size may help refine quantitative results, such as those pertaining to the exam scores.

J08–4: 11:36–11:48 a.m. Problem-Solving Framework in Upper-Division Electromagnetism Tutorials: First Semester vs. Second Semester

Andrew J. Mason, University of Central Arkansas,
James C. Hecht, Matthew Rundquist, Seth Read, John S. Colton

In a multi-semester project, we have been examining the effectiveness of explicit implementation of problem-solving frameworks in a first-semester upper-division electromagnetism course. Specifically, we have developed a set of tutorials structured on an explicit problem-solving framework, e.g. from the Minnesota model for introductory physics,* adapted where appropriate within the tutorial. Recently, we have begun preliminary qualitative comparisons between this first-semester intervention and a similar intervention in the paired second-semester electromagnetism course. Throughout the involved sections, data was taken through interviews with students, post-tutorial self-assessments, and by examining students' work on both the tutorials and on related exam problems. We present a preliminary qualitative analysis on how a problem-solving framework implemented through tutorials affect student problem-solving success on paired exam problems; how students have perceived the usefulness of the tutorials structured around the framework; and how students' views of the intervention may change from the first semester to the second semester. *e.g. J. Docktor, J. Dornfeld, E. Frodermann, K. Heller, L. Hsu, K. A. Jackson, A. Mason, Q. Ryan, and J. Yang, Assessing student written problem solutions: A problem-solving rubric with application to introductory physics, Phys. Rev. Phys. Educ. Res. 12, 010130 (2016).

J08–5: 11:48 a.m.–12 p.m. Affordances and Challenges of Formative Self-Assessment in Upper-Division Physics

Molly Griston, University of Colorado - Boulder, Bethany R. Wilcox

In supporting student learning, it is necessary to foster conceptual understanding and metacognitive skills. By forefronting reflection as a part of problem solving, formative self-assessment can target both of these competencies. Here, we present a specific type of self-assessment, homework corrections (HWCs), in which students have the opportunity to earn credit by correcting their homework assignments. Using data from an upper-division physics course, we consider the potential benefits of HWCs, as well as the observed challenges. Specifically, we focus our attention on students' difficulties in identifying their errors, the insight this provides into their problem solving and reflective processes, and the necessary considerations for implementation to ensure meaningful and productive engagement.

Session J10: Advocacy in Physics Education: Part 2–Sponsored by AIP

Location: Farragut Square **Time:** 11 a.m.–12 p.m. **Date:** Wednesday, Aug. 6, 2025 **Moderator:** Gabriel Spalding

This session will focus on the major issues facing science and science education with the new administration. Topics such as the FY26 Federal research and development budget and the Department of Education will be discussed. The panel will delve into practical strategies for interacting with state and national legislators, issues coming up in the next year, resources to stay informed and actively advocating, etc. This is an opportunity for attendees to have questions answered and get more insight into the policy and funding issues that the science and education community is facing. This panel is sponsored by the American Institute of Physics.

SPEAKERS:
Charlotte Selton
David Crowley
Roohi Dalal
Della Cronin
Matthew Jepsen, SPIE

Session J11: Astronomy Share-A-Thon

Location: Salon E **Time:** 11 a.m.–12 p.m. **Date:** Wednesday, Aug. 6, 2025 **Moderator:** Tracy Hodge

Come share your activities, demonstrations and engaging ideas for teaching astronomy from K-12 to Astro101. From the scale of the solar system to the expanding universe, participants will leave the session with myriad ideas for hands-on learning in astronomy.