2023 AAPT Winter Meeting

AAPT
PHYSICS EDUCATION

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Special Thanks

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

Toby A. Dittrich, Portland Community College

David Sokoloff

Christine and David Vernier

Bus Schedule to Portland Community College on Sunday, January 15

7:30 am — Bus will depart the Hilton

12 noon — Bus will return from the college to the Hilton

Bus is ADA compliant

Bus Departs Broadway Street (parallel to 5th)

Wireless

Network: **Hilton Meeting Room**

Password: **AAPT23**

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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 #aaptwm23. 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 Portland area. We look forward to connecting with you!

Facebook: facebook.com/AAPTHQ **Twitter** twitter.com/AAPTHQ **Pinterest:** pinterest.com/AAPTHQ

2023 John David Jackson Excellence in Graduate Physics Education Award to Kimberly Ann Coble

Kimberly Ann Coble

Human Potentials in the Universe of Graduate Teaching and Mentoring

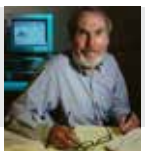
Sunday, January 15
12:30–1:30 p.m.

Grand Ballroom I

Kimberly Ann Coble was selected to receive the Jackson Award in recognition of her work as a teacher of graduate Physics and Astronomy. She is a pioneer in graduate physics & astronomy education. Coble earned her B.A. in Physics, Astronomy, and Astrophysics at The University of Pennsylvania. Both her M.S. and Ph.D. in Astronomy & Astrophysics were earned at The University of Chicago. She was a Postdoctoral Fellow at the University of California, Santa Barbara and a National Science Foundation Astronomy and Astrophysics Postdoctoral Fellow at The University of Chicago and Adler Planetarium.

At San Francisco State University (SFSU) she created a new course called PHYS 885: Inclusive Pedagogy for the Physical Sciences. Nearly all master's students who are Graduate Teaching Assistants (GTAs) in Physics & Astronomy at SFSU take this class to learn how to become more effective teachers for the ever more diverse students enrolling in the physical sciences. Despite a third of undergraduate students belonging to groups underrepresented in the physical sciences fewer than 5% of graduate degrees are eventually awarded to these students. The problem is complex, but part of the solution is better training of the GTAs who teach undergraduate students in lower-division introductory laboratory courses – these are often the first instructors that undergraduates see in smaller class settings. Yet, GTAs typically have the least training in teaching. Coble's course introduces GTAs to evidence-based, student-centered, equitable and inclusive teaching strategies, the social science literature on cultural capital, asset framing and growth mindsets, stereotype threat, and micro vs. macro aggressions vs. affirmations. The course is practical, helping GTAs learn how to create lesson plans, student learning outcomes, differentiated assessments, and grading rubrics. GTAs also reflect on their teaching practice and collaborate with peers to identify successes and challenges in their teaching.

Throughout her career she has created opportunities for graduate students and beyond to become involved in research in meaningful ways and to engage in the academic work, such as presenting at conferences and writing manuscripts for publication, and supporting them in doing so well. When these students attend conferences, Coble goes out of her way to help students network, identify learning opportunities, and model academic engagement so that they get the most out of their experience.



The John David Jackson Award for Excellence in Graduate Physics Education is presented to physicists and physics educators who, like John David Jackson after whom the award is named, have made outstanding contributions to curriculum development, mentorship, or classroom teaching in graduate physics education. The award is presented only occasionally.

Jocelyn Bell Burnell Recognized as 2023 Recipient of the Richtmyer Memorial Lecture Award

Jocelyn Bell Burnell

We Are Made of Star Stuff

Monday, January 16
11:00 a.m.–12:00 p.m.

Grand Ballroom I

Jocelyn Bell Burnell is Dame of the British Empire, and a professor of Astrophysics at Oxford University. She graduated from the University of Glasgow with a Bachelor of Science degree in Natural Philosophy (physics) and obtained a PhD degree from the University of Cambridge. At Cambridge, she attended New Hall, Cambridge, and worked with Hewish and others to construct the Interplanetary Scintillation Array just outside Cambridge to study quasars, which had recently been discovered.

On 28 November 1967, she detected a "bit of scruff" on her chart-recorder papers that tracked across the sky with the stars. She established that the signal was pulsing with great regularity, at a rate of about one pulse every one and a third seconds. Temporarily dubbed "Little Green Man" the source was identified after several years as a rapidly rotating neutron star. The Daily Telegraph science reporter shortened "pulsating radio source" to pulsar. She has become an icon among scientists, not only for her indisputable discovery of pulsars as a young graduate student, but also because of her lifetime of consistent dedication to lifting up and supporting all those who want to study physics with both her voice and funding.

She has demonstrated leadership and vision in numerous positions in her career and has been the recipient of nearly every major scientific prize, been the subject of documentaries, and was named as Dame Commander of the Order of the British Empire in 2007. She is a past president of the Institute of Physics in the United Kingdom, (UK). In 2018, she was a recipient of the Breakthrough Prize in Fundamental Physics.

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 Winter 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.

S. James Gates, Jr.

2023 Oersted Medal Awarded to S. James Gates, Jr.

A Half Century of a Mathematically Enabled Physicist's Life

Monday, January 16
4:30 p.m.–5:30 p.m.
Grand Ballroom I

Dr. Sylvester James Gates, Jr. has been named as the 2023 recipient of the prestigious Hans Christian Oersted Medal. The Oersted Medal recognizes his outstanding, widespread, and lasting impact on the teaching of physics through his national leadership in physics education, his exceptional service to AAPT, and his mentoring of students and in-service teachers. The year of 2022 marks the 51st consecutive year of his service as a university instructor in mathematics and physics.

Gates is the Clark Leadership Chair in Science in the Department of Physics and School of Public Policy at the University of Maryland at College Park (UMCP). Prior to July of 2022 he spent the previous six years at Brown University, where he held appointments as the Brown Theoretical Physics Center Director, Ford Foundation Professor of Physics, an Affiliate Mathematics Professor, and a Faculty Fellow of the Watson Institute for International Studies & Public Affairs. In addition he was the 2021 president of the American Physical Society (APS).

Gates has had a very long and successful career as a theoretical physicist and an educator. He is well known for his work on supersymmetry, supergravity, and superstring theory. From 1985-2016 he was a faculty member at University of Maryland, College Park as a University System Regents Professor, the John S. Toll Professor of Physics, the Director of the String and Particle Theory Center, and Affiliate Professor of Mathematics. He also served on the U.S. President's Council of Advisors on Science and Technology (PCAST) under President Barack Obama. He served on the Maryland State Board of Education from 2009-2016, and the National Commission on Forensic Science from 2013-2016. Though he resigned in 2017 from the University of Maryland, he has recently returned in 2022.

Sensitive to diversity issues over the duration of his career, in 1995 he authored an essay entitled "Equity versus Excellence: A False Dichotomy in Science and Society." This avenue of his writings eventually led to a work "Thoughts on Creativity, Diversity and Innovation in Science and Education" that was cited by the U.S. Supreme Court of the United States in its 2016 decision in the case 'Abigail N. Fisher v. University of Texas at Austin, et. al.' Gates has engaged efforts to look at social justice themes within physics, physics education and policy. He held the position of the president of the National Society of Black Physicists. He also is an

Named for Hans Christian Oersted, the Oersted Medal recognizes those who have had an outstanding, widespread, and lasting impact on the teaching of physics. The recipient delivers an address at an AAPT Winter Meeting and receives a monetary award, the Oersted Medal, an Award Certificate, and travel expenses to the meeting. The award was established in 1936.

Darsa Donelan

2023 Doc Brown Futures Award Awarded to Darsa Donelan

Tuesday, January 17
10:30–11:30 a.m.
Grand Ballroom I

AAPT has announced that the 2023 recipient of the Doc Brown Futures Award is Darsa Donelan. The Doc Brown Futures Award recognizes early-career members who demonstrate excellence in their contributions to AAPT and physics education and exhibit the potential to serve in an AAPT leadership role. The award will be presented during this meeting.

"Being selected for this award has made me feel very accepted by the physics teaching community which is not something that I have always felt from the broader physics community. I am so happy to be valued for who I am and what I do," said Donelan.

A member of AAPT since 2014, she earned a B.S. in Physics and B.A. in Mathematics at Massachusetts College of Liberal Arts and a Ph.D in Physics at the University of Florida. Donelan is Continuing Assistant Professor at Gustavus Adolphus College in Saint Peter, Minnesota.

In 2019 Donelan joined the AAPT/NASA collaboration to produce space science themed educational supplements supported by a grant from NASA. Her scientific background in planetary science and obvious skill in teaching and working with students made for an ideal addition to the team. Our team is an eclectic group with a range of skills and background, and Donelan fit right in. At the time, we had received instructions from the project leadership at Goddard Space Flight Center that we could expand the context area beyond heliosphysics to include subjects like planetary science. This led to the development of tutorials on Habitable Zones, Exoplanet Atmospheres, and Stellar Spectra.

The Doc Brown Futures Award recognizes early-career members who demonstrate excellence in their contributions to AAPT and physics education and exhibit the potential to serve in an AAPT leadership role. A monetary prize of $1,000, a commemorative certificate, complimentary registration to an AAPT National Meeting and two nights lodging in the conference hotel,. In addition, the awardee will be assigned a mentor who is a current AAPT leader and will be offered the opportunity to serve on a committee or task force of their choice (in collaboration with the AAPT President or equivalent)

Next steps in gravitational-wave astronomy

by M. Landry for the LIGO Scientific and Virgo Collaborations

LIGO, Virgo, and KAGRA will soon embark on O4, the fourth observation run of terrestrial gravitational-wave detectors. To date, 90 sources have been observed including mergers of binary black holes, binary neutron stars, or one of each of those compact objects. In this talk we will review the status of detectors as they are commissioned for the spring 2023 O4 start of that ~year-long observation run, and prospects for detection. Furthermore, we will sketch plans for O5 and beyond, and survey ideas for next-generation detectors, particularly Cosmic Explorer.

Michael Landry is the Head of LIGO Hanford Observatory (LHO) in Richland , WA, and a physicist with the California Institute of Technology. He received his PhD from the University of Manitoba in 2000, with experimental studies in strange hadronic matter at the Brookhaven AGS and TRIUMF accelerators. Michael started with Caltech as a postdoc at LHO in 2000, working his way through a series of science roles on the interferometers in Initial and Advanced LIGO phases. He was Detection Lead Scientist at the time of the first direct detection of gravitational-waves, GW150914, and was named LIGO Hanford Observatory Head in 2016.

Michael R. Landry

"Next steps in gravitational-wave astronomy"

Tuesday, January 17
9:30 a.m.–10:30 a.m.
Grand Ballroom I

Plenary: Centering AAPT Members: How DEI Work Gives Us a Roadmap

Catherine Herne, State University of New York at New Paltz

David Marasco, Foothill College

AAPT envisions a world where all physics educators and AAPT staff feel a sense of belonging; where physics educators combat the unconscious harassment and discrimination that is pervasive across the field of physics. AAPT has dedicated intensive resources over the past year to create a roadmap for change. Structural changes will make the member experience better for all of AAPT. In this presentation we lay the groundwork for DEI growth in AAPT and how our members can engage. We share elements of the roadmap, the new proposed governance structure, and discuss AAPT's progress from a historic and current perspective.

Sunday, January 15
7–8 p.m.
Grand Ballroom I

Homer L. Dodge Citations for Distinguished Service to AAPT

Tuesday, January 17 • 10:30–11:30 a.m. • Location: Grand Ballroom I

Glenda Denicolo

Glenda Denicolo

Glenda Denicolo earned her B.S in Physics at Federal University of Paraná, Curitiba, Brazil. Her M.S. in Astronomy, was from National Observatory, Rio de Janeiro, Brazil and her Ph.D. in Astronomy from the Institute of Astronomy, University of Cambridge, Cambridge, UK. She did Postdoctoral research in Spectroscopy of globular clusters, Dept. of Astronomy and Astrophysics, at the University of California at Santa Cruz, Santa Cruz, CA.

A member of AAPT since 2008, Denicolo became a member of the Committee on Physics in Two-Year Colleges in 2015 and served as Vice Chair in 2018 and as Chair in 2020. She has provided exceptional leadership and motivation to the TYC community, AAPT's Committee on Physics in Two-Year Colleges, and to individual members personally. Her efforts resulted in significantly reducing the isolation felt by Two-Year College Physics faculty across the nation at the beginning and through the pandemic. In her work on the Committee, she has been a consistent leader and motivator. During the early days of the COVID-19 pandemic, teachers across the country found themselves strangely isolated from their home institutions, many for the first time. Denicolo initiated a series of virtual committee meetings via Zoom that not only served to reunite them literally from coast to coast but to allow them to commiserate and share ideas for how to make it through what would be almost two years of unprecedented activity. She even established a YouTube channel so TYC faculty could make use of the sharing from these meetings. In addition, Denicolo acted as the driving force behind the movement to build on previous successful professional development efforts for Two-Year College faculty in a more permanent and sustainable way. Her efforts in motivating colleagues and tirelessly working on an NSF white paper have led to the successful funding of The Organization for Physics at Two Year Colleges (OPTYCs) NSF grant that will positively affect the future of the AAPT TYC Physics community for years to come.

Alice Flarend

Alice Flarend

Alice Flarend's B.S. in Nuclear Engineering is from the University of Illinois – Urbana. She earned her M.S. in Nuclear Engineering at the University of Michigan – Ann Arbor, her Certification in Secondary Physics and Chemistry at the University of Pittsburgh – Johnstown, and her Ph.D. in Curriculum & Instruction at Pennsylvania State University – University Park.

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The Homer L. Dodge Citation for Distinguished Service to AAPT was established in 1953, was renamed in 2012 to recognize the foundational service and contributions of Homer Levi Dodge, AAPT's first president. The Homer L. Dodge Citation for Distinguished Service to AAPT recognizes AAPT members for their exceptional contributions to the association at the national, section, or local level.

AAPT Fellowship

- *Richard Gelderman,* emeritus professor, Physics and Astronomy Department, Western Kentucky University, Bowling Green, KY

Committee Meetings at Winter Meeting

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

Friday, January 13

Finance Committee	7–8 p.m.	Skyline I

Saturday, January 14

Meetings Structure Committee	8–9:30 a.m.	Studio Suite
Publications Committee	8–9:30 a.m.	Directors Suite
Board of Directors II	10:15 a.m.–4:15 p.m.	Skyline I
Resource Letters Committee	11:30 a.m.–2 p.m.	Broadway I/II
Section Representatives and Officers*	4:30–5:30 p.m.	Pavilion West
ALPhA Open Meeting*	5:30–7:30 p.m.	Broadway I/II
Programs and Planning I	6:30–7:30 p.m.	Pavilion East

Sunday, January 15

Review Board	7:30–9:30 a.m.	Broadway I/II
Physics Bowl Advisory Committee	8–10 a.m.	Broadway III/IV
Apparatus Committee*	4–6 p.m.	Grand Ballroom II
Diversity in Physics*	4–6 p.m.	Pavillion East
History & Philosophy of Physics *	4–6 p.m.	Broadway I/II
International Physics Education*	4–6 p.m.	Skyline II
Physics in Pre-High School Education*	4–6 p.m.	Galleria North
Physics in Undergraduate Education*	4–6 p.m.	Galleria South
Professional Concerns*	4–6 p.m.	Directors Suite
Interests of Senior Physicists*	4–6 p.m.	Broadway III/IV
PER Leadership Organizing Council	4–6 p.m.	Pavillion West

Monday, January 16

Graduate Education in Physics*	7–8:30 a.m.	Pavillion East
Laboratories Committee*	7–8:30 a.m.	Galleria South
Research in Physics Education*	7–8:30 a.m.	Grand Ballroom II
Science Education for the Public*	7–8:30 a.m.	Broadway I/II
Membership and Benefits Committee	7–8:30 a.m.	Broadway III/IV
PTRA Oversight	7–8:30 a.m.	Galleria North
Bauder Endowment	12–2 p.m.	Broadway III/IV
Contemporary Physics Committee*	12–2 p.m.	Grand Ballroom II
Educational Technologies Committee*	12–2 p.m.	Galleria North
Physics in High Schools Committee*	12–2 p.m.	Skyline I
Physics in Two-Year Colleges Committee*	12–2 p.m.	Galleria South
Space Science and Astronomy*	12–2 p.m.	Broadway I/II
Teacher Preparation*	12–2 p.m.	Skyline II
Meetings Location Committee	12–2 p.m.	Directors Suite
PERTG Town Hall	12–2 p.m.	Pavillion West

Tuesday, January 17

Programs and Planning II	1:40–3 p.m.	Pavillion East
Investment Advisory	2–3 p.m.	Skyline I
Nominating Committee II	1:40–3 p.m.	Pavillion East
Board of Directors III	3–5 p.m.	Skyline I

AAPT Exhibitors

Atrium Ballroom: Saturday, 7:30-9:30 p.m.,
Sunday, 10 a.m.–5 p.m., Monday, 10 a.m.–4 p.m.

American Association of Physics Teachers

Booth 10, 11
One Physics Ellipse
College Park, MD 20740
301-209-3300, www.aapt.org, janderson@aapt.org

AAPT® is a strong professional physics science society dedicated to the pursuit of excellence in physical science education. Want to know more about AAPT's mission, history, goals, and organizational structure? Stop by our booth to learn more and get involved!

AAPT Nominating Committee

Booth 21
One Physics Ellipse
College Park, MD 20740
301-209-3300; www.aip.org, membership@aapt.org

The AAPT Nominating Committee strongly encourages interested AAPT members to submit a nomination for any Board of Directors or Area Committee position at any time during the year. Please stop by the booth to visit us and learn more!

AAPT Publications

Booth 13
One Physics Ellipse
College Park, MD 20740, www.aapt.org, TPT@aapt.org

AAPT publishes two peer-reviewed journals and many other publications in both print and online. *The American Journal of Physics* is geared to an advanced audience, primarily at the college level. *The Physics Teacher* focuses on teaching introductory physics at all levels. *AAPT eNNOUNCER*, is an online-only publication that summarizes recent news from the association, its members, its partners, and from the physical sciences world in general.

American Institute of Physics

One Physics Ellipse
College Park, MD 20740
301-209-3100; www.aip.org

The American Institute of Physics is a federation that advances the success of our 10 Member Societies and an institute that operates as a center of excellence supporting the physical sciences enterprise.

American Institute of Physics

Booth #500
One Physics Ellipse
College Park, MD 20740
301-209-3100, www.aip.org

AAPT is a Member Society of the American Institute of Physics (AIP), a federation representing 123,000 scientists, educators, and students. In addition to *Physics Today,* AIP offers many resources you can tap into in the areas of careers and education, science policy, fellowships, history, and media—even group insurance. Stop by the AIP booth to learn more.

Digitalis Education Solutions

Booth 7, 8, 15, 16
www.digitaliseducation.com

Digitalis started the affordable digital planetarium revolution back in 2003. We are now the leading global manufacturer of these immersive simulators. A digital planetarium allows you to travel anywhere through time and space, making spatial concepts much easier to teach. Despite the name, you are not limited to astronomy topics. Using a fixed or portable dome, you can create mind-expanding shared immersive experiences for entire groups—no VR goggles required!

McGraw Hill

Booth 3
mheducation.com

Our vision is to guide you along the path to unlock your potential, no matter where your starting point may be. We'll help you access all the value that education can offer, through high-quality, trusted content developed with world-class authors – and flexible tools to meet the needs of different teaching and learning styles. Our digital platforms provide data-driven insights, adapting to help meet learners where they are – and advancing with them as they progress toward their goals.

PASCO scientific

Booth 23
www.pasco.com

Students need modern tools and technology to succeed in STEM. At PASCO, we have been creating and manufacturing award-winning, hands-on science education tools and datalogging solutions since 1964. With our unique blend of dedication and experience, we think no one combines innovative, easy-to-use products with world-class support like we do.!

Society of Physics Students

Booth22
One Physics Ellipse
College Park, MD 20740
www.spsnational.org

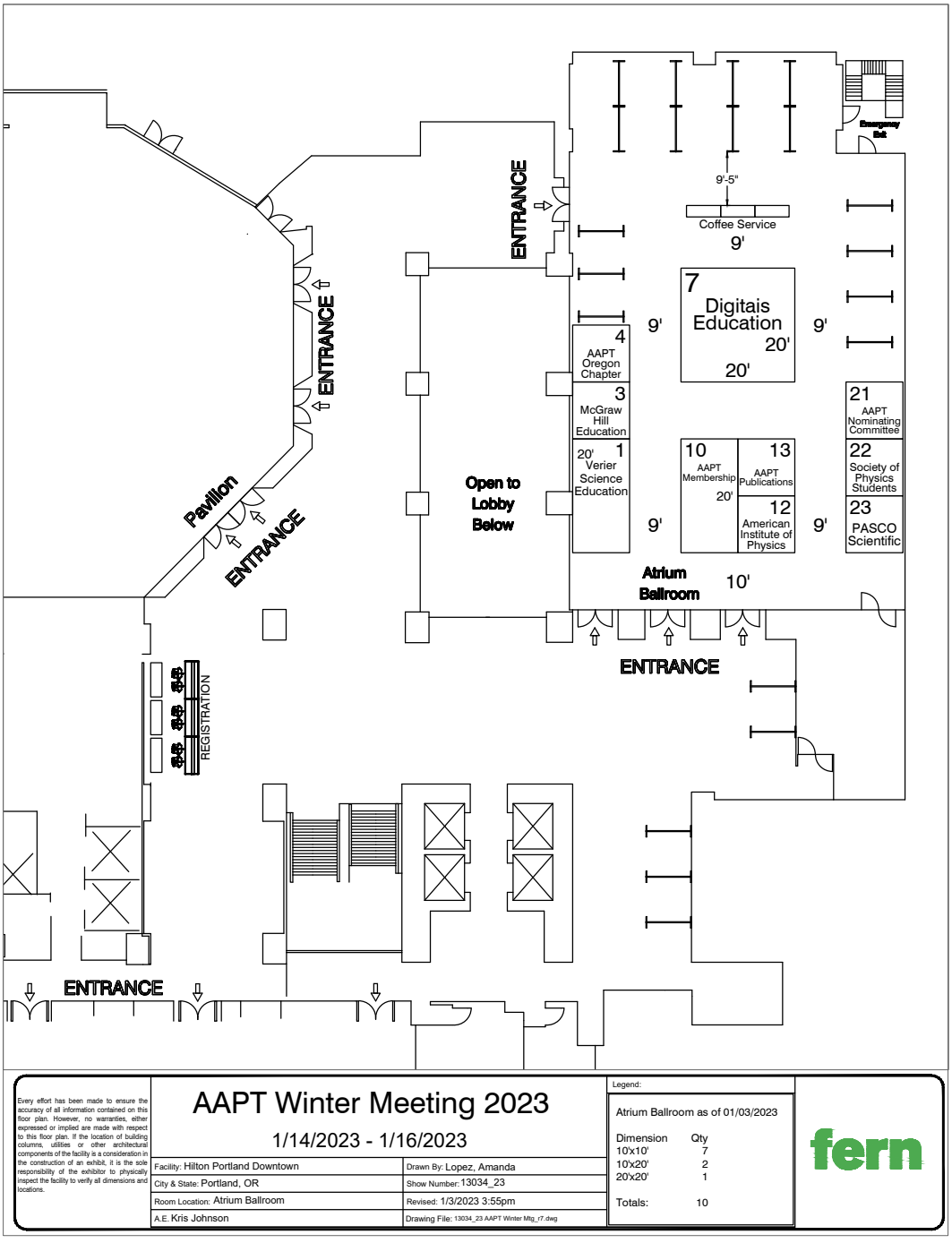
The Society of Physics Students (SPS) is a professional association explicitly designed for students and their advisers. Membership, through collegiate chapters, is open to anyone interested in physics. The only requirement for membership is that you be interested in physics. Besides physics majors, our members include majors in astronomy, chemistry, computer science, engineering, geology, mathematics, medicine, and other fields. SPS is open to everyone. Within SPS is housed Sigma Pi Sigma, the national physics honor society, which elects members on the basis of outstanding academic achievement. This unique two-in-one society operates within the American Institute of Physics, an umbrella organization for ten other professional science societies.

Vernier Science Education

Booth 1,2
613979 SW Millikan Way
Beaverton, OR 97005
888-837-6437, www.vernier.com

For more than 40 years, we have empowered educators like you with world-class data-collection technology and innovative experiments. Your passion and dedication, along with the implementation of high-quality sensors, experiments, and resources in your classroom or laboratory, enable your students to explore science in new ways. Our mission is to provide you with the tools you need to encourage scientific curiosity in all students. See what partnering with us can do.

Exhibit Hall – Atrium Ballroom



Every effort has been made to ensure the accuracy of all information contained on this floor plan. However, no warranties, either expressed or implied are made with respect to this floor plan. If the location of building columns, utilities or other architectural components of the facility is a consideration in the construction of an exhibit, it is the sole responsibility of the exhibitor to physically inspect the facility to verify all dimensions and locations.

AAPT Winter Meeting 2023

1/14/2023 - 1/16/2023

Facility: Hilton Portland Downtown	Drawn By: Lopez, Amanda
City & State: Portland, OR	Show Number: 13034_23
Room Location: Atrium Ballroom	Revised: 1/3/2023 3:55pm
A.E. Kris Johnson	Drawing File: 13034_23 AAPT Winter Mtg_r7.dwg

Legend:

Atrium Ballroom as of 01/03/2023

Dimension	Qty
10'x10'	7
10'x20'	2
20'x20'	1
Totals:	10

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Saturday, January 14, 2023 1–5 p.m. PST

Fun, Engaging, Effective, Research-Validated Lab Activities and Demos for Introductory University, College and High School Physics (including Virtual Learning Options}

Participants in this workshop will have hands-on experience with the research-validated active learning introductory labs, RealTime Physics (RTP) which make extensive use of computer-based tools and video analysis. These labs have been used effectively in college, university and high school introductory physics courses. Participants will also experience Interactive Lecture Demonstrations (ILDs)-a strategy for making learning in lectures more active and effective. These active learning approaches are fun, engaging and validated by physics education research (PER). Participants will also work with adaptations of these materials for distance and virtual learning. Modules from the Third Edition of RTP and links to online materials will be distributed. Note that while this workshop will be held at Vernier Science and Technology (easily accessible by light rail* from downtown Portland) it is a pedagogical not a commercial workshop. There will be a brief "happy hour" at the end of the workshop. Registration is required.

Organizer(s}: David Sokoloff and Ron Thornton

Location: Vernier Science Education

Effective Undergraduate Departments: Curriculum, Cohesion, and Career Pathways

This interactive workshop will be focused around effective practices in creating healthy undergraduate physics and astronomy departments and classrooms. As departments aim to build thriving undergraduate programs, developing course sequences and environments that both serve and recruit undergraduates for a broad array of career outcomes is vital for a successful department. Advising, course sequences, and undergraduate clubs can be tools that serve students aiming for both graduate school and careers. This interactive workshop will focus on the identification of departmental goals, discussions around implementation, and establishing pathways for change.

Topics will also include recent community reports and data, curriculum development, student/faculty cohesion, alumni, and career pathways in 2023. Registration is required.

Organizer(s): Brad Conrad

Location: Hilton Hotel Studio Suite

PICUP: Integrating Computation in Introductory Physics Courses

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. PLEASE BRING A LAPTOP COMPUTER. In this workshop, we will focus on computational activities using spreadsheets and web-based "Trinkets" so you do not need to have any specialized software installed. This workshop is supported by OPTYCs, The Organization for Physics at Two-Year Colleges (NSF-DUE-2212807). Registration required.

Organizer(s): Larry Engelhardt, Aaron Titus, and Tony Musumba

Location: Hilton Hotel Directors Suite

Sunday, January 15, 2023 8 a.m.–12 p.m. PST

Modern Eddington Experiment

It is not too late to start preparations for performing the Modern Eddington Experiment (MEE) with your students in April 2024. Portland Community College (PCC) students were the first students ever to have measured the curvature of space by successfully determining the Einstein Coefficient during the 2017 eclipse. Now, PCC has as many as seven teams for the MEE and is looking for many more, since twelve teams can perform the experiment at 8000' elevation in the central Mexican arid plateau between Mazatlan and Durango with the cooperation of the El Salto Technological Institute. As many as 12 more teams can perform the experiment in Southern Texas, so attending this workshop will enable you to proceed with preparations. The workshop will cover the required equipment, initial preparations and calibrations, the procedures during the eclipse period of five days and four nights at a resort compound, and post eclipse data processing. Grants will be discussed which may allow you to purchase the needed equipment and fund the travel for you and your students to the research site in Mexico, a site that is exactly on centerline at the point of maximum eclipse. The equipment to be used in 2024 will be at the workshop for some hands-on practice with one of the world's greatest amateur astronomers, Mr. Richard Berry. If you have your own experiment that you would like to perform an experiment with us at the Mexican or Texan research site, please join us in this workshop and describe your ideas to the group. You too can join us in Mexico on April 8, 2024 by attending this workshop. Registration required.

Organizer(s): William A. Dittrich

Location: Portland Community College

Neutrino Physics Masterclasses

More than 13000 students from over 60 countries gather at a nearby lab or university each year in order to become "particle physicists" for a day by participating in a particle physics masterclass. In these masterclasses, students work directly with physicists to analyze real data from one of several particle physics experiments. This workshop will focus on masterclasses that feature data from MINERvA and NOvA, both neutrino experiments based at Fermilab. Participants will alternate between "student mode" and "teacher mode" in this workshop and will get a chance to analyze some particle physics data themselves. In addition, we will go through some of the standards-based classroom activities that prepare students for the masterclass, and connect introductory physics topics to contemporary physics research. Please bring along a laptop! Registration required.

Organizer(s): Shane Wood

Location: Portland Community College

Physics in an Astronomy Context: NASA HEAT Resources for High School and College

Join this fully reimbursable workshop to engage in integrated activities appropriate for high school and introductory college physics and astronomy teachers who want to teach with integration and authentic NASA data. Attendees will use resources developed and tested by physics and astronomy education researchers through the NASA Heliophysics Education Activation Team, including labs, lecture tutorials, clicker questions, and diagnostic assessments. These materials address topics that integrate Physics, Earth Science, and Space Science, including (but not limited to) (1) coronal mass ejection videos to understand both simple mechanics as well as accelerations of relativistic particles, (2) sunspot data to understand period and frequency, (3) eclipses to understand geometric optics, and (4) smartphone magnetic field sensors to understand planetary magnetism. (This workshop is fully funded by a NASA Grant/Cooperative Agreement Number 80NSSC22K1071 awarded to AAPT. Participants who complete the workshop may seek full reimbursement of their workshop registration fee.) Registration required.

Organizer(s): Janelle Bailey, Brad Ambrose, Ximena Cid, Darsa Donelan, and Shannon Willoughby

Location: Portland Community College

Teaching Collaborative Mathematical Modeling in VR with NOMR (Novel Observations in Mixed Reality) Labs

Participants in this session will learn about incorporating virtual reality (VR) technology into the physics laboratory. This application of VR is based on the Investigative Science Learning Environment (ISLE), and focuses specifically on creating opportunities for students to test and generate new hypotheses associated with particle interactions. Participants will engage in activities the way students do, starting with a testing experiment of Coulomb's Law and moving into hypothesis-generating experiments with exotic matter that obeys known laws of physics, plus a few more. These activities facilitate students' engagement in the process of mathematical modeling of additional laws the particles obey in the VR space. Participants will learn to leverage VR technology to provide opportunities for students to be immersed in a complete cycle of quantitative hypothesis generation, testing, and revision. VR is used in this context for its appeal to students' familiarity with game play, specifically targeting the learning outcomes identified by the AAPT Lab Guidelines and the Science and Engineering Practices of the Next Generation Science Standards. Registration required.

Organizer(s): Jared Canright and Suzanne White Brahmia

Location:Portland Community College

The Patterns Approach: Kick Starting Students Inquiry and Mathematical Modeling Skills so Experiments Drive Their Learning

Experience how we model, guide, step-aside to scaffold student talk to be the primary driver of student learning as students conduct experiments, mathematical modeling systems, argue from evidence (CERs), and explicitly compare and contrast low evidence predictions with data-informed predictions of the real world. We will introduce the anchoring experiments that contextualize four common patterns in physics and kick start student inquiry and mathematical modeling skills. At the end of the workshop, the full year of collaboratively developed Patterns Physics, NGSS aligned, student centered curriculum that meaningfully integrates across the STEM disciplines will be shared. Registration required.

Organizer(s): Bradford Hill and Stephen Scannell

Location: Portland Community College

WebVPython for Non-beginners: Integrating Coding in the Classroom

Over the last few years, there has been a push to integrate computational modeling in the introductory physics curriculum. This is a workshop for instructors with some general experience in coding. Participants will practice with codes in WebVPython (also known as GlowScript) that demonstrate physics principles ranging from conceptual to calculus-based level. Participants will develop activities for classroom students that could start with simple working codes, where physical modelling is then incrementally added through guided steps. Further examples of classroom utilization of coding will be provided, and a discussion on the frequency of integration of computational methods in the classroom will be promoted. Participants are asked to bring their own laptops and to create an account in webvpython.org before arrival. This workshop is proudly supported by the Organization of Physics in Two Year Colleges, OPTYCs.z. Registration required.

Organizer(s): Joe Heafner, Kris Lui, Tom O'Kuma

Location: Portland Community College

Note: This workshop is supported by OPTYCs, The Organization for Physics at Two-Year Colleges, which is funded by NSF-DUE-2212807. TYC participants can be reimbursed for the workshop fee and are eligible for travel reimbursements through OPTYCs.

SPS Undergraduate Poster Session

Saturday, Jan. 14, 7:30–9:30 p.m. Moderator: Brad Conrad Sponsor: AAPT Atrium

SPS01 (7:30 to 9:30 PM) | Poster | Neutron Studies in Preparation for the 2024 Total Solar Eclipse

Presenting Author: Hope Holte, St. Catherine University

Co-presenting Authors: Kaitlyn Blair, Zoe Sternberg, and Anisa Tapper, St. Catherine University

The St. Catherine University helium-filled High Altitude Ballooning (HAB) team plans to investigate uncharged and charged particles from cosmic ray showers in the near-space environment during the 2024 total solar eclipse. Cosmic rays collide with atmospheric particles resulting in a collision cascade where a portion of the collision products are neutrons created in the stratospheric region. A personal neutron dosimeter (PND) will be used to quantify neutrons through the appearance of bubbles as a result of neutron interaction with a liquid substrate, Freon-12. The 2024 total solar eclipse flight will consist of two payloads with two PNDs, a heater circuit, Geiger – Müller (GM) tubes, GPS, and a GoPro® camera in each payload. The summer of 2022 was used by the team to refine the data collection methods and the set up of the payloads including lighting and positioning of the instrumentation.

Session A1: Astronomy Education Research Broadway III/IV

Sunday, Jan. 15, 10:30 a.m.–12:20 p.m. Moderator: Janelle Bailey Sponsor: Committee on Space Science and Astronomy

A1-01 (10:30 to 11:00 AM) | Research at Your Fingertips: An Online CURE for Astronomy Majors

Presenting Author: Molly Simon, Arizona State University

Additional Authors: Heather Hewitt, Chris Mead, Grace Haverstock, and Ariel Anbar, Arizona State University

There has been a tremendous shift towards online learning over the past two decades. At the crux of this shift is the desire to make higher education accessible to a more diverse population of students for whom commuting to a physical campus is unfeasible. In the summer of 2020, Arizona State University introduced the nation's first online bachelor's degree program in Astronomical and Planetary Sciences (hereafter, the APS program). To provide online students in the APS program with research opportunities equivalent to those accessible to their in-person peers, we developed the first online course-based undergraduate research experience (CURE) for astronomy majors. In this talk, I will discuss the development of our exoplanet-based CURE. I will also present preliminary results from the first semester of the CURE, and discuss impacts on students' content comprehension, research literacy, and sense of belonging.

A1-02 (11:00 to 11:30 AM) | Space for All: International Astronomy Education Efforts

Presenting Author: Christine Hirst Bernhardt, University of Maryland

Additional Author | Janelle M. Bailey, Temple University

Existing research in astronomy education is largely centered on undergraduates. A qualitative astronomy education survey in international K-12 formal education has never been completed prior to now. This project will inform future studies and collaborations between educators and researchers, and provide examples of astronomy integrations in coursework and community. Our methods included online surveys (N=66) and interviews with select participants to discover the methods of learning and teaching in K-12 classrooms. Our data informed comparisons and case studies of international astronomy education efforts in both community and formal education settings. This, along with the ongoing work of Salimpour and Fitzgerald, can provide multinational curricular and pedagogical examples of leveraging astronomy as a "science gateway" and inform interdisciplinary/transdisciplinary approaches to teaching science. Numerous countries are developing frameworks based upon the Next Generation Science Standards, and investigating how teachers implement these frameworks can in return inform instruction within the US.

A1-03 (11:30 to 11:40 AM) | Contributed | Eclipses Across Physics Disciplines

Presenting Author: Michael Fortner, Beloit College

The study of eclipses is as old as astronomy. However, eclipses can be used to motivate a number of areas of physics beyond astronomy, including dynamics, optics, thermodynamics, and relativity. The visual spectacle of an eclipse makes the topic more meaningful to the student. The annular eclipse in 2023 and total solar eclipse in 2024 both cross the US and provide a natural tie to use eclipses as part of physics education. For schools lucky eneough to be in the direct path of either eclipse, that tie is even stronger.

I've personally been in the Moon's shadow for five total solar eclipses, one annular eclipse and many partial solar eclipses, and I've enjoyed the many times I've caught Earth's shadow on the Moon.

A1-04 (11:40 to 11:50 AM) | Contributed | 9 Solar System Myths You Might Actually Believe In

Presenting Author: James Lincoln, SCAAPT.org

In the process of learning about the solar system, we are all subject to forming our own (often incorrect) opinions because there is little opportunity for direct observation. s to questions that no one is around to answer. Some of these myths are well-known and well-published, others are subtle, and you may not have even realized that you believe it them. Yet, the most concerning type of myths are the ones you might be teaching to your students! Together we will find the answers, I welcome suggestions for other myths you may have discovered in this ongoing project.

A1-05 (11:50 to 12:00 PM) | Contributed | Promoting Student Inquiry Using WorldWide Telescope

Presenting Author: Aaron Lee, Saint Mary's College of California

Introductory astronomy courses continue to remain popular at the university level, particularly with students satisfying broader education requirements. As many students' terminal science course, these classes may be the last formal opportunity to develop an appreciation for the scientific process. Increasing appreciation and overall scientific literacy requires that students are capable of seeing themselves "doing" science and not viewing the subject as understandable only by a privileged few. However, accessible and engaging laboratory activities for non-majors that utilize real astronomical data remain wanting. I describe three lab activities that use the freely-available WorldWide Telescope software. Students use WorldWide Telescope to perform real scientific experiments by asking questions, collecting data, and reaching evidence-based conclusions on topics related to the phases of the Moon, electromagnetic radiation, and retrograde motion. Students are ultimately responsible for conducting their own investigations and leave with higher confidence in their own ability to understand science-related topics.

Session A2: Digital Ideas for Mechanics and Upper Division Sunday, Jan. 15, 10:30 a.m.–12:20 p.m. Broadway I/II

Moderator: Jay Wang Sponsors: Committee on Educational Technologies, Committee on Contemporary Physics

A2-01 (10:30 to 10:40 AM) | Contributed | Acceleration in Free Fall Spark Train Audio Analysis

Presenting Author: Duncan Carlsmith, University of Wisconsin-Madison, Dept. of Physics

Mobile phone audio recordings of a 60-cycle triggered spark generator used in an acceleration in free-fall experiment are examined to determine the local line frequency. Spark times are identified and the mean time between sparks is found using peak finding and autocorrelation. This analysis can introduce several signal processing techniques to first-year physics students with access to a computational environment.

A2-02 (10:40 to 10:50 AM) | Contributed | Computational and Experimental Methods to Introduce and Analyze Air Resistance

Presenting Author: Larry Engelhardt, Francis Marion University

I will discuss assignments, activities, and experiments that I use in introductory classes to introduce the effects of air resistance. In introductory mechanics, I assign homework problems where students use a glowscript simulation to explore the effect of air resistance. For these problems, students generate numerical results from the simulation that they submit into their online homework system for automatic grading. In the associated lab, students use video analysis to observe the effect of air resistance on a lightweight ball tossed straight up. They are able to observe the change in direction of the drag force, and the v-squared proportionality of the drag force. In my sophomore-level computational methods course, students create simulations that explore the effect of air resistance using models of increasing complexity, starting with no drag force, and ending with a model that includes varying air density and drag coefficient – calculated from the Reynolds number.

A2-03 (10:50 to 11:00 AM) | Contributed | Bringing Ternary Energy Diagrams into the Mainstream

Presenting Author: Bob Brazzle, Jefferson College

A ternary energy diagram is a powerful tool for computational physics, used to model systems with energy distributed among three or more forms. Unlike an energy bar chart, a single ternary energy diagram can be packed with thousands of individual energy distributions, and can thus uniquely show how a system's energy distribution evolves at the finest scales of time or position changes. However, students won't be able to fully realize the diagram's value as a learning tool unless it starts gaining more widespread use. In this talk, I'll describe four tools that can now be used to generate ternary energy diagrams. All these use standard, readily-available software: Excel, Glowscript, Desmos and Jupyter Notebook. I'll show the computational simulations we develop in my Introductory Physics lab: 1) projectile with air resistance, 2) mass on a vertical spring, 3) solids rolling down an incline, and 4) an RLC circuit.

A2-04 (11:00 to 11:10 AM) | Contributed | RelativityLand

Presenting Author: Randall Smith, Oracle Labs

RelativityLand is a 2-D interactive simulation environment based on Lorentzian spacetime. It is an "as measured" or "map" representation, and so (intentionally) leaves out effects of light delay. We believe RelativityLand is the only such environment to include the Thomas rotation effect that results from successive non-linear boosts, making it suitable as an exploratory environment for more advanced students of special relativity.

RelativityLand is an open, exploratory environment, in which students can modify and combine objects as the world runs. The user will find in-world tools sufficient for making various kinds of measurements, and can construct, then immediately experience various scenarios such as settings for famous paradoxes. RelativityLand will run in any browser and is freely available through Oracle Academy. The associated OA workshop includes videos, slides, and several simulation "lab" settings to comprise a instructor's construction kit for a unit on relativity. The presentation will include a live demonstration.

A2-05 (11:10 to 11:20 AM) | Contributed | Newtonian Momentum Conservation Related to the 3-D Metric

Presenting Author: Clinton Lewis, West Valley College (retired)

Conservation of momentum, or non-conservation, can be examined in any coordinate system with external forces applied to the particles using Lagrangian mechanics.

A2-06 (11:20 to 11:30 AM) | Contributed | Quickly Demonstrate the Power of Lagrangian Mechanics

Presenting Author: Clinton Lewis, West Valley College (retired)

The power of Lagrangian mechanics remains clear without using the mathematical tools of the calculus of variation. Using Newton's F=ma as an example, the student will quickly see the connection between the Lagrangian and the equation of motion. A simpler approach may allow earlier introduction of these tools in the Physics curriculum.

A2-07 (11:30 to 11:40 AM) | Contributed | Roles of External Representations in Upper-Division Electrostatics Problem-Solving

Presenting Author: Jonathan Alfson, Oregon State University

Additional Author | Paul J. Emigh, Oregon State University

Additional Author | Elizabeth Gire, Oregon State University

Using a variety of external representations is an effective pedagogical approach that can also lead to deeper student understanding of these representations. We will present the results of studying a small-group classroom activity that includes several external representations (a pre-programmed Mathematica notebook, a tabletop whiteboard, and a 3D plastic graph), which each had some feature that was generated by the students themselves. We discuss how these external representations supported the students' efforts in analyzing the electric potential due to collections of point charges. Our analysis suggests that there are unique benefits to the use of these external representations, and that some of these benefits differ between the representations. We found particularly interesting effects on student reasoning due to the incremental nature of generating these representations, as well as the ways the students connected between representations.

A2-08 (11:40 to 11:50 AM) | Contributed | Teaching and Learning Physics with Alogrithmics

Presenting Author: Emmanuel Ngijoi-Yogo, Waynesburg University

Algorithms have been used to help students develop problem-solving skills in Physics at the collegiate level. This presentation will mostly focus on the 2nd Law of Motion.

Session A3: Geophysics of the Pacific Northwest Sunday, Jan. 15, 10:30 a.m.–12:30 p.m.

Moderator: Randall Knight Sponsor: Committee on the Interests of Senior Physicists Pavillion West

A3-01 (10:30 to 11:00 AM) | Why are There Volcanoes in the Cascade Range?

Presenting Author: Adam Kent, College of Earth, Ocean, and Atmospheric Sciences Oregon State University

The volcanoes in the Cascade Range are an inevitable product of the plate tectonic process of subduction – where an oceanic tectonic plate is pushed beneath the continental North American plate. The oceanic plate warms and dehydrates, releasing aqueous fluids which trigger partial melting. Melts are buoyant and ascend through the crust to form volcanoes like Mount St Helens, Mount Hood, Mount Rainier, and many others. Eruption of volcanoes at the Earth's surface can be highly energetic – mostly due to release of thermal, gravitational or chemical potential energy, and leads to a range of volcanic phenomena such as relatively placid lava flows and lava domes, through to explosive eruptions that can disperse volcanic material for many 1000s of kilometers. To understand the behavior of volcanoes and associated hazards, volcanologists rely heavily on knowledge of the physical and chemical processes that occur during the production, evolution and eruption of magma.

A3-02 (11:00 to 11:30 AM) | Earthquakes and Shaking in the Pacific Northwest

Presenting Author: Valerie Sahakian, University of Oregon

Additional Author | Pieter-Ewald Share, College of Earth, Ocean, and Atmospheric Sciences, Oregon State University

Additional Author | Diego Melgar Moctezuma, University of Oregon

Underneath our feet in the Pacific Northwest (PNW), a slow battle rages on between tectonic plates in the Cascadia Subduction Zone. Dense oceanic crust sinks where it meets buoyant continental crust, generating a buildup of forces between and inside the plates. From these forces, a host of earthquakes are born, including large earthquakes. Once the stresses surpass the crust's strength, it begins to break ("rupture"), generating seismic waves. The physics of how the fault ruptures plays a key role in how strong shaking is once the seismic waves reach the Earth's surface. Together, the strength and likelihood of shaking define seismic hazard, and affect how we build a more earthquake resilient society. I'll present some background on the types of earthquakes we experience, how we know that we can have large earthquakes, will discuss what we know about shaking in the region, and what that means for our daily life.

A3-03 (11:30 to 12:00 PM) | Real Time Observations of the Northeast Pacific Coastal Ocean

Presenting Author: Edward Dever, Oregon State University

The coastal ocean off Oregon and Washington is one of the best-observed pieces of ocean real estate in the world. Networks of ocean sensors funded by the National Science Foundation (NSF), National Oceanic and Atmospheric Administration, and state, tribal, and other organizations make data available to researchers, educators, policy-makers, and the public. I work with the NSF Ocean Observatories Initiative (OOI) coastal Endurance Array. The Endurance Array is designed to make long-term observations of fundamental scientific and societally relevant processes including ocean heat waves, hypoxia, and ocean acidification. Measurements include physical processes (ocean velocity, temperature, and salinity), optics, and acoustics. They are made available in real time through the OOI Data Explorer, a portal which allows plotting and download of data. I will describe some interesting features of these measurements and how to access them for use in the classroom or to satisfy your own curiosity.

A3-04 (12:00 to 12:30 PM) | Terroir of the Willamette Valley: Geology, Soil, Climate, and Wine

Presenting Author: Scott Burns

Terroir is a French term that is over 400 years old and was used to describe why wines of one area tasted different from wines of another area, even though they were the same variety. It is the "taste of the place". It is determined by the geology, soil, climate and soil biota. One of the greatest places in the world to taste differences in terroir is the Willamette Valley (wine region of the year for the whole world for 2017 – Wine Enthusiast). The valley grows primarily cool climate grapes like pinot noir, pinot gris, chardonnay, riesling, Muller-Thurgau, and gewurtztraminer. Terroir is best expressed in cool climate grapes like the thin skinned red grape, pinot noir. There are four main geological units, three of which are the main wine producing soils: volcanic soils (Columbia River Basalts and the Jory Soil), marine sediments (sandstones and shales and the Willakenzie

Soil). Terroir is a French term used to describe why wines of one area taste different from the same varieties of wines in another. It is the "taste of the place". It is determined by the geology, soil, climate, and soil biota. One of the greatest places in the world to taste differences in terroir is Oregon's Willamette Valley. Terroir is best expressed in cool climate grapes such as pinot noir. There are four main geological units: volcanic soils (Columbia River Basalts and the Jory Soil), marine sediments (sandstones and shales and Willakenzie Soil), volcanic soils with old silt mixed in (Laurelwood Soil) and the lesser used Missoula Flood deposits (Woodburn Soil). The same winemaker can produce three different wines in the same year with similar clones if different soils are used. Learn how to be an educated wine taster in Oregon by attending this talk.

Session A4: Ideas for and Analysis of Remote Learning post-COVID Sunday, Jan. 15, 10:30 a.m.–12:20 p.m.

Moderator: TBA Sponsor: AAPT Galleria North

A4-01 (10:30 to 10:40 AM) | Contributed | Using Digital Resources to Benefit In Class Experiences Post-COVID

Presenting Author: Aaron Debbink, Indian Hill High School

The digital resources created during the COVID years can be used effectively to serve students both inside and outside the classroom post-COVID. In the classroom, digital resources can be used to "flip the classroom" to have students watch and take notes of small lectures for homework. This opens up more class time for students to collaborate in small group problem-solving and laboratory investigations. The digital resources can also replace some content delivery during class, allowing individual students or small groups to move at their own pace, and allowing the teacher to work with an individual or small group of students who need extra support. Additionally, the digital resources can be used for absent students who miss a lecture or part of a multi-day investigative lab. Digital resources can include separate videos for pre-lab discussions, data collection, conclusion discussions, and lectures.

A4-02 (10:40 to 10:50 AM) | Contributed | Essential Skills – Doing Digital Offline!

Presenting Author: Derek Fish, Unizulu Science Centre

Unizulu Science Centre (USC) in South Africa, has presented live school science workshops for 25 years to 200 000 students. The 2020 lockdown saw schools closed and many institutions around the world went online, making digital content available through the internet. Few of the rural schools in which USC works have reliable internet so this route was not possible. Thus a 4 hour contact workshop was converted into 16 one-hour videos, highlighting the essential skills needed for the physics exam paper. These videos were physically distributed on memory sticks to teachers, along with an accompanying workbook. Industry funding and SA Institute of Physics support has now enabled 80 000 students all across SA to use these resources. While this project was aimed at matric (final year of school) students, it would work well in a tertiary setting and valuable lessons learnt in the process will be shared.

A4-03 (10:50 to 11:00 AM) | Contributed | Impact of Online Instruction Due To COVID-19 On Student Learning

Presenting Author: Taylor GurrEithun, University of Washington - Seattle

Additional Author | Peter Shaffer, University of Washington - Seattle

The COVID-19 pandemic led to many schools teaching online. This had a significant impact on the ways in which students studied physics at the university and high school levels. For example, in the introductory sequence at the University of Washington, lectures, tutorials, and labs were administered entirely online. Later in the pandemic, students coming to this sequence had received online instruction in high school. We are interested in the impact on student learning. Results from pretests administered after lecture instruction are presented that allow us to probe the learning and teaching of physics throughout the pandemic.

A4-05 (11:10 to 11:20 AM) | Contributed | Teaching Introductory Physics Labs Remotely Using iOlab

Presenting Author: David Wisbey, Saint Louis University

While there is much controversy around the idea of teaching experiential physics labs at home, Dr. Wisbey will demonstrate how they can be done effectively. Dr. Wisbey will share what he learned while using techniques developed during the pandemic. By effective use of Zoom and the iOlab sensor package, students where not only able to complete labs remotely, but they could also work in groups. This allowed students to complete a battery of physics I labs at home, completing the experiment themselves. Dr. Wisbey compares this to physics labs where students observed the experiment on video and could only analyze data collected previously by someone else. While in person learning is the preferred method for students and instructors, Dr. Wisbey demonstrates safe and effective ways for students to complete introductory level physics labs at home.

A4-06 (11:20 to 11:30 AM) | Contributed | Flipped Classroom College Physics Courses in 7 Weeks

Presenting Author: Kim Arvidsson, Schreiner University

At a small university with small class sizes (about 20), the introductory College Physics I (non-calculus based) and University Physics I (calculus based) were redesigned to fit in courses that only lasts 7 weeks. The courses adopted a flipped classroom model where homework was due online before class started almost every day. Maximum in-class time was spent on reviewing the homework problems the students had already seen. The student learning outcomes were redesigned so that they correspond to a general method of breaking down a physics problem, and the students were required to submit homework that aligned with the learning outcomes. Exams were then evaluated in the exact same way. Students showed a significant improvement in adhering to the student learning outcomes and solving physics problems.

A4-04 (11:30 to 11:40 AM) | Contributed | Replacing Pre-class Textbook Readings with Videos

Presenting Author: Paul Emigh, Oregon State University

Traditional textbooks have historically been viewed as an important component in students' learning of introductory physics, especially as part of the work that students are expected to complete before attending class. However, many students either dislike physics textbooks, or do not know how to learn from them, and in practice many students do not follow through on assigned readings. We discuss an effort, during emergency remote instruction, to transition students pre-class assignments from textbook readings to videos, in the hope of achieving both greater participation and greater learning from the assignments. We highlight the design principles behind the videos, the constraints and challenges we faced in making them, and our hopes to improve upon the videos in an effort to make them more widely available.

Session A5: Teaching the IPLS Course

Sunday, Jan. 15, Pavillion East

10:30 a.m.–12:30 p.m. Moderator: Juan Burciaga Sponsor: Committee on Physics in Undergraduate Education

A5-01 (10:30 to 11:00 AM) | Medical Physics as a Tool for Classroom Engagement

Presenting Author: Jessica Fagerstrom, Northwest Medical Physics Center

Physics education research has indicated that students who perceive curricula as relating to real life applications are more engaged with learning materials, and medical physics may provide an absorbing anchoring context. Medical physics is an evolving and expanding field in which concepts in physics and engineering are applied to challenges in medicine. Medical physicists perform critical job functions in healthcare every day, but many physics students complete their entire course of study without learning about the existence of the field. Medical physics, as an applied science, offers an abundance of real-world examples for wide ranging concepts in physics courses. For example, an introductory unit on basic concepts in nuclear physics could be brought to life by a discussion of radioisotopes and positron emission tomography (PET) imaging. Students learning about electromagnetic radiation may bolster their engagement by learning about radiation therapy used to ablate lung tumors.

A5-02 (11:00 to 11:30 AM) | Careers in Medical Physics

Presenting Author: Krista Burton, Northwest Medical Physics Center

Working in the field of medical physics can take many different forms, with careers including regulatory, industry, clinical, research, and/or teaching responsibilities. Medical physicists work in a variety of specializations, including health physics, imaging science, nuclear medicine, and therapy radiation physics. Depending on their specialty, a day in the life of a medical physicist may involve calculating the thickness of concrete shielding required for a proton therapy vault, modeling the radiobiological effects of various radioisotopes, using machine learning to improve computer-aided diagnosis of disease, or acquiring linear accelerator data with a high-precision water tank. The American Association of Physicists in Medicine (AAPM), an AAPT affiliated organization, offers resources for educators interested in discussing a real-world career field for students who hope to help patients while pursuing a career in physics.

A5-03 (11:30 AM to 12:00 PM) | Physics at the Molecular and Cellular Level (P@MCL)

Presenting Author: Lisa Lapidus, Michigan State University

In 2016, Michigan State University began a pilot of a new curriculum of introductory physics for life scientists. Because biology-related applications on the macroscale are complex and require mathematics beyond introductory calculus, the focus is entirely on applications from molecular and cellular biology. Topics that are more relevant for engineering have been removed and topics relevant to biology have been added. The curriculum is designed around two main themes, diffusion and electric dipoles. Diffusion illustrates the concepts of conservation of momentum and energy and provides the framework for introducing entropy from the perspective of statistical mechanics. Electric dipoles illustrate the basic concepts of electromagnetic theory and provides the framework for understanding light waves and light interactions with biomolecules. These themes are supported by small computational activities to help students understand the physics without advanced mathematics. Currently the curriculum is offered to ~800 students per semester.

A5-04 (12:00 to 12:10 PM) | Contributed | Utilizing Our Bodily Senses to Enhance Learning Physics

Presenting Author: Tennille Presley, Winston-Salem State University

The most common senses of the human body are sight, smell, taste, touch, and hearing; however, the body can also respond to various stimuli such as imbalance, pain, and temperature. Our five senses are instrumental in explaining the way in which mechanics and energy play an instrumental role in how the body works. From the human mind to the body's movement and tempo, the way in which physics and biology integrate is unwavering. Considering that the body is one large electrical circuit, the intricate nature of how nerve impulses send signals through the body defines the distinct nature in which the five senses exist. In this presentation, a view of how sensory aspects of biophysics are utilized in everyday life will be addressed.

A5-05 (12:10 to 12:20 PM) | Poster | Teaching an IPLS Class? NEXUS/Physics Can Help

Presenting Author: Edward Redish, University of Maryland

Making the transition from a general algebra-based physics class to one specifically oriented towards life-science majors and pre-health care students? NEXUS/Physics [1] can help. We provide a wide variety of materials and activities, both free for downloading and in reasonably priced commercial contexts. The class assumes students have had the equivalent of high school biology, chemistry, algebra and trig (though calculus concepts are not shied away from and are introduced using algebraic and geometric tools as needed) so connections to the life sciences can be stressed throughout. Our materials include readings, problems, and group-learning activities that help students learn scientific thinking skills stressed by the biology and medical communities [2] including learning to think with symbolic math [3], modeling, and synthesis. Our materials can help you add topics identified as high priority physics for the MCAT [4] including dimensional analysis, fluid dynamics, and free energy.

[1] E. F. Redish, et al., NEXUS/Physics: An interdisciplinary repurposing of physics for biologists, Am. J. Phys. 82:5 (2014) 368-377. doi: 10.1119/1.4870386
[2] E. F. Redish, Using math in physics - Overview, The Physics Teacher, 59 (2021) 314-318.
doi: 0.1119/5.0021129
[3] HHMI-AAMC, Scientific Foundations for Future Physicians (2009); AAAS, Vision and change in undergraduate biology education: a call to action (2011)
[4] MR5: Ratings of the Importance of Topics in the Natural Sciences, Research Methods, Statistics, and Behavioral Sciences to Success in Medical School (AAMC, 2010). (https://www.aamc.org/students/download/262820/data/ugsnsreport.pdf)

A5-06 (12:20 to 12:30 PM) | Poster | Pre-meds vs. Pre-PTs in Separate IPLS Courses

Presenting Author: Nancy Beverly, Mercy College

Our institution has recently created two separate Introductory for Life Science (IPLS) courses – one calculus-based (taken primarily by pre-meds) and the other algebra-based (taken primarily by pre-physical therapists). These courses diverged in content depth, coverage, and focus due to the differences in academic background, future preparation needs, interests and attitudes of these two populations. A comparison of the two courses, the students in them, and the resulting pedagogy will be presented,

Session A6: What PER Tells us About Physics Learning Sunday, Jan. 15, Galleria South

10:30 a.m.–12:20 p.m. Moderator: TBA Sponsor: Committee on Research in Physics Education

A6-01 (10:30 to 10:40 AM) | Contributed | Investigating Students' Perceptions of How Instruction Impacts Their Ideas*

Presenting Author: Anne Alesandrini, University of Washington Seattle
Additional Author | Clausell Mathis, Michigan State University
Additional Author | Paula RL Heron, University of Washington Seattle
Additional Author | Amy D. Robertson, Seattle Pacific University

As instructors, we are interested in the many ways our instruction impacts students. Researchers have provided instruments to measure different aspects of the impact of introductory physics instruction on students. This talk describes our process of developing a tool to assess students' perceptions of and feelings about the interaction between their ideas and instruction. We define categories of idea change based on students' own descriptions, so that students can self-report how they experience instruction impacting their ideas. Our goal is to have a tool that can be easily administered and used to evaluate student experience across different types of instruction. In assessing how students experience their ideas changing, we hope to be better equipped to create instruction where students feel their ideas matter.
*Supported in part by NSF DUE-1914572

A6-02 (10:40 to 10:50 AM) | Contributed | Student Identity Modulates Calculus Proficiency and Calculus Self-efficacy

Presenting Author: Christopher Fischer, University of Kansas
Additional Author | Sarah LeGresley, University of Kansas
Additional Author | Jennifer J Delgado, University of Kansas

We assessed changes in calculus proficiency and calculus self-efficacy during both semesters of introductory physics. While all students demonstrated an increase in calculus proficiency, including a possible improvement in calculus transfer to physics, women displayed larger gains than men. Conversely, men showed larger gains in calculus self-efficacy. When combined, these data suggest that student identity can modulate the correlation between a student's calculus abilities and their perception or self-evaluation of those abilities. These data highlight a potential contributing factor to gender-related differences in physics self-efficacy as well as the complexity of addressing those differences.

A6-03 (10:50 to 11:00 AM) | Contributed | Posing a Thought Experiment as a Science-specific Formative Assessment Strategy

Presenting Author: Jon Owen, Seattle Pacific University
Additional Author | Brynna Hansen, Seattle Pacific University
Additional Author | Lisa M Goodhew, Seattle Pacific University

Conceptual resources theory proposes that teaching should elicit and then refine and connect student ideas. One teaching practice that aligns with this theory is formative assessment, in which instructors pay "genuine, extended attention to the substance of student reasoning," and adapt their teaching accordingly. Education research literature puts forth formative assessment as one of the most effective tools for enriching student understanding in science. However, there are few concrete examples from university-level science classrooms of effective formative assessment strategies. We present an example of formative assessment from a small group discussion about heat and temperature in an introductory, calculus-based physics course. In this example, an instructor proposes a thought experiment that advances students' thinking about heat and temperature. We hypothesize that carefully-chosen thought experiments can build on what students already know, and that posing a thought experiment is a specific strategy for implementing formative assessment in university-level science classrooms.

A6-04 (11:00 to 11:10 AM) | Contributed | Developing Question Sequences to Identify and Remedy Student Reasoning Inconsistencies*

Presenting Author: Kristin Kellar, University of Washington

Additional Author | Paula Heron, University of Washington

Dual process theories of reasoning suggest that humans reason using System 1 (heuristic) and System 2 (analytic) thinking processes. This research aims to develop question sequences that serve two purposes: to identify students with relevant content knowledge who nevertheless relied on System 1 thinking on a "target" question, and to help students recognize reasoning inconsistencies and activate System 2 thinking effectively to override initial incorrect responses. Screening and target questions are used to identify students making reasoning errors, and intervention questions are designed to alert students of the need to reevaluate their reasoning. Students then have an opportunity to re-answer the target question. The cognitive reflection test (1) (CRT) is often used to assess the propensity for cognitive reflection, and student scores on the CRT will be compared to their responses to our questions. Data from recent iterations in calculus-based physics courses at the University of Washington will be discussed.

(1) Frederick, S., J. Econ. Perspect. 19, 2005.

*This study is supported by the National Science Foundation under Grant No. DUE 615418.

A6-05 (11:10 to 11:20 AM) | Contributed | Classification of Sound Conceptions

Presenting Author: Derek Fish, Unizulu Science Centre

An example from rural schools in South Africa will be discussed of student prior conceptions with regard to sound and waves: a brief literature survey will outline pre-existent conceptions noted around the world. The 4 level framework is then used to classify these conceptions and modify them in the light of data gathered. Student responses to a questionnaire provide multiple mode (MCQ, written and drawings) feedback into this process. The result is a modified table of local students' prior conceptions with regard to sound and waves. This is a useful resource when designing (and improving) science shows, exhibits and other programme materials in this area. While the specific example of sound and waves will be the focus of this presentation, suggestions will be made of how this resource can be used in other subject areas.

A6-06 (11:20 to 11:30 AM) | Contributed | Building on Student Resources for Understanding Circuits: A Classroom Example

Presenting Author: Al Snow, University of Washington, Seattle

Additional Author | Amy Robertson, Seattle Pacific University

Additional Author | Lauren Bauman, University of Washington, Seattle

Additional Author | Paula Heron, University of Washington, Seattle

Additional Author | Lisa Goodhew, Seattle Pacific University

Resource theory depicts resources as dynamic, context-dependent "pieces of knowledge" and learning as building from students' resources. Our team developed research-based instructional materials meant to elicit and build on common conceptual resources for understanding circuits. In this talk, we will use a classroom video example to explore the following questions: How do students interact with these tutorials? How do students build on their resources? What features of these tutorials support students in developing their resources?

A6-07 (11:30 to 11:40 AM) | Contributed | Physics Students' Mathematical Environment: Operational Skills, Contextual Understanding, Symbolic Representation*

Presenting Author: David Meltzer, Arizona State University

Additional Author | Dakota H. King, Arizona State University

Additional Author | John D. Byrd, Michigan State University

We will present a perspective on introductory physics students' mathematical difficulties that places operational skills in a broader context, incorporating challenges related to symbol and language difficulties, understanding of context, and self-checking behavior. The mathematical difficulties encountered by physics students are generated and influenced by a broad array of factors, including weak understanding of both mathematical concepts and their interpretation in physical contexts, and mismatches in content and language between mathematics and physics courses. Many students also suffer from insufficiently developed self-checking and self-correcting behavior that can become a persistent obstacle to success with mathematics-intensive subject matter. Our most recent findings reflecting administration of a mathematics diagnostic text will be presented within this broader context, and used to offer perspective on the nature and scope of the challenges students face.

*Supported in part by NSF DUE #1504986 and #1914712

A6-08 (11:40 to 11:50 AM) | Contributed | Examining Student Reasoning about Graphs with Salient, Distracting Features

Presenting Author: Charlotte Zimmerman, University of Washington

Additional Author | Ian Carter, University of Washington

Additional Author | Suzanne White Brahmia, University of Washington

A blending of quantitative reasoning and conceptual knowledge is ubiquitous and essential in physics. One facet of this blended reasoning is making sense of graphical representations. Student facility with graphical representations has been studied in physics education research through multiple lenses, including Dual Process Theory (DPT). In particular, many graphical reasoning items that have been the subject of DPT research include salient distracting features (SDF), which have been shown to cloud the thinker's ability to reason correctly regardless of the content knowledge the thinker holds. In this work, a quantitative study and a qualitative study are used to examine a hypothesis of DPT and student reasoning with SDF in graphing questions. The results suggest that while DPT is helpful in describing student reasoning, there may be more to student reasoning with items that contain SDF than has yet been described.

A6-09 (11:50 AM to 12:00 PM) | Contributed | Do Students Still Sensemake if They are Given the Answer?

Presenting Author: LISA GOODHEW, Seattle Pacific University
Additional Author | Paula R.L. Heron, University of Washington Seattle
Additional Author | Amy D. Robertson, Seattle Pacific University
Additional Author | Rachel E. Scherr, University of Washington Bothell

Active-engagement physics courses often ask students to predict the outcome of an experiment that is expected to surprise many students. The instructional purpose of making a prediction is to support students in recognizing that there is a gap in their understanding, thus catalyzing sensemaking that leads to deeper understanding. Our team has designed introductory physics materials that use the alternative strategy of telling students what happens in an experiment and directing them to explain that outcome. We explore the question: does this alternative strategy miss critical steps in the sensemaking process, or do students recognize gaps in their understanding organically? We observe that asking students to explain the outcome of an experiment often prompts rich conversation in which students do the work of articulating and resolving gaps in their understandings. We illustrate this with an example from a group of introductory physics students discussing electric circuits.

Session A7: How Diversity, Equity, and Inclusion Issues Impact Physics Learning/Teaching Sunday, Jan. 15,

10:30 a.m.–12:20 p.m. Moderator: TBA Sponsor: Committee on Diversity in Physics Skyline II

A7-01 (10:30 to 10:40 AM) | Contributed | Creating Physics and Equity Taxonomies: What Counts as "Physics"?

Presenting Author: Adrian Madsen, Seattle Pacific University
Additional Author | Tra Huynh, Western Washington University
Additional Authors | Lane Seeley, Sarah McKagan, Seattle Pacific University

The Energy and Equity Portal (www.energyandequity.org) is an online community for sharing teaching materials that integrate equity into science teaching. The Portal materials are tagged with physics and equity topics to help teachers characterize their submitted materials and find others' materials. When developing these physics and equity topics, we interrogated what counts as "physics" and sought to broaden our definition by including topics at the intersection of energy and equity in the physics taxonomy. We also developed an equity taxonomy based on the ways equity was integrated into the materials on the Portal and discussed in the project's professional development activities. We tested these new taxonomies in interviews with high school teachers who are part of the projects' professional development, and found that the teachers felt the topics described their materials well. We learned that teachers need pop-ups defining the equity topics and got suggestions for new topics to add.

A7-02 (10:40 to 10:50 AM) | Contributed | EP3 Guide Recommendations for Improving EDI in a Physics Department

Presenting Author: Sarah McKagan, American Physical Society

The Effective Practices for Physics Programs (EP3) Guide (www.ep3guide.org) is a living collection of knowledge and practices to support physics programs with collections of knowledge, experience, and proven good practice for responding to challenges and engaging in systematic improvement. Produced by the American Physical Society, in collaboration with the American Association of Physics Teachers, the EP3 Guide draws from the expertise of hundreds of contributors and reviewers to produce recommendations for how to improve nearly every aspect of your undergraduate physics program. Our section on equity, diversity, and inclusion is a synthesis of contributions and reviews from experts in the physics community and beyond on equity, climate, and issues facing people of color, women, LGBTQ+ people, and disabled people, along with recommendations from key reports and publications. This section provides an extensive collection of recommendations for making your department more equitable and inclusive for members of marginalized groups.

A7-03 (10:50 to 11:00 AM) | Contributed | Sharing the Whole Self in Qualitative Research*

Presenting Author: Xandria Quichocho, Texas State University
Additional Author | Eleanor W Close, Texas State University

Studies that dive into the ways physics students build their physics identity are typically conducted at Predominately White Institutions and focus solely on the physics part, often missing the intersections of gender, sexuality, or race. We invite multiply-marginalized physics students—Black, Indigenous, Women of Color, LGBTQ+ women, including trans women, and genderqueer folks—at Hispanic Serving Institutions to participate in semi-structured interviews about their physics experiences. Participants were asked about their physics environments, and how their social identities relate to their physics identities. Throughout the project we've practiced weaving in decolonization methodologies of research and found that being in right relation with participants opens discussions to be more insightful. The analysis examines the narratives using intersectionality and critical race theory, and found themes of community, recognition, and institutional support appear regularly. In this presentation we will share these findings, as well as methods of developing a human relationship with participants.

*This work has been supported in part by NSF grants DUE-1557405, DUE-1928596

A7-04 (11:00 to 11:10 AM) | Contributed | Connecting Physics to Issues of Equity, Social Justice, and Environmentalism

Presenting Author: Kristine Washburn, Everett Community College

Equity, social justice, and environmentalism are crucial topics. While many feel these deserve intentional presence in our curriculum, most find it difficult to incorporate concepts that seem so distant from Physics in nature. I'll present curriculum work from the past two years where I've augmented typical Physics problems to incorporate various topics related to equity, social justice, and environmentalism. I'll also present student feedback on this curriculum and lessons learned after two years of implementation.

A7-05 (11:10 to 11:20 AM) | Contributed | The Long-Term Impacts of Attending a Low-Income School

Presenting Author: Taylor Overcast, Union University

The issues with today's educational system are multifaceted. There are issues relating to ethnic segregation, socioeconomic segregation, locational issues, and many more; however, the issue of socioeconomic segregation perpetrates several common dividers – gender, ethnicity, and location. Therefore, the long-term impacts of attending a low-income school will be the focus. Specifically, the relationship of a low-income childhood and attending a 4-year institution to study a STEM field will be the focal point of the presentation. The data behind the cyclical nature of poverty, and the impact of parental education level on students' projected education completion will be studied. The additional hardships that low-income students face will be examined – lack of sleep, technology, and extracurriculars. In addition, the impacts of low-income conditions on test scores, teacher retention rates, and college attendance will be explored. Finally, the data of STEM-focused bachelor degrees achieved by low-income students will be presented.

A7-05 (11:20 to 11:30 AM) | Contributed | Aligning Grading with Learning Outcomes through Standards-based Courses

Presenting Author: Anthony Villano, University of Colorado Denver

I will present key features of my journey to convert two upper-level physics courses into a standards-based grading model. I argue that typical grading models for physics courses beyond the introductory level are not well aligned with student learning and are often inequitable. Over 3 years I have re-modeled my approach to Analytical Mechanics and Thermal Physics by using standards-based grading to bring student assessment (grading) into synergy with learning outcomes and provide increased equity by accommodating many modes of learning.

Session A8: PhysTEC and Get The Facts Out: Addressing the Physics Teacher Shortage Sunday, Jan. 15,

10:30 a.m.–12:30 p.m. Moderator: Scott Paulson Sponsor: Committee on Teacher Preparation Grand Ballroom II

A8-01 (10:30 to 11:00 AM) | PhysTEC: Supporting Physics Teacher Education Champions and Programs*

Presenting Author: Michael Wittmann, American Physical Society

The Physics Teacher Education Coalition (PhysTEC), a joint effort by the AAPT and APS, is working to address the severe national shortage of high school physics teachers. Our vision is that every student in the country has the opportunity to take physics from a qualified teacher. In this talk, I summarize our efforts in supporting physics teacher education programs, building community among these programs, and recognizing leaders in teaching and physics teacher preparation. I describe the elements of effective programs, including individual champions of physics teaching, structural support within an institution, and a culture that supports physics teacher education. Some institutions have faced challenges when building and sustaining their teacher education programs, and I describe how they have responded to these challenges. Finally, I describe our vision for expanding and strengthening the community of physics teacher educators and physics teacher education programs as PhysTEC moves into the future. *Supported in part by NSF grant PHY-1707990.

A8-02 (11:00 to 11:30 AM) | What's New with Get the Facts Out*

Presenting Author: Elias Euler, Department of Physics, Colorado School of Mines

The Get the Facts Out project does research on resources for and perceptions of the teaching profession through studies on the effectiveness resources as well as analysis of student and faculty data from over 50 US institutions. In this presentation we will share several updates from the project this year including new evidence of GFO's effectiveness in shifting perceptions of the teaching profession, findings around teacher retention rates, and feedback from our GFO 'champions' across the country. We will also provide updates on a few new resources that we are currently developing.

*This project is supported by NSF DUE-1821710 & 1821462.

A8-03 (11:30 to 11:40 AM) | Contributed | Casting a Wide Net: How WGU Educates Physics Teachers Nationwide

Presenting Author: Brenna Gillman, Western Governor's University

Western Governors University (WGU) offers programs to prepare initial licensure and graduate level Physics teachers. WGU is the only teacher's college in the country who is able to recommend licensure for Physics teachers in all 50 states as well as offering opportunities for current teachers to gain endorsement in the field. WGU is graduating more Physics teacher candidates each year than any other institution in the country and the School of Education at WGU is offering meaningful contributions in addressing the Physics teacher shortage in the United States. Information about our WGU Physics Education programs, our competency-based approach to education, and a discussion about pathways to licensure and endorsement in all 50 states will be presented highlighting how this allows for the widest net possible in targeting and recruiting future and current educators to the Physics Education field.

A8-04 (11:40 to 11:50 AM) | Contributed | Update on Teacher Recruitment Strategies Coming out of COVID

Presenting Author: Joseph Kozminski, Lewis University

Additional Author | James Hofmann, Lewis University

Additional Author | Dorene Huvaere, Lewis University

Through its PhysTEC recruiting grant, Lewis University has developed various strategies to grow its physics teacher preparation program, including launching a five-year BS/MA program in physics and secondary education leading to licensure and modifying Get the Facts Out resources to produce marketing materials, presentations for faculty and students, and an interactive website with salary and economic data specific to the Chicagoland area. However, we have had some challenges reaching high school and community colleges students during COVID. This presentation will

provide an update on our grant activites and discuss new programming we have developed to bring these potential future teacher candidates to campus to engage in various hands-on activities and to learn more about the teacher preparation program. This work is supported by the National Science Foundation and the Physics Teacher Education Coalition (PhysTEC) under grant no. 1707990.

A8-05 (11:50 AM to 12:00 PM) | Contributed | Building Teacher Preparation Program Support Networks at Worcester Polytechnic Institute

Presenting Author: Douglas Petkie, Worcester Polytechnic Institute
Additional Author | Jillian DiBonaventura, Worcester Polytechnic Institute
Additional Author | Thomas P Noviello, Worcester Polytechnic Institute
Additional Author | Rudra P Kafle, Worcester Polytechnic Institute

Worcester Polytechnic Institute (WPI) is a STEM university with a wide range of science, engineering and humanities programs in the context of a project-based learning curriculum. Without an education school or department, the STEM Education Center houses the Teacher Preparation Program and has many students, and several majors, to draw from for the physics teacher preparation program. As a PhysTEC Comprehensive Site, the Physics Department and the STEM Education Center have teamed up to promote STEM teaching careers to several audiences and recruit students to the program through events that include student/parent open houses, the learning assistant program, administrative and faculty groups, and students in a variety of settings. The Get the Facts Out network and resources have influenced our strategies and we will discuss how we leverage these resources to build the physics teacher preparation program and a supportive ecosystem.

AAPT Awards Session: 2023 JD Jackson Excellence in Graduate Physics Education Award, Kimberly Ann Coble

Sunday, Jan. 15, 12:30–1:30 p.m. Moderator: Jan L. Mader Sponsor: AAPT Grand Ballroom I

Welcome from Dr. Adrien L. Bennings, Portland Community College President

Human Potentials in the Universe of Graduate Teaching and Mentoring

Presenting Author: Kimberly Ann Coble, San Francisco State University

As someone who transitioned from cosmology science research to physics and astronomy education research, I like to say that human beings are more complex than the Universe– and that is thrilling! I have had the privilege of being able to work in diverse environments that support my core values of equity and justice, and to work with incredible students, colleagues, teachers, and mentors who have shaped who I am, how I think, and how I approach teaching, learning, mentoring, research, and leadership. Here I describe asset-based approaches to graduate teaching, mentoring, and networking, aligned with a number of recent national reports and other efforts. I also describe an inclusive pedagogy course for graduate teaching assistants at San Francisco State University that empowers a new generation of scholars to change the culture of our institutions and field. Most importantly, I celebrate the full, unique human beings that are our students.

Kimberly Ann Coble, Professor of Physics at San Francisco State University, earned her B.A. in Physics, Astronomy, and Astrophysics at The University of Pennsylvania. Both her M.S. and Ph.D. in Astronomy & Astrophysics were earned at The University of Chicago. She was a Postdoctoral Fellow at the University of California, Santa Barbara and a National Science Foundation Astronomy and Astrophysics Postdoctoral Fellow at The University of Chicago and Adler Planetarium.

Session POS-A: Assessment of Lab Recommendations Posters

Sunday, Jan. 15, 2–3:20 p.m. Moderator: TBA Sponsor: AAPT Atrium

POS-A02 (2:45 to 3:30 PM) | Poster | Open Ended Labs

Presenting Author: Nadene Klein, DC Oakes High School

I will share a process to frame students designing and conducting their own experiments in the middle or high school lab. I have found a lot of success with this process with increased student engagement and science learning. Real student examples and testimonials will also be shared.

POS-A03 (2:00 to 2:45 PM) | Poster | How Do Students Use Experimental Evidence When Rejecting a Hypothesis?

Presenting Author: Heidi Schlunt, Washington State University
Additional Author | Anya Guy, Washington State University

The General Physics Labs at Washington State University, the lab for the first semester physics for life sciences majors, are being redesigned around the AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum. In a newly implemented activity students test an incorrect hypothesis that the force provided by the bicep is proportional to the weight of anything held in the hand. In this work we qualitatively examine how students use experimental evidence when communicating their reasoning for rejecting a hypothesis.

Session POS-B: Assessment Grading, and Feedback Posters Sunday, Jan. 15,

2–3:30 p.m. Moderator: TBA Sponsor: AAPT Atrium

POS-B01 (2:00 to 2:45 PM) | Poster | 2.5D Magnetic Field Test

Presenting Author: Colleen Megowan-Romanowicz, American Modeling Teachers Association

Co-presenting Author | Rebecca Vieyra, Vieyra Software

Additional Author | Chrystian Vieyra, Vieyra Software

Additional Author | Mina Johnson Glenberg, Arizona State University

Until recently, 2D representations (e.g., static diagrams in textbooks) were students' primary way of visualizing the magnetic field. With augmented reality (AR), it is possible for a student with a free smartphone app (e.g., MagnaAR NSF #1822728) to map and display the magnetic field in a region of space. But how do they interpret what they are seeing? A web-based 2.5D assessment has been developed to address this question. The 16-question Magnetic Field Test, created on the Unity development platform allows students to manipulate the field of view in questions by rotating the image horizontally or vertically. While it is particularly suited to measuring conceptual learning gains in situations where students have used been able to use 3D imaging such as the smartphone app mentioned above to learn about magnetic fields, it can be used to assess any student's understanding of field direction, strength and superposition of magnetic fields.

POS-B01B (2:45 t0 3:00 PM) | Poster | Embodied Learning Using LiDAR-enabled Smartphones

Presenting Author: Colleen Megowan-Romanowicz, American Modeling Teachers Association

Co-presenting Author | Rebecca Vieyra, Vieyra Software

Additional Author | Chrystian Vieyra, Vieyra Software

Additional Author | Daniel O'Brien, Georgetown University

Additional Author | Mina Johnson-Glenberg, Arizona State University

This poster presents early results of field testing of a new free LiDAR-aided smartphone app (NSF #2114586) for understanding velocity and acceleration. This tool can be used in both traditional laboratory classrooms and distance learning contexts and builds on our prior success with Magna-AR (NSF #1822728), a smartphone app for visualizing 3-D magnetic fields that has been downloaded by more than 500,000 users. The app pushes the limits of and set the standards for LiDAR-aided AR use in classroom settings, equips teachers and learners and students to explore position-based STEM concepts in various contexts, (possibly including remote learning settings), and will eventually be used determine how learners' exploration of LiDAR-aided AR impacts their conceptual understanding of STEM concepts.

POS-B02 (2:45 to 3:30 PM) | Poster | Unpacking Grading & Feedback in Upper-Division Physics

Presenting Author: Jessica Searl, Union University

Additional Author | Warren Christensen, North Dakota State University

Racial and gender disparities in physics student outcomes have prompted research into a variety of possible contributing factors. There has, however, been very little research conducted examining the impact of grading and assessment methods in upper-division physics on student engagement and success. We examined the impact of different types of feedback and assessment, particularly comparing students' experience in an 'ungraded' course, a class where the assignments were not graded but were assessed with verbal feedback, versus a traditionally graded course. We spoke with four upper-division physics students about their experiences with both standard physics grading and assessment practices as well as in an ungraded course. Interview analysis revealed that the traditional method of written feedback had no reported impact on students' comprehension of the material while the verbal feedback prompted further engagement.

POS-B03 (2:00 to 2:45 PM) | Poster | Using the PhysPort Data Explorer to Analyze Research-based Assessment Results

Presenting Author: Adrian Madsen, American Association of Physics Teachers

Additional Author | Sarah McKagan, American Association of Physics Teachers

Additional Author | Lauren C. Bauman, University of Washington Bothell

The PhysPort Data Explorer (www.physport.org/dataexplorer) is an online tool that helps physics instructors analyze their students' responses to 36 research-based assessments. Instructors upload their students' responses using our secure interface. The Data Explorer matches their pre/post data, scores it, compares it to national data, and graphs it in an interactive way. Instructors can look at results over time, breakdown by topic or question, and comparisons between courses. Instructors can also upload data related to student demographics, academic record, or background, and look at their results based on this information. We present the Data Explorer and discuss equity issues around analysis and interpretation of research-based assessment results, in order to support faculty in using data to reveal and address inequities, to support minoritized groups of students, and to minimize and eliminate harm. Bring your laptop and a spreadsheet of student assessment data and we can help you use the Data Explorer.

POS-B04 (2:45 to 3:30 PM) | Poster | Using Gradescope to Make Grading Fun and Consistent

Presenting Author: David Johnston, Oregon Institute of Technology

Grading is often times the least rewarding and most time consuming aspect of teaching. Many are probably familiar with the sentiment, "I teach for free. I get paid to grade!" However, grading and providing meaningful and consistent feedback is essential to the learning process for our students. Fortunately, there is a wonderful tool available called, Gradescope. This poster will cover some of the most useful features of Gradescope that can be used to grade homework, exams, and even written assingments with much more ease and flexibility compared to traditional grading methods, and to provide more robust and meanfigul feedback to students.

Session POS-C: Astronomy Education Research Posters Sunday, Jan. 15,

2–3:30 p.m. Moderator: TBA Sponsor: AAPT Atrium

POS-C01 (2:00 to 2:45 PM) | Poster | Visuospatial Skills and Learning Astronomy: Visualizing the Solar System

Presenting Author: Rebecca Lindell, Tiliadal STEM Education: Solutions for Higher Education

Co-presenting Author | Mary L Urquhart, University of Texas Dallas

Additional Author | Michele McColgan, Michele McColgan

Many cognitive scientists believe that visuospatial skills allow individuals to learn abstract concepts. This is especially the case when learning astronomy, where students must continually switch between their own 3-D horizon views, what they see when they go outside; and a 2-D solar system view, what they would observe if they were looking straight down on the solar system from an imaginary point above. To improve students' visuospatial skills, researchers at Siena College have created over one hundred Manipulative Augmented Reality Visualizations to Learn Spatially (MARVLS) to teach physics, chemistry, math, and engineering. Working with the MARVLS developers, we will be developing Visualizing the Solar System MARVLS. To begin the design process, we have created an accompanying learning module based on a modified Karplus Learning Cycle. In this poster, we will present the pedagogical design of the Visualizing the Solar System learning module.

POS-C02 (2:45 to 3:30 PM) | Poster | Visuospatial Skills and Learning Astronomy: Visualizing Eclipses

Presenting Author: Mary Urquhart, University of Texas at Dallas

Co-presenting Author | Rebecca Lindell, Tilladel STEM Education: Solutions for Higher Education

Additional Author | Michele McColgan, Siena College

Teaching the how and why of eclipses often involves the use of modeling and simulations to illustrate both the scale and complexities of the Earth-Moon-Sun geometry. However, the success of these approaches depends upon both the use of multiple representations and the visuospatial skills of students. To improve students' visuospatial skills, researchers at Siena College have created over one hundred Manipulative Augmented Reality Visualizations to Learn Spatially (MARVLS) to teach physics, chemistry, math, and engineering. Working with the MARVLS developers, we will be developing a Visualizing Eclipses MARVLS. In this poster, we will present the pedagogical design of the Visualizing Eclipses learning module and how it can augment using existing instructional eclipse models and representations. A connection to the upcoming total solar eclipse in the United States on April 8, 2024, and the preceding annular eclipse on October 14, 2023, gives Visualizing Eclipses particular relevance for astronomy educators.

Session POS-D: Can Online Labs Effectively Serve Undergraduates Post-COVID? Posters Sunday, Jan. 15,

2–3:30 p.m. Moderator: TBA Sponsor: AAPT Atrium

POS-D01 (2:00 to 2:45 PM) | Poster | Measuring Student Achievement in Self-Directed, Project-Based, At-Home, Laboratory Experiments

Presenting Author: Steven Fullerton, Portland State University

Co-presenting Author | Hoang Tran, Portland State University

Additional Author | Tiffany Bui, Portland State University

Additional Author | Brian Martinez Andrade, Portland State University

Additional Author | Paul R DeStefano, Portland State University

In response to the shift to remote teaching in Spring 2020, Portland State University (PSU) in Oregon created a new, project-based, series of assignments where students designed and implemented their own experimental research using everyday, readily available at home items. We explored student outcomes by implementing a thematic analysis of the reports at key milestones: initial design phase, data analysis, and final write-up. This analysis was carried out by deductive coding of individual student work, as well as the use of inter-rater reliability (IRR) to determine coder agreement. We describe the development of codes for this analysis and detail some of the challenges of this work.

POS-D02 (2:45 to 3:30 PM) | Poster | Analyzing Experimental Critical Thinking through Case Study Interviews

Presenting Author: Tiffany Bui, Portland State University

Additional Author | Hoang Tran, Portland State University

Additional Author | Steven Fullerton, Portland State University

Additional Author | Brian Martinez Andrade, Portland State University

Additional Author | Paul R DeStefano, Portland State University

Oregon's Portland State University (PSU) introductory physics laboratory curriculum has been focused on involving students in experimental methods and design, specifically looking at how students apply and use uncertainty. Students were tasked with a "Design Your Own Experiment" project where they develop their own experimental procedure from the fields of optics, waves, or thermal physics. This curriculum is delivered online and was developed in response to the COVID-19 pandemic. To gain insight of the curriculum's impact, we conducted interviews with students at the end of the series of introductory labs. Here, we describe our analyses to study their project development approaches. In particular we looked into their views on the role of uncertainty in their experimental design and subsequently obtained data.

POS-D03 (2:00 to 2:45 PM) | Poster | Interpreting Students' Free-Text Survey Responses for Remote Introductory Physics Lab

Presenting Author: Hoang Tran, Portland State University
Additional Author | Tiffany Bui, Portland State University
Additional Author | Steven Fullerton, Portland State University
Additional Author | Brian Martinez Andrade, Portland State University
Additional Author | Paul DeStefano, Portland State University

Since the transition to emergency remote teaching (ERT) at the beginning of the COVID-19, the introductory physics laboratory curriculum at Portland State University (PSU) in Oregon has been evolving toward increased focus on uncertainty and experimental design skills. To help understand the effect of these curriculum changes on student learning, we have administered pre- and post-instruction surveys containing several original, open, short-response prompts as part of a research study. We review the iterative process of thematic analysis via inductive coding, the use of inter-rater reliability (IRR) as a metric to quantify agreement between independent coders, and our impressions of working with this methodology. We also provide preliminary results from this study.

POS-D04 (2:45 to 3:30 PM) | Poster | Development and Piloting of a CURE-aligned Non-Majors Online Lab Curriculum

Presenting Author: Nekeisha Johnson, North Dakota State University

To facilitate an initiative to offer all general education courses online, North Dakota State University (NDSU) funded a rewrite of the introductory physics lab curriculum. Taking inspiration from Course-Based Undergraduate Research Experience (CURE) courses in Biology at NDSU, we modified the framework to fit a one credit-hour, online, non-majors lab. The resulting CURE-aligned course uses iOLab to facilitate data collection, and scaffolds students to undergo a condensed version of the scientific process by writing an experimental proposal, collecting data, performing analysis, writing a full report, and peer-reviewing each other's work. In this poster we will present an overview of the new curriculum, as well as outline results from piloting the materials during the Fall 2022 semester.

POS-D05 (2:00 to 2:45 PM) | Poster | Impact of Online Instruction due to COVID-19 on Student

Presenting Author: Taylor GurrEithun, University of Washington - Seattle
Additional Author | Peter Shaffer, University of Washington - Seattle, WA

The COVID-19 pandemic led to many schools teaching online. This had a significant impact on the ways in which students studied physics at the university and high school levels. For example, in the introductory sequence at the University of Washington, lectures, tutorials, and labs were administered entirely online. Later in the pandemic, students coming to this sequence had received online instruction in high school. We are interested in the impact on student learning. Results from pretests and post-tests are presented that allow us to probe the learning and teaching of physics throughout the pandemic.

Session POS-E: Computational Physics and Data Science Posters Sunday, Jan. 15,

2–3:30 p.m. Moderator: TBA Sponsor: AAPT Atrium

POS-E01 (2:00 to 2:45 PM) | Poster | Introducing Ternary Energy Diagrams to your Introductory Physics Students

Presenting Author: Bob Brazzle, Jefferson College

Ternary Energy diagrams have several significant advantages over energy bar charts, which are currently in more wide-spread use. Unlike energy bar charts, a single ternary energy diagram can display not only the initial and final system energy distributions, but also the distributions of many thousands of intermediate states. Therefore, they are a powerful tool for computational physics, and are easily accessible for Introductory Physics students. Specifically, they can display an entire scenario of transformations of a system's energy; for example, an entire roller coaster ride with transformations among gravitational, kinetic, and thermal forms of energy. Other advantages are based on mathematical properties of any ternary graph. This poster is intended to describe these advantages, and discuss how you can introduce ternary energy diagrams to your Introductory Physics students. They are appropriate for algebra- or calculus-based courses at the High school or college level.

POS-E03 (2:00 to 2:45 PM) | Poster | Don't Give up on Pair Programming

Presenting Author: Katrina Hay, Pacific Lutheran University

Pair programming is a collaborative learning method, in which students work on computational tasks in pairs. During pair programming, students collaborate on a single computer. The "Driver" focuses on details and controls the mouse and keyboard; the "Navigator" manages the work, makes suggestions, watches for errors, and asks logical questions. The partners regularly switch roles. This method improves student programming competency. I acknowledge the obstacles in the early stages of teaching using pair programming that led to me feeling like I wanted to give up on the method, and ideas to overcome these. I will share strategies for implementation and provide examples of tailoring activities to better suit my introductory engineering students as they study Excel and MATLAB. I observe improved student engagement and collaboration during pair programming activities that are highly scaffolded, where the "Driver" and "Navigator" are given specific and different tasks.

POS-E03 (2:00 to 2:45 PM) | Poster | Epidemic Modeling: Computational Physics in Interdisciplinary Undergraduate Research

Presenting Author: Jesse Kinder, Oregon Institute of Technology
Additional Author | Satomi Kiriakedis, OHSU School of Medicine

Additional Author | Zackary Williams, OIT Class of 2020

Epidemic models are fertile ground for interdisciplinary undergraduate research, and they provide an opportunity to introduce computational physics to students in many disciplines. I discuss three complementary methods from applied physics that provide insight into epidemics: continuous dynamics, stochastic dynamics, and Monte Carlo simulation. I also describe the efforts of a biology student, an applied mathematics student, and a physics professor in applying these methods to study the effects of fluctuations and social networks on the spread of epidemics — preliminary results, lessons learned, current work, and future directions.

Session POS-F: Curriculum and Instruction Posters

Sunday, Jan. 15, 2–3:30 p.m. Moderator: TBA Sponsor: AAPT Atrium

POS-F01 (2:00 to 2:45 PM) | Poster | Adjusting Content Level and Course Breadth for Non-major Introductory Courses

Presenting Author: Timothy McCaskey, Columbia College Chicago

We have transitioned from teaching a course called Physics for Filmmakers (PfF) to one called simply Conceptual Physics (CP). PfF did many things at the level of an introductory algebra-based physics course, but used film clips as both a jumping off point for lectures and a basis for final projects. CP was designed to be more accessible to our arts and media-focused student body by removing a lot of the purely mathematical content (simultaneously decreasing overlap with the standard introductory course) and opening up final projects to different art forms. My goal was to take the best demos and film discussions from PfF and include hands-on activities and content from other courses such as optics and electronics. This poster will outline some choices made in transitioning between these courses, focusing on how the first round of CP projects cultivated physics interest from an arts perspective.

POS-F02 (2:45 to 3:30 PM) | Poster | Resonances Between Physics Faculty Discourse and Cognitive Theories of Learning*

Presenting Author: Lauren Bauman, University of Washington-Seattle
Additional Author | Sarah B McKagan, Seattle Pacific University
Additional Author | Tra Huynh, University of Washington-Bothell
Additional Author | Adrian M Madsen, Seattle Pacific University
Additional Author | Amy D Robertson, Seattle Pacific University

Recent research on faculty adoption and adaptation of research-based instructional materials suggests that the development and dissemination of such materials are most effective when they center instructors' productive ideas about teaching and learning and when they build on instructors' current instructional practices. We interviewed 17 physics faculty to understand their instructional values and practices, for the purpose of informing the development and dissemination of resources-oriented instructional materials—materials that elicit and build on students' productive ideas. In this poster, we will explore the ways in which faculty discourse aligned (and did not align) with features of the misconceptions and resources frameworks that have influenced curriculum development in PER.*Supported by Grants No. 1914603 & 1914572

POS-F03 (2:00 to 2:45 PM) | Poster | Implementing Lecture/Studio at a New Institution

Presenting Author: Alice Churukian, University of South Carolina
Additional Author | David J. Tedeschi, University of South Carolina

Over the last several years, the Department of Physics and Astronomy at the University of South Carolina has been working to improve the learning gains of the students enrolled in both introductory physics sequences. Recognizing that properly implemented, research-validated, active-learning approaches have been shown to improve student learning as compared to the traditional lecture/recitation/laboratory format, we have adopted the Lecture/Studio format and are in the process of adapting the curricular materials developed at the University of North Carolina at Chapel Hill to meet the needs of our students. Room renovation began in Spring 2022 and the first semester of the calculus-based sequence went live in Fall 2022. In this poster we will describe the decision process, implementation, and pre/post-implementation results from the FCI. We will also discuss future plans for expanding Lecture/Studio to the second semester calculus-based course as well as to the algebra-based sequence.

POS-F04 (2:45 to 3:30 PM) | Poster | Creating Quizzes and Exams Programmatically

Presenting Author: Steve Spicklemire, University of Indianapolis

The open-source python module genlatex is a tool that enables instructors to generate beautiful randomized assessments with corresponding solutions using LaTeX and python together. Examples of source files and output will be provided including diagrams, graphs, and, of course, lots of mathematical equations.

POS-F06 (2:45 to 3:30 PM) | Poster | Mathematical Preparation: Math Methods Courses in Physics vs. Other Models*

Presenting Author: Eve Chicas, California State University, Fullerton
Additional Author | Michael Loverude, California State University, Fullerton

Any university's standard undergraduate physics curriculum generally consists of classical mechanics, electromagnetism, and quantum mechanics physics. Currently, not every university follows the same academic course outline; therefore, we are studying the physics major course offerings to identify and document different models. An important course: Mathematical Methods in Physics course bridges complex mathematical concepts with various physics concepts to prepare students for future upper division physics courses. Two research questions we aim to answer: What

course models exist in US universities for the mathematical preparation of physics students? And is there a correlation between course model and institutional variables such as the number of majors, retention rates, student demographics, public versus private, research-intensive, and primarily undergraduate, and to what extent? By reviewing catalogs from colleges and universities in California, we gathered data on the effects of a Mathematical Methods course in Physics vs. a non-Mathematical Methods course physics curriculum. *Supported in part by NSF grant PHY#1912660 as well as the Black Family Foundation.

POS-F07 (2:00 to 2:45 PM) | Poster | Comparison in Resource Usage Between Online and Face-to-face Intro Courses

Presenting Author: Shawn Weatherford, University of Florida

Additional Author | Kathryn McGill, University of Florida

Additional Author | Sujata Krishna, University of Florida

Prior to COVID, we surveyed students taking introductory physics courses either online or face-to-face to compare the resources students reportedly used to learn physics. In the study, the same instructor was assigned to both online and face-to-face sections. Respondents reported differences in the motivation behind resource-seeking behaviors.

Session POS-G: First Year Labs - Apparatus, Tricks, and Tips Posters Sunday, Jan. 15,

2–3:30 p.m. Moderator: TBA Sponsor: AAPT Atrium

POS-G01 (2:00 to 2:45 PM) | Poster | Lab Activities for Conceptual Physics

Presenting Author: Pei Xiong-Skiba, Austin Peay State University

This presentation includes two lab activities developed for our conceptual physics course where mathematics is kept at a minimum level. The first lab is static equilibrium lab. Multiple forces are applied to an object in different directions. Instead of using sine and cosine functions to determine force components, students used a polar graph paper to draw all forces in scale and examine the equilibrium conditions by reading the components of the forces directly from the graph paper. The second lab is projectile motion. Students were asked to draw the path of a projectile by following the principle that the project falls from a straight line extended from the initial launch direction. In both activities, experimental conditions are carefully selected to minimize calculation. It appears that students were able to master the concepts through these activities.

POS-G02 (2:45 to 3:30 PM) | Poster | Measuring Energy and Coefficients of Friction through Rotational Mechanics

Presenting Author: Patrick Polley, Beloit College

Additional Author | Keeler Tardiff, Beloit College

Rotational mechanics is neglected in the introductory physics course, compared to the amount of time spent on translational mechanics. We present a set of four laboratory exercises that enhance the offerings in the introductory course. These exercises employ rotational statics and dynamics, as well as rotational kinematics, in a coherent and connected manner, along with concepts from translational mechanics. Students determine the coefficients of static and kinetic friction of a ball on a ramp, the conditions that characterize rolling motion without slipping, and rolling motion with slipping. Students apply the conservation of energy, and the work-energy theorem in the analysis of these two cases of motion.

Session POS-H: General Topics in Teaching Physics Posters Sunday, Jan. 15,

2–3:30 p.m. Moderator: TBA Sponsor: AAPT

POS-H01 (2:00 to 2:45 PM) | Poster | Emphasizing Scientific Modeling in Pre-med Physics Courses

Presenting Author: Madeline Harmer, Brigham Young University

Additional Author | Adam H Bennion, Brigham Young Unversity

The vast majority of pre-med students major in life science and can be unfamiliar with the application of physics in their fields of interest. With an emphasis on scientific practices and their applications in physics, we re-designed key labs in a program required general physics lab course to better accommodate the needs and goals of the students. We made these changes to encourage scientific modeling practices, opportunities to revise, and practical applications such as exploring the gradient magnetic field created by an MRI machine by using alternating and direct current solenoids. We surveyed the students and collected responses on their perceptions of the importance of modeling, the application of scientific modeling to their future careers, and analyzed the methods they used in the new labs. We found that pre-med students in our program generally came to understand scientific modeling as both a tool and a process in experimentation.

POS-H02 (2:45 to 3:30 PM) | Poster | Where Should I Start this Unholy Problem?

Presenting Author: Thomas Foster, Southern Illinois University Edwardsville

When a novice encounters a problem statement that does not explicily inform them what section in the text to review, they have a meaningful problem before them, specifically, How am I, a mere mortal, supposed to solve this problem? There are numerous non physics-specific paths they can take such as working with friends, or looking for the formula that uses all the variables, or simply not solve the problem. There are many on-line tools available and cheating is a very accessible option (hasn't it always been?). To help our students to get over this roadblock, we have

created flow charts that help students deconstruct the information in a problem statement and select a probable physics principle to start thier solution. These are not concept maps, but rather a pathfinding map for the students.

Session POS-I: How Diversity, Equity, and Inclusion Issues Impact Physics Learning/Teaching Posters

Sunday, Jan. 15, 2–3:30 p.m. Moderator: TBA Sponsor: AAPT Pavilion Foyer

POS-I01 (2:00 to 2:45 PM) | Poster | STEP UP: Shifting the Culture of Who Does Physics

Presenting Author: Bree Barnett Dreyfuss, STEP UP

Stereotypes about who can pursue physics and what careers one can have with a physics degree still persist. The STEP UP program developed two lessons designed for the high school physics classroom to help shift the culture and inspire all students to consider a future in physics. Our research-backed lessons help students: (1) discover potential careers possible with a degree in physics and (2) learn more about who has and has not traditionally been included in physics. Each free lesson comes with a teacher guide, in-class materials and teacher guides. Our online discussion board includes high school teachers that have done the lessons and share the ways they have customized them for their own classrooms. A teacher self-reflection form helps identify areas in and out of the classroom where teachers may transform their classrooms more into inclusive spaces that encourage all their students to pursue physics.

POS-I02 (2:45 to 3:30 PM) | Poster | STEP UP: Supporting Teachers Encourage the Pursuit of Undergraduate Physics

Presenting Author: Bree Barnett Dreyfuss, STEP UP

Additional Author | Pooneh Sabouri, STEP UP, Florida International University

Given continued marginalization of women and minoritized racial/ethnic groups (MRE) in physics, STEP UP works with high school physics teachers to transform culture in physics classes. A STEP UP team of teachers, researchers, and students co-designed lessons to disrupt narrow perceptions of physics, discuss unconscious bias, and recognize those who have been invisible. In this poster, we present the findings from two large scale studies that showed that engaging in these lessons have a positive effect on the future physics intentions of women and MRE groups.

Session POS-JB: Integrated Physics for the Life Sciences Posters

Sunday, Jan. 15, 2–3:30 p.m. Moderator: TBA Sponsor: AAPT Pavilion Foyer

POS-JB01 (2:00 to 2:45 PM) | Poster | Attitudes and Engagement of Introductory Physics for Life Sciences Students*

Presenting Author: Travis Kregear, Portland State University

Additional Author | Priya Jamkhedkar, Portland State University

Additional Author | Ralf Widenhorn, Portland State University

At Portland State University we have developed a full-year algebra based Introductory Physics for Life Sciences Majors sequence to better serve the population of pre-health and life-sciences students. The new course contains a new biomedical relevant physics curriculum, interactive simulations, and video interviews by biomedical experts. We developed and conducted assessments to probe the effectiveness of this course on student attitudes and engagement. The assessments are intended to gauge student attitudes, content learning goals, biomedical relevance of content and transferability of problem solving skills. This poster summarizes the results of the student surveys and group interviews performed throughout the sequence. Results will be used to refine and improve the protocol for future assessment as well as improve the curriculum.

*This work is supported by the grants DUE- 1624192 and DUE- 1933984 from the National Science Foundation and Portland State University Faculty Development Grant.

POS-JB02 (2:45 to 3:30 PM) | Poster | Development of the Fluids Conceptual Evaluation (FCE): Challenges and Successes*

Presenting Author: Rebecca Lindell, Tiliadal STEM Education: Solutions for Higher Education

Additional Author | Dawn Meredith, University of New Hampshire

Additional Author | James Vesenka, University of New England

Additional Author | D J Wagner, Grove City College

Additional Author | Daniel Young, University of North Carolina Chapel Hill

The FCE, is a research-based two-tier conceptual assessment to evaluate IPLS students' conceptual difficulty with fluids. As part of the FCE development, researchers utilized both qualitative phenomenology and phenomenography frameworks to meet three of the goals associated with the development of the FCE. These goals included 1) Assuring that IPLS students understood the Tier 1 multiple-choice questions and responses as intended, 2) All possible responses were included in those listed for each item and 3) To develop tier 2 responses of all possible reasons for answering the Tier 1 item the way that they did. Multiple challenges occurred during this process, including conducting all interviews virtually due to COVID; lack of student participation in the study; and reduced size of sample population especially for lower income and minority students. This poster presents how the FCE developers overcame these challenges that occurred during the FCE development process.

* Introductory Physics for Life Science Students. This project supported by the NSF IUSE 2021273

Session POS-J: Introductory Physics Courses– Calculus Based Posters

Sunday, Jan. 15, 2–3:30 p.m. Moderator: TBA Sponsor: AAPT Pavilion Foyer

POS-J03 (2:00 to 2:45 PM) | Poster | Supplemental Resources Impact on Student Outcomes in Introductory E&M

Presenting Author: Brant Conway, Texas A&M University
Additional Author | Dawson Nodurft, Texas A&M University
Additional Author | Jonathan Perry, University of Texas at Austin
Additional Author | Michael Kordell, Texas A&M University
Additional Author | Carlee Garrett, Texas A&M University

Calculus-based introductory physics classes are prerequisite courses for many STEM majors and traditionally have a large attrition rate. One way to improve student learning is by creating open-access supplemental materials to support the learning of a diverse student population beyond the formal class structure. We investigated the relation between student engagement with supplemental materials and their performance in a calculus-based introductory course on electricity and magnetism. The resources examined in this study included videos, summarizing important concepts, showing example problems, and covering in-depth problem-solving techniques, as well as prior years' exams. We will present results analyzing the relation between student use of supplemental resources with course performance, including midterm and final exams as well as letter grades, accounting for demographic factors and their prior preparation. Responses to the anonymous questionnaires showed that most (80-90%) students felt the supplemental materials had a positive impact on their learning and performance on exams.

POS-J04 (2:45 to 3:30 PM) | Poster | Supporting Institutional Goals with Assessable Learning Objectives for Introductory Physics

Presenting Author: Alexis Olsho, United States Air Force Academy
Co-presenting Author | Kimberly de La Harpe, United States Air Force Academy
Co-presenting Author | David C. Meier, United States Air Force Academy

Many undergraduate institutions have requirements related to quantitative or scientific reasoning that must be met in order for students to earn a degree. Introductory physics courses typically can be used to help meet such requirements. This is for good reason: physics courses can be uniquely suited to improve students' quantitative reasoning, because of physics' reliance on quantitative models of real-world phenomena. However, little work has been done to connect broader institutional learning goals to learning objectives specific to physics. In this poster, we present work done at the U.S. Air Force Academy as a case study that illustrates how to develop physics-specific assessable learning objectives in order to support the institution's desired scientific reasoning outcome.

Session POS-K: Physics Outside the Classroom and Lab – Interdisciplinary Work Posters

Sunday, Jan. 15, 2–3:30 p.m. Moderator: TBA Sponsor: AAPT Pavilion Foyer

POS-K01 (2:00 to 2:45 PM) | Poster | Microbots Swimmer Prototype

Presenting Author: EVELYN VALLADOLID, SOUTH EARLY COLLEGE HS
Co-presenting Author | PADRON FRANCISCO, CY-FAIR ISD

The current nano and microbot technology are being researched for medical uses. What was once considered fiction is now viewed as the reality of science. Microbots are developed to mimic any unicellular prokaryotes and be able to survive the low viscous environment in humans. The NSF-funded RET (Research Experience for Teachers) Program at the University of Houston College of Technology was a great program to further develop the curiosity and problemsolving skills of three teachers from different School Districts in Houston. Under the supervision of Dr. Zheng Fan, the challenge was to design, create and optimize a functional swimmer in highly viscous media to simulate a microbot in a fluid environment. The task included fluid calculations in high viscosity (low Reynold's number),prototype design, construction, testing; and parts 3d printing. It took six weeks of trial and error, troubleshooting, and redesigning before being able to choose a suitable microbot swimmer prototype.

Session POS-L: Research on Diversity, Equity, and Inclusion in Physics Teaching Posters

Sunday, Jan. 15, 2–3:30 p.m. Moderator: TBA Sponsor: AAPT Pavilion Foyer

POS-L01 (2:00 to 2:45 PM) | Poster | Promoting Deeper Physics Learning through Informal Physics Program Facilitation

Presenting Author: Carlee Garrett, Texas A&M University
Additional Author | Jonathan Perry, University of Texas
Additional Author | Tatiana Erukhimova, Texas A&M University

Physics outreach programs are vital for providing meaningful informal experiences that promote student development and self-efficacy beyond the formal setting of a classroom. This work builds on our recent studies which have broadened our understanding of the positive impacts of such programs on students' physics identity, sense of belonging, and 21st century career skills. We employed a student-focused investigation based on self-reported data gathered through didactic interviews with 35 undergraduate and graduate students who facilitated one or more outreach

programs. We focused on student experiences related to their perceptions of their learning and understanding of physics, as well as confidence in their knowledge, gained through engaging the public through informal physics programs. We will present results of our analysis of the interviews, highlighting relations between facilitation of informal physics programs and student learning.

POS-L02 (2:45 to 3:30 PM) | Poster | Concealed Craftswomen of Physics

Presenting Author: Emma Goulet, Saint Anselm College | Society of Physics Students with the AIP Center for History of Physics/ Neils Bohr Library & Archives

Women in physics have been continuously undercredited for their efforts throughout history. It is essential to research and amplify their stories to promote representation in the field. This poster describes the research of two incredible women in physics: Katherine Clerk Maxwell and Émilie du Châtelet. I present outreach projects to attempt to share these women's stories, including multiple articles for broader and older audiences, Wikipedia edits, and K-2 teaching guides on their work to expose impressionable kids to women in physics. Katherine serves as a case study of how companions of scientists often go uncredited for their research contributions. The media around Émilie illustrates how stories are exaggerated and misconstrued, particularly when referring to marginalized groups. This poster will touch upon the method of researching these two concealed craftswomen of physics, share their unique stories, and present the outreach efforts in the form of teaching guides and articles about them.

Session POS-M: Teaching Advance Labs (Beyond First Year) Posters

Sunday, Jan. 15, 2–3:30 p.m. Moderator: TBA Sponsor: AAPT

POS-M01 (2:00 to 2:45 PM) | Poster | Radius of the Earth from Photo of Two Distant Bridges

Presenting Author: Clinton Lewis, West Valley College (retired)

An unusual photograph through a telescope of two distant San Francisco bridges, one close, one far, shows the curvature of the Earth. The more distant bridge is clearly lower in the water of SF Bay than a Flat-Earth calculation would indicate. Measurments of this photo, bridge dimensions, and a calculation results in an estimate of the radius of the Earth suprisingly accurate!

Session POS-N: Work in Content Understanding, Problem Solving, and Reasoning Posters

Sunday, Jan. 15, 2–3:30 p.m. Moderator: TBA Sponsor: AAPT Pavilion Foyer

POS-N01 (2:00 to 2:45 PM) | Poster | Newtonian Momentum Conservation in an Arbitrary Metric

Presenting Author: Clinton Lewis, West Valley College (retired)

Conservation of momentum, or non-conservation, can be examined in any coordinate system with external forces applied to the particles using Lagrangian mechanics.

POS-N02 (2:45 to 3:30 PM) | Poster | Preliminary Assessment of an Implementation of Essential Skills practice

Presenting Author: John Goldak, University of Washington

Additional Author | Peter S Shaffer, University of Washington

For the past year, we have been using the Essential Skills Framework [1] from The Ohio State University in introductory mechanics courses and junior-level quantum mechanics courses at the University of Washington. We present details of the implementation and preliminary findings that suggest that this structured practice can help students become more accurate and fluent in their application of some of the basic skills required in each course.

[1] B. Mikula and A. Heckler, Framework and Implementation for Improving Physics Essential Skills via Computer-Based Practice: Vector Math, Phys. Edu. Phys. Educ. Res. 13, 010122 (2017).

POS-N03 (2:00 to 2:45 PM) | Poster | Understanding Scientific Reasoning of High School Students with CMS Data

Presenting Author: Marla Glover, Purdue University

The skills of scientific reasoning cut across multiple physics activities. Understanding and improving the ability of students to use scientific reasoning is an emphasis of the Next Generation Science Standards. The nature of reasoning skills has not been explored in particle physics with high school students. My research will determine the reasoning skills students use during activities using data from the Compact Muon Solenoid experiment and the degree to which those skills are improved.

POS-N04 (2:45 to 3:30 PM) | Poster | Student Justification for Scientific Claims in Physics and Your World

Presenting Author: Anya Guy, Washington State University

Co-presenting Author | Alexis Pleskovitch, Allegheny College

The Physics and Your World course at Washington State University aims to teach students about core ideas in physical and space science, science and engineering practices covered in the Next Generation Science Standards (NGSS), and how to use the crosscutting concepts also included in NGSS that scientists and engineers use in order to develop and refine their ideas. Qualitative analysis of student responses on the color spectrum worksheet showed that students were able to move through the activity and most were able to justify their claims. However, many students do not back up their answers and even more do not make connections between their observations and the concepts in order to answer all parts of the question. Qualitative analysis on the worksheet questions will be used in the future to make informed changes about the alteration of curriculum.

Session POS-0: Other Poster Topics

Sunday, Jan. 15, 2–3:30 p.m. Moderator: TBA Sponsor: AAPT Pavilion Foyer

POS-001 (2:00 to 2:45 PM) | Poster | Getting from Data to Analysis with Less Pain

Presenting Author: Amy Roberts, CU Denver
Additional Author | Ben Galewsky, UIUC
Additional Author | Andrea Zonca, SDSC

Scientific data comes in many formats, and some of those are better-supported than others. When students begin research projects, it's nice to have datasets that enjoy robust supporting tools like spreadsheet programs and well-supported libraries like python's pandas. Research that starts with custom-format data requires custom programs that read the data and often these programs are difficult for students to start using. In an ideal world, these data would instead be written in a standard data format, but that's often not possible or requires significant disk space. This poster will discuss data description and Kaitai as an alternative for our custom datasets. By describing the data once, Kaitai can generate code that reads the data into data structures in languages like python and C++. With this method, scientists with custom data can become part of a larger community that can share tools, documentation, and improvements.

POS-002 (2:45 PM to 3:30 PM) | Poster | Physics Lab with Drones

Presenting Author: Chadwick Young, Nicholls State University
Additional Author | Kaisa Young, Nicholls State University

We present several undergraduate physics lab experiments that utilize drones and other measurement devices. These labs make use of inexpensive equipment and are intended for the introductory physics lab.

POS-003 (2:00 to 2:45 PM) | Poster | SUPER Cohort Program: Student Wellbeing*

Presenting Author: Peter Sheldon, Randolph College
Additional Author | Meghan Halbrook, Randolph College
Additional Author | Jesse Kern, Randolph College
Additional Author | Sarah Sojka, Randolph College

Randolph College instituted a recruitment and retention program funded by three NSF S-STEM grants that has contributed significantly to the success of our STEM students. We have significantly increased the numbers of our science graduates, particularly in physics. This comprehensive STEM honors program is SUPER: Step Up to Physical Science and Engineering at Randolph. It includes a summer transition program, first-year living-learning community, mentoring, career services, tailored seminars, and enhanced academic support services. The newest iteration of the S-STEM grant focuses on mental wellness and inclusiveness. We will discuss the programs and services we have implemented, and will share any research results that we have about effectiveness.

*This project is supported by the National Science Foundation under Grant Nos. DUE-1153997, 1564970, 2029082. 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.

POS-004 (2:45 to 3:30 PM) | Poster | Mapping out the Puzzles of Nucleosynthesis

Presenting Author: Sean O'Neill, Pacific Lutheran University

For students in introductory astronomy courses, the cosmic origins of the chemical elements provide a rare and striking connection between astrophysics and everyday life. Most students arrive in such courses completely unaware that the majority of chemicals on Earth - including those that comprise the students themselves - were once contained within the stars. The challenge for an astronomy instructor is to guide students through the fascinating implications of nucleosynthesis without losing them in a complicated forest of nuclear reaction pathways. In this presentation, I will share methods for visually representing the essential details of Big Bang and stellar nucleosynthesis by having students trace out the origins of the elements using puzzles and maps. These approaches have been tested using in-person and online lab formats and have been found to help make this intimidating subject more accessible, rewarding, and fun.

POS-005 (2:00 to 2:45 PM) | Poster | Preliminary Findings from Educational QIS Game World Testing

Presenting Author: Devon Christman, UC Santa Barbara
Additional Author | Collin Lejano, UC Santa Barbara
Additional Author | Liliana Garcia, UC Santa Barbara
Additional Author | David Gonzalez-Maldonado, University of Chicago
Additional Author | Tianle Liu, University of Chicago

Assist a forgetful chef in meeting the demands of his zombie customers. Help a werewolf and vampire find buried quantum computer parts. Reduce logic gates to unlock the door to a hidden laboratory. All these things can be done in an effort to introduce Quantum Information Science (QIS) concepts to middle school-aged learners. To make QIS concepts fun and accessible, we developed a whimsical QIS-inspired game world with five interconnected minigames which highlight key topics such as measurement, quantum state, quantum operations, superposition, and entanglement without introducing any mathematics or quantum jargon. As part of an ongoing study, we conducted semi-structured think-aloud

interviews to explore students' (ages 13+) baseline understanding of quantum concepts and what ideas about QIS arise from gameplay. This poster presents preliminary findings from the interviews along with implications and directions for future research and development involving the QIS game world.

POS-006 (2:45 to 3:30 PM) | Poster | Fostering Student Engagement with Socio-scientific Issues and Scientific Literature

Presenting Author: Cassandra Croft, Portland State University

Additional Author | Priya Jamkhedkar, Portland State University

Additional Author | Ralf Widenhorn, Portland State University

With the rapid development of information technology, students have easier access to information than ever before. This also entails that they are more likely to face misinformation and resistance to scientific knowledge. Students must be prepared for scientific citizenship, fostering scientific communication skills and active engagement in scientific issues. We use Deliberative Democracy (DD) active-learning model, a deliberative pedagogy that focuses on socio-scientific issues (SSI) to promote active scientific citizenship & greater awareness of connections between science in the classroom & in daily life. Each DD module presents a SSI that is relevant to current society and to the course curriculum in which these interventions are implemented. Students are tasked to read scientific & media articles, collaborate with peers to identify potential solutions, building scientific models, researching & deliberating solutions through policies and regulations, and communicating these through written assignments. We will walk through the development process in this presentation.

POS-007 (2:00 to 2:45 PM) | Poster | 2-D Resonant Oscillator Demonstration Bowls

Presenting Author: Cheryl Davis, Brigham Young University

Additional Author | Robert Davis, Brigham Young University

Additional Author | Clark Snelgrove, Brigham Young University

In junior level classical mechanics we teach 2-D resonant oscillators but lack good physical demonstrations of this phenomenon. These oscillators are usually represented in textbooks using springs in x and y directions with different spring constants but connected to the same central mass. If a physical demonstration is made using springs, the stretching of the springs couples the x and y motion except at very small amplitudes, limiting our ability to observe the phenomenon clearly. We have developed a demonstration of 2-D oscillators using machined bowls with different curvature in the x and y directions to producing different effective spring constants without coupling the x and y motion. When ky = 4kx, this creates a resonant frequency in the x direction twice that in the y direction and a ball can be rolled in the bowl in a figure-8 pattern as predicted by the 2-D oscillator equations.

Session POS-P: Teaching Physics at Two Year Colleges Posters

Sunday, Jan. 15, 2–3:30 p.m. Moderator: TBA Sponsor: AAPT Pavilion Foyer

POS-P01 (2:00 to 2:45 PM) | Poster | DEI Change Teams Program for TYC Faculty

Presenting Author: Kristine Lui, AAPT/OPTYCs

Co-presenting Author | Glenda Denicolo, Suffolk County Community College

Co-presenting Author | Dwain Desbien, Estrella Mountain Community College

The Organization for Physics at Two-Year Colleges (OPTYCs) will begin a cohort program to support faculty interested in diversity, equity, and inclusion in their classrooms: The DEI Change Teams Program. Participants in this two-year program will begin with a two-day intensive training and planning session. During year one of the program, participants will implement strategies, reflect on their experiences, share with their cohort, all with the support of regular virtual meetings. A one-year reunion in-person meeting is scheduled, with more leadership training, and with the goal of dissemination in year two of the program. Training workshops and discussions sessions will be offered to provide continuous support to participants throughout the two-year program. The DEI Change Teams Program will begin accepting applications summer 2023. OPTYCs is supported by NSF-DUE-2212807.

POS-P02 (2:45 PM to 3:30 PM) | Poster | You Are Not Alone: OPTYCs New Faculty Development Series*

Presenting Author: Krista Wood, University of Cincinnati Blue Ash College

Co-presenting Author | Brooke Haag, Path Stream

Co-presenting Author | Dwain M Desbien, Estrella Mountain Community College

OPTYCs (Organization for Physics at Two-Year Colleges) and American Association of Physics Teachers (AAPT) present an 18-month experience designed specifically for Two-Year College (TYC) Physics Faculty in their first six years of TYC teaching. This New Faculty Development Series (NFDS) will support new full-time, part-time, and prospective TYC physics faculty incorporating student-centered active learning, and research-based instructional strategies for inclusive classroom practices. NFDS is an exceptional opportunity that provides new TYC Physics Faculty (1) a foundation in Physics Education Research (PER) with online discussions, (2) a 4-day Immersion Conference to engage in PER-based instructional and inclusive strategies, (3) online mentoring through the implementation phase, and (4) a 3-day Commencement Conference in conjunction with a National AAPT Conference. This NSF-funded program provides a community to support you and travel funding for the Immersion and Commencement Conferences! Want to learn more? Join us in this poster session and ask us about NFDS!

*(Supported by NSF-DUE-2212807)

POS-P03 (2:00 to 2:45 PM) | Poster | Implementing a CURE in Terminal Introductory Physics Course

Presenting Author: Wayne Manrakhan, Harford Community College

Course-based undergraduate research experiences (CUREs) have been shown to have a number of benefits for students1. This study will detail the design of CUREs for students enrolled in their third semester introductory physics course in the Spring 2023 semester. To tailor the experiences for maximum benefit of the students, the CURE topics will be matched as close as possible to students' interest. The major issues limiting this include limited laboratory and equipment resources and STEM faculty members' time constraints. The first part of the implementation includes a survey of students topic interest (already completed) and a pre-semester meeting between each student and I. This will be completed in the current Fall 2022 semester so that research projects and group members selection is completed before the start of 2023. This report will detail the selected projects and timeline for completion of CURE and proposed evaluation of educational outcomes.

1. Auchincloss, L. C., Laursen, S. L., Branchaw, J. L., Eagan, K., Graham, M., Hanauer, D. I., et al. (2014). Assessment of course-based undergraduate research experiences: a meeting report. CBE Life Sci. Educ. 13, 29–40. doi: 10.1187/cbe.14-01-0004

POS-P04 (2:45 to 3:30 PM) | Poster | CPDW/Tandem Meeting of OPTYCs

Presenting Author: Tom O'Kuma, Lee College

Co-presenting Author | Joe Heafner, OPTYCs

Co-presenting Author | Kris Lui, OPTYCs Director

OPTYCs is The Organization for Physics at Two-Year Colleges (https://sites.google.com/a/aapt.org/comm/optycs). 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 workshops that have already occurred, workshops at the current meeting, future workshops, and the forthcoming tandem meeting in Sacramento. We will also invite TYC physics colleagues to submit ideas for workshop content. OPTYCs is supported by NSF-DUE-2212807.

POS-P05 (2:00 to 2:45 PM) | Poster | The TYC PER-Interest Group

Presenting Author: Glenda Denicolo, Suffolk County Community College, NY

Co-presenting Author | Karim Diff, Santa Fe College, FL

Co-presenting Author | Sherry Savrda, Seminole State College, FL (retd)

The TYC PER-Interest Group is an initiative by OPTYCs (NSF-DUE-2212807) that has the mission to gradually develop and support a more widespread culture of knowledge and involvement in educational research within the TYC physics community. The TYC PER-Interest Group promotes monthly events that include journal club meetings; presentations by TYC practitioners of PER and by PER specialists from the greater community; tutorials on research-validated teaching strategies and assessments; mini-workshops on analysis tools; meetings to connect faculty with similar PER interests; and presentations on ways to disseminate TYC-PER results, with available financial aid to assist TYC PER practitioners in presenting their work at regional and national meetings. Through the OPTYCs website, participants can register for those events, find more information, resources, and contact the facilitators about ideas, suggestions, questions and support.

Plenary I: Centering AAPT Members: How DEI Work Gives Us a Roadmap

Sunday, Jan. 15, 7–8 p.m. **Moderator: Toni Sauncy** **Sponsor: AAPT** **Grand Ballroom I**

Centering AAPT Members: How DEI Work Gives Us a Roadmap

Presenting Author: Catherine Herne, State University of New York at New Paltz

Co-presenting Author | David Marasco, Foothill College

AAPT envisions a world where all physics educators and AAPT staff feel a sense of belonging; where physics educators combat the unconscious harassment and discrimination that is pervasive across the field of physics. AAPT has dedicated intensive resources over the past year to create a roadmap for change. Structural changes will make the member experience better for all of AAPT. In this presentation we lay the groundwork for DEI growth in AAPT and how our members can engage. We share elements of the roadmap, the new proposed governance structure, and discuss AAPT's progress from a historic and current perspective.

Session B1: Advanced Topics for Grades 8-12

Monday, Jan. 16, 9 a.m.–10:30 p.m. **Moderator: TBA** **Sponsor: Committee on Physics in Pre-High School Education** **Pavillion East**

B1-01 (9:00 to 9:10 AM) | Contributed | Using Neutrinos to Emphasize the Process of Science

Presenting Author: Richard Gelderman, Western Kentucky University

To better appreciate the process of science, encourage students to compare neutrinos to supernatural/psuedoscientific beings claimed to be undetctable (e.g., ghosts, angels, Big Foot, Nessie, ...). In 1930, a new subatomic paticle was proposed to preserve Conservations Laws during beta decay. This particle would have to have no electric charge and very, very low mass - hence interaction with other matter would be miniscule. In 1956 Project Poltergeist detected neutrinos emanating from nuclear reactors. Another 12-years were required to dectect neutrinos created in fusion reactions powering our Sun, and the repeated result of only 1/3 the predicted number of neutrinos becomes the new conundrum. It takes until 2002 to establish evidence for the spontaneous changes between types as a solution to this solar neutrino problem. A lifetime of studying neutrinos

provides mysteries about our understanding of subatomic physics. Use these outstanding questions to remind students that unexplained phenomena drive science.

B1-02 (9:10 to 9:20 AM) | Contributed | Teaching Special Relativity to Talented High School Students

Presenting Author: James Lupton, Greenhills School

Special Relativity in High School is a challenging yet accessible subject. Special Relativity lends itself to careful thinking about relations in time and space that challenge and motivate young minds. As we prepare our students for the science of the Twenty First Century we are obligated to seek new and inovative ways of presenting challenging physics. I will share my experience in teaching Special Relativity in High School including pitfalls and successes.

B1-03 (9:20 to 9:30 AM) | Contributed | Using Mechanical Models to Teach Secondary School Students Particle Trapping

Presenting Author: Sebastian Kilde Löfgren, Department of Physics, University of Gothenburg
Additional Author | Jonathan Weidow, Department of Physics, Chalmers University of Technology
Additional Author | Jonas Enger, Department of Physics, University of Gothenburg

Using models in the physics laboratory allows students to explore phenomena in new ways that could improve understanding. However, it is necessary to provide adequate instruction to help guide students ability to relate models to the actual phenomenon. A mechanical Paul trap and a simulation were used to investigate the usefulness of toy models in the physics laboratory, to help students understand how a real Paul trap works. This was done by developing a laboratory exercise using a design-based approach over three iterations, involving 12 classroom observations in six upper secondary schools in Sweden. Using variation theory to understand and inform how students learn during the lessons, student interviews, field notes, and pre- and post-tests were analyzed to identify critical aspects. Results from the study provide further insight into the role of toy models in physics education and how variation theory can be used to design effective physics laboratory exercises.

B1-04 (9:30 to 9:40 AM) | Contributed | Introducing Quander: A QIS Game World for The Secondary Level

Presenting Author: Devon Christman, UC Santa Barbara
Additional Author | Liliana Garcia, UC Santa Barbara
Additional Author | Collin Lejano, UC Santa Barbara
Additional Author | Kaylee Laub, UC Santa Barbara
Additional Author | Tianle Liu, University of Chicago

What does a vampire, a zombie cupcake chef, and a werewolf have to do with QIS? They are characters in a new game world to introduce Quantum Information Science (QIS). QIS combines quantum mechanical effects with information science for applications in communication, sensing, and computing. The gateway to this rapidly growing multidisciplinary field is often upper-level undergraduate chemistry, computer science, and physics courses. However, these fields lack the diversity that is representational of our global community. To foster interest in QIS and inspire a wider audience of learners, we developed Quander, a game world with five interconnected QIS- themed minigames aimed to capture the interest of middle school-aged students and inspire them to view QIS as a field that is open to them. This talk presents the game world, its QIS connections, and how these games can be used as a gateway to QIS for young and diverse learners.

B1-05 (9:40 to 09:50 AM) | Contributed | Jupyter Notebooks, Data, and QuarkNet (Oh, my!)

Presenting Author: Charlie Payne, North Carolina School of Science and Mathematics

Data sets, large or small, from the web or produced by students, all provide insights into physics that might be difficult to produce in a school lab setting. Each year QuarkNet provides opportunities for teachers to incorporate these methods into their classrooms. The programming language Python is relatively easy to learn and using Jupyter Notebooks the analysis can be online in such GUIs as Google Colabs This presentation will demonstrate some programming to examine simple data sets such as in a lab as well as the utilization of open access particle physics data from CERN to determine muon mass and data from LIGO to examine gravitational waves.

B1-06 (9:50 to 10:00 AM) | Contributed | Neutrino Physics Masterclasses

*Presenting Author: Shane Wood, QuarkNet**

Each year in International Masterclasses, more than 13000 high school students become “particle physicists” for a day at one of over 200 nearby universities or laboratories around the world. These students work with physicists to learn about 21st century research and to analyze authentic data from one of several particle physics experiments. Ideally, high school teachers are involved as well, and can prepare their students for the Masterclass day by using provided classroom activities that connect to topics and standards typically covered in introductory physics classes. This talk will focus on Neutrino Masterclasses featuring data from neutrino experiments such as MINERvA and NOvA. Learn how you can become involved in this exciting opportunity that brings 21st century physics to high school students!

*QuarkNet is funded by the National Science Foundation.

B1-07 (10:00 to 10:10 AM) | Interactive (e.g. panel, round table discussion, hands-on activity) | Motivating Teachers/Students to Learn Quantum Science via Engaging Activities

Presenting Author: Maajida Murdock, Morgan State University

Informal science education activities (ISEA) have long played an essential role in helping create and recruit the next generation of scientists. Facilitators not having constraints from the curriculum, textbooks, and tests have a freedom that allows creative and culturally relevant learning experiences of science. This freedom can present opportunities for engagement by presenting Quantum Science key concepts to the K-12 teachers

and students and communicating exciting results from the researcher's work allowing K-12 teachers and students to have more access to science. This presentation will demonstrate the use of the two-way interactive method to bring science "alive," sparking interest and stimulating curiosity.

B1-08 (10:10 to 10:20 AM) | Interactive (e.g. panel, round table discussion, hands-on activity) | Using Neutrino Science to Engage Students in the K-12 Classroom

Presenting Author: Chad Ronish, Sanford Underground Research Facility

At the Sanford Underground Research Facility, the home of the detectors for the LBNF/DUNE experiment, we leverage the challenges of performing neutrino physics experiments almost a mile underground. Our presentations, activities, and curriculum units allow students to explore the history of neutrino science with the Ray Davis Experiment and the Solar Neutrino problem through the current investigations into Neutrino Oscillations and Symmetry investigations. Students have the chance to investigate the engineering challenges of an underground research lab, detector design and construction, and the science behind experimenting with almost undetectable particles. We use a 3-Dimensional, Next Generation Science Standards approach in all of our resources and instruction that allow students to anchor their questions and learning on the phenomena of neutrino science. Our variety of resources allows us to work with local, regional, national, and international student groups and locations. Come explore Neutrino Science in the classroom with SURF!

The Education and Outreach program is a collaborative venture between Sanford Underground Research Facility and Black Hills State University. Our goal is to use the excitement and promise of deep underground science and engineering to inspire and engage students, educators, and the wider community through a variety of programming, including:

Curriculum units tied to the science and engineering taking place at Sanford Lab

Onsite surface tours, workshops, and presentations for K-12 school field trips

Offsite workshops and presentations at schools and communities across South Dakota and the surrounding region

Distance Education utilizing videoconferencing technology

Undergraduate internships

Professional development opportunities for educators

Davis-Bahcall Scholars summer program

Education and Outreach staff are committed to increasing the number of students pursuing Science, Technology, Engineering and Mathematics (STEM) careers, especially students who belong to groups historically under-represented in those fields.

Session B3: Computational Physics and Quantum-PER and Practice

Monday, Jan. 16, 9 a.m.–10:30 p.m. Moderator: TBA Sponsor: AAPT Galleria North

B3-01 (9:00 to 9:10 AM) | Contributed | Computational Projects with the Quantum Landau-Zener Problem for Undergraduates*

Presenting Author: James Freericks, Georgetown University

Additional Author | Livia A. J. Guttieres, University of Chicago

Additional Author | Marko D. Petrovic, Georgetown University

There is a growing consensus to include computational pedagogy within physics coursework. We discuss how the Landau-Zener problem, where a minimum energy separation is passed with constant velocity in a two-state quantum-mechanical system is an excellent example of a computational project. It teaches computational concepts such as accuracy, discretization, and extrapolation, and reinforces quantum concepts of time-evolution via a time-ordered product and of extrapolation to infinite time via time-dependent perturbation theory. We feel it is an ideal project to consider using in a quantum mechanics setting---it requires a low-level computational effort, but has a number of complex numerical and algorithmic issues that can be resolved through dedicated work. In addition, if time allows, we will discuss the concept of compression algorithms, which are employed in many advanced quantum computing strategies---compression algorithms are easy to implement and examine within the Landau-Zener problem.

*This work was supported by the NSF under grants numbered DMR-1950502 and PHY-1915130 and from the DOE under grant number DE-FG02-08ER46542.

B3-02 (9:10 to 9:20 AM) | Contributed | Teaching, Learning, Research and Developing Materials for Quantum Computing Courses

Presenting Author: Beth Thacker, Texas Tech University

Additional Author | Tunde Kushimo, Southern Methodist University

Quantum Information Science and Quantum Computing are exciting fields that draw from information theory, computer science, mathematics, and quantum physics to process information in fundamentally new ways. Although the field of Quantum Computing is not entirely new, interest in it has accelerated in recent years. The development of quantum computers and advancement in quantum information technology must be accompanied by a push for the design and development of courses, curricular materials and pedagogical approaches needed to expand and support an inclusive quantum workforce. We discuss the development of a Quantum Computing course at Texas Tech University in an interactive-engagement, semi-flipped classroom environment. We also present research on students' understanding of topics taught in the course, research on students' strengths and difficulties in learning the topics. This research aims to inform the design and modification of pedagogical strategies and materials used in teaching an introductory course in Quantum Computing.

B3-03 (9:20 to 9:30 AM) | Contributed | Quantum Mechanics Students' Understanding of "Discrete", "Continuous", and Computational Approximations

Presenting Author: Christian Solorio, Oregon State University

Additional Author | Elizabeth Gire, giree@oregonstate.edu

Additional Author | David Roundy, roundyd@oregonstate.edu

Institutions are teaching quantum mechanics with a "spins-first" more commonly, where students are first introduced to quantum mechanics with spin systems and later learn about systems with wavefunctions. We are studying the ideas that students have about discrete bases, continuous bases, and the ways that they connect the two. We interviewed six participants concurrently enrolled in a spins-first course and a computational lab course. The activity of the interview was a card sorting task. Participants organized twenty cards with a variety of quantum mechanics concepts and notations including Dirac notation, matrix notation, function notation, and code snippets. In this talk, we will discuss the ways participants described what it means for quantum states and bases to be discrete and continuous. Additionally, we will discuss the ways students connected discrete and continuous in the context of computational approximations.

B3-04 (9:30 to 9:40 AM) | Contributed | Implementation of Essential Skills Practice in a Quantum Mechanics Course

Presenting Author: John Goldak, University of Washington

Additional Author | Peter S Shaffer, University of Washington

At the University of Washington, we have been using the Essential Skills Framework from The Ohio State University [1] in our introductory mechanics course and adapting it for use in the first quarter of the junior-level quantum mechanics course. We discuss the motivation and the implementation of this system in the quantum course. Results from the practice questions that have been implemented corroborate the difficulties that students have in quantum mechanics as shown through prior research as well as providing additional insights into student reasoning. Preliminary findings also suggest that this structured practice can help students become more accurate and fluent in their application of some of the atomistic skills required to solve quantum mechanics problems.

[1] B. Mikula and A. Heckler, Framework and Implementation for Improving Physics Essential Skills via Computer-Based Practice: Vector Math, Phys. Edu. Phys. Educ. Res. 13, 010122 (2017).

B3-05 (9:40 to 9:50 AM) | Contributed | Modified Color Frames for Analyzing Group Interactions During Online Tutorial

Presenting Author: Bianca Cervantes, California State University, Fullerton

Additional Author | Gina Passante, California State University, Fullerton

Additional Author | Giaco Corsiglia, University of Colorado, Boulder

Additional Author | Steven Pollock, University of Colorado, Boulder

In this paper, we analyze video recordings of student groups working on tutorials during a distance-learning upper-division quantum mechanics course. We investigate group behaviors in this virtual environment, including the effects of instructor presence. Modifying the Color Frames coding scheme allows for multiple overlapping frames, describing some group behaviors not otherwise captured. Examples include when students take on in-group authority roles, and when they engage in "friendly" on-topic discussion. We observe significant variation in group time spent in each frame, though all groups spend time in all frames. Instructors can be present without dominating or eliminating discussion between students, are found to significantly reduce group time spent working individually, and may not impact time spent in a "friendly" frame. Our findings will support additional research into dynamics of student discussions during tutorials and aid ongoing development of online tutorials that can, e.g., be assigned for use outside of class

B3-06 (9:50 to 10:00 AM) | Contributed | Quantum Science in Visible Range

Presenting Author: Yogesh Vijay, IIS deemed to be University, Jaipur 302020, INDIA

The fundamental interaction and collective behaviour could be demonstrated throgh physical modeling where quantum science principles and phenomena could be bought in the range of human perception. We have designed and developed several models to illustrate the phenomena like Van der Wal force, dipole interaction, equlibrium in a plan, atomic configuration, Bohe orbitals, Raman effect, Rutherford scattering, Molecular vibration modes etc. All these are mechanical models working at low frequency range depicting quantum phenomena in visible range. The material used for developing these models are permanent magnets, balls, springs and audio signal generator. In Van del wal force the superposition of gravitational and magnetic interaction is used. In Raman model the energy transfer as a function of phase of the pendulum is used. For Bohe orbitals stationary waves in circular loop are generated. Simple molecules like water, methane and amonia are made using springs and balls .

Session B4: Critical Race Spatial Analysis: Methodological Possibilities for Mapping Injustice Monday, Jan. 16, 9 a.m.–10:30 p.m. Moderator: Amy Robertson / Co-Organizer: Vero Velez Sponsor: Committee on Diversity in Physics, Grand Ballroom II

B4-01 (9:00 to 9:30 AM) | Back to Basics with Critical Race Theory

Presenting Author: Katemari Rosa, Federal University of Bahia

Critical Race Theory (CRT) is a movement that emerged in the 1970s within legal studies, interrogating racism as the underlying structure in our society. Over time, CRT ideas, concepts, and methodologies reached various academic fields such as education. In this presentation, I will examine a set of basic tenets of CRT, including the social construction of race, normality of racism, interest convergence, differential racialization, intersectionality, and people of color voices' recognition. In addition, let's discuss how CRT connects with physics education. Finally, I hope to show the implications CRT can bring to our understanding of physics teaching and learning, our practice, and our research.

B4-02 (9:30 to 10:00 AM) | Advancing Critical Race Spatial Analysis with Rural Latinx Youth

Presenting Author: Mayra Puente, Gevirtz Graduate School of Education, University of California, Santa Barbara

This presentation advances critical race spatial analysis (CRSA) by proposing the Chicana/Latina feminist methodology of Platicando y Mapeando. By drawing on critical raced-gendered epistemologies and Chicana/Latina feminist methodology of pláticas, the use of digital map-making (GIS) is transformed into a collectivist endeavor that depicts embodied and situated knowledges for social justice. This article outlines five principles of a Platicando y Mapeando methodology and provides a case study of the college (in)opportunities available to rural Latinx youth from California's San Joaquin Valley to illuminate the significance of this methodology for researchers and educators interested in interrogating the intersections of race, gender, space, and educational (in)opportunity. We explore what these findings mean for scaffolding students' understanding of spatiality, which deepens how Platicando y Mapeando furthers critical approaches to exploring and learning about space and place.

B4-03 (10:00 to 10:30 AM) | Critical Race Spatial Analysis: Exploring Map-Making as Anti-Racist Praxis

Presenting Author: Veronica Velez, Western Washington University

Critical race scholars in education recently developed a methodological framework that employs digital map-making (GIS) and spatial analysis from a critical race lens (Vélez & Solorzano, 2017). This approach, known as critical race spatial analysis (CRSA) extends GIS from its traditional use in geography and urban planning into new avenues and possibilities for educational inquiry concerned with the socio-spatial relationship between race and educational (in)opportunity. By (re)imagining how socio-spatial relationships are explored, analyzed, and displayed, CRSA positions GIS as a critical research and pedagogical tool for furthering racial justice. This presentation introduces CRSA and explores its potential as anti-racist praxis. We will examine its theoretical and methodological origins and discuss how it centers an iterative process of reflexivity, where the map-maker is attuned to their own epistemological anchors that shape their construction and use of maps. We will end with implications for physics classrooms and inquiry.

B4-04 (10:30 to 11:00 AM) | Panel Discussion

Presenting Authors: Amy Robertson, Vero Velez

Panel Discussion

Session B5: Engaging Students with Games and APPs Monday, Jan. 16,

9 a.m.–10:30 p.m. Moderator: Erick Agrimson Sponsor: Committee on Educational Technologies Pavillion West

B5-01 (9:00 to 10:00 AM) | Interactive (e.g. panel, round table discussion, hands-on activity) | Engage Every Student With Phenomena's New Interactive STEM Experiences

Presenting Author: Jessica Silverman, Phenomena

Co-presenting Author | Jared Schiffman, Phenomena

Co-presenting Author | David Nguyen, Phenomena

Dynamic STEM concepts are best conveyed through dynamic experiences, where students learn by seeing and doing. Phenomena is a new creator-driven app for STEM learning developed by three MIT alums with bite-sized interactive experiences for students in grades 5-12. Phenomena's experiences build intuition, simplify complex ideas, and nurture hands-on, interactive learning. Teachers can use Phenomena experiences as a "do-now", a demonstration, an inquiry-based lab or to bring textbook readings to life. Experiences are highly visual and modular, allowing for personalized support by addressing learning gaps, providing extension opportunities and overcoming reading or language barriers. In this hands-on session, participants will learn how to use Phenomena's standards-aligned experiences to engage every student. Participants will explore the experiences library, identify experiences they can incorporate into their existing curriculum, and learn how to share these experiences with their students through Phenomena courses. The session will conclude with a moderated Q&A discussion.

Session B6: Graduate Education in Physics Topical Discussion Monday, Jan. 16,

9 a.m.–10:30 p.m. Moderator: Shannon Willoughby Sponsor: Committee on Graduate Education in Physics Galleria South

In this topical discussion, various stakeholders will discuss how graduate admissions have been and continue to change since the start of the COVID pandemic.

Session B7: Ideas and Activities for Intro College Physics Monday, Jan. 16,

9 a.m.–10:30 p.m. Moderator: TBA Sponsor: AAPT Broadway I/II

B7-01 (9:00 to 9:10 AM) | Contributed | Interdisciplinary Diffusion Lab

Presenting Author: Sable Canales, Andrews University

Additional Author | Micky Kutzner, Andrews University

Additional Author | Chloe Gaban, Andrews University

Diffusion is a principle in Physics, Chemistry, and Biology. The rate of diffusion is affected by temperature, particle size, concentration, and material type. Students can model the rate of diffusion based on particle size by contrasting blue and yellow dyes. Two petri dishes containing agar-agar receive a drop of dye at the center. The radius of expansion is recorded over time. The variance of the distribution grows as $sigma^2 = 4Dt$, where sigma2 is the variance, D is the diffusion constant, and t is time. Graphing variance versus time gives a slope of 4D. Diffusion constants vary by particle size, allowing for a size ratio comparison between blue and yellow dyes. Relating this to cells, students predict that smaller molecules diffuse into living cells, whereas larger molecules need some assistance from protein channels as in facilitated diffusion. In Physics and Chemistry, the data can be related to Kinetic Energy.

B7-02 (9:10 to 9:20 AM) | Contributed | Student Machine Learning Projects

Presenting Author: Donald Smith, Guilford College

I will present my observations of student machine learning projects from three different general education classes. As part of a class on Galaxies and Cosmology, I guided the students through an application of neural network classification of galaxy images. I also taught two three-week, intensive, project-based courses on Machine Learning. Students learned tools to classify, predict, and generate data, and then they developed their own projects. Students in the cosmology class were much less comfortable with quantitative analysis than those who specifically chose a machine learning class. For their projects, students in the Machine Learning course tended to pick either image classification projects or predictive projects, usually relating to some kind of competition. I will share my recommendations for how to make Machine Learning less intimidating to beginning students and what approaches to avoid.

B7-03 (9:20 to 9:30 AM) | Contributed | Practice Makes Better: Benefits of Practice Study in Introductory Physics

Presenting Author: William Black, University of Michigan

Additional Author | August E Evrard, University of Michigan

Additional Author | Mark Mills, University of Michigan

Additional Author | Rebecca L Matz, University of Michigan

Problem Roulette is an online study service offering low-stress practice to students preparing for examinations in introductory STEM subjects at University of Michigan. Using four years of service data, involving millions of questions attempted by thousands of students, we quantify the benefits of increased practice study volume in introductory physics. Relative to a mean grade conditioned on students' ACT or SAT math score, we find that grade point earned rises roughly quadratically with the logarithm of NQ, the total number of questions attempted over the term, with an overall gain of 0.75 ± 0.15 points between $0<NQ<1000$. Using both test score and study volume to predict final grade, we measure demographic deviations, noting significantly lower scores among students whose parents never earned a college degree. Our findings can motivate low-volume students to study more and help teachers identify which types of students especially need such encouragement.

B7-04 (9:30 to 9:40 AM) | Contributed | Case Studies in the Large-Enrollment Introductory Physics Classes

Presenting Author: Tetyana Antimirova, Toronto Metropolitan University (formerly Ryerson)

One of the valid arguments against overuse of the multiple-choice questions for instructions and evaluation is that they do not allow the students to explicitly formulate their own ideas. Mini-case studies can provide a viable alternative allowing students to explore more open-ended scenarios with a potential to reduce the reliance on multiple-choice format questions. Course materials, in the form of case studies were created for use in the large-enrollment introductory physics classes for science programs. They were designed to target the most fundamental concepts of the first-year physics curriculum. These case studies are being used for collaborative group in-class activities in the partially flipped classroom. Examples of the activities will be demonstrated and discussed.

B7-05 (9:40 to 9:50 AM) | Contributed | Six HTML5 Simulators for a Next Gen PET course

Presenting Author: Steven Sahyun, University of Wisconson - Whitewater

This talk describes several single-concept simulators I created after attending an AAPT HTML5 workshop. While these simulators have been specifically developed to aid instruction for a Next Gen Physics and Everyday Thinking (Next Gen PET) guided-inquiry course [1], they have also been helpful for instruction in other introductory courses. These available sims [2] can be used as dynamic diagrams to complement student discussions during in-class activities relating to the concepts of: initial models ("Mystery Tube"), Newton's Second Law, Centripetal Force, Drag Force, Reflection and Refraction. The "Mystery Tube" sim was developed so that remote and on-line students could participate in an activity that would have otherwise only had an apparatus available in-class.

[1] F. Goldberg, et al. Next Gen PET (Activate Learning, 2007)

[2] S. Sahyun. http://sahyun.net/html5.php

B7-06 (9:50 to 10:00 AM) | Contributed | Worksheets to Accompany HTML5 Physics Simulations

Presenting Author: Andrew Duffy, Boston University

There is a nice collection of HTML5 physics simulations available, at https://physics.bu.edu/~duffy/sims.html We have been starting to collect worksheets to go with these simulations, to make the simulations more useful for teaching and learning. Some of these worksheets have been developed by us at Boston University, and others have been written by participants in AAPT workshops. We'll use this talk to give some examples of the worksheets.

B7-07 (10:00 to 10:10 AM) | Contributed | Apps as a Final Project Idea for First Year Class

Presenting Author: Erick Agrimson, St. Catherine University

At St. Catherine University, I used the idea of an app to re-invent the traditional final in the calculus based physics course. Rather than offer a paper exam, I had the students instead create an app, or the idea of what one would look like as thier final project. I will show how I constructed the project as well as will show some of the student examples garnered by using this as a way to have a final in the course. The results were very interesting and allowed students a fair amount of creativity and additional learning in the course.

B7-08 (10:10 to 10:20 AM) | Contributed | Embedding Global Competencies into the Introductory Physics Curriculum

Presenting Author: Irene Guerinot, Maryville College

Science does not happen in a vacuum. Women make up less than thirty percent of the workforce in STEM fields in the US and despite increases in the number of women earning degrees in physics, the proportion of women in this field averages 20% (the lowest of all the physical sciences). Through research, interviews, and conversations students in my introductory physics classes (algebra-based & calculus-based) have analyzed experiences females (all over the world) in STEM fields encounter(ed). The interviewees ranged between four continents and three generations. The students got a sense of the treatment and struggles these women faced; got a sense of how similar and how different these experiences between continents have been; got a sense of how similar and how different those experiences might be between generations. I will report on the student learning outcomes, the students' reactions to this project, the challenges faced, and the knowledge gained.

B7-09 (10:20 to 10:30 AM) | Contributed | Differential Equations in Physics

Presenting Author: Nathan Netzer, Braude College, Karmiel, Israel

Since freshmen have not yet undergone any course of differential equations, it is common to give the solution of an equation without a proof. I think that by doing so, one misses an important point. The matter of fact is that these equations are very few, the first and simplest of them can be solved very easily, whereas the others can be derived from it step by step. In addition to reasoning the solution, one achives by this two goals: (a) These equations are useful for a large variety of cases. In a course of electricity and Magnetism, all the equations needed are those known from mechanics and no new equations are involved. (b) It turns out to be very useful for the mathematical course in differential equation, taught commonly at a later stage, since it gives differential equations the proper context. We demonstrate how to do it.

B7-10 (10:30 to 10:40 AM) | Contributed | CloudLab – Physics Experiments Operated Remotely Online

Presenting Author: Takashi Sato, Kwantlen Polytechnic University

When lab equipment is operated via a computer, an offsite user remotely logged on to that computer can control the experiment. We have been operating two such experiments at Kwantlen Polytechnic University (KPU) since 2017 as part of an online lab section for first year physics. Referred to as CloudLab, students connect to the equipment, instructor and other students using Zoom. Originally developed as RWSL and NANSLO in grant funded consortia, the current implementation at KPU includes a "cart on an inclined track" and a "electron charge to mass ratio" (or "e/m") experiments. We have also worked successfully to provide access to classes at other institutions. Hardware, software, student and instructor experiences, as well as future expansion plans are described.

Session B8: SEA Change for Physics and Astronomy

Monday, Jan. 16, 9 a.m.–10:30 p.m. Moderators: Juan Burciaga / David Marasco Sponsor: Committee on Physics in Undergraduate Education / Committee on Diversity in Physics Broadway III/IV

B8-01 (9:00 to 9:30 AM) | Physics and Astronomy SEA Change – Where Are We Now?

Presenting Author: Alexis Knaub, AAPT

The Physics and Astronomy STEMM Equity Achievment (SEA) Change is a collaboration among multiple physics and astronomy professional societies within the AIP Federation, as well as AAAS SEA Change. P/A SEA Change involves departments undergoing a self-assessment, reflecting on what the data tell them, and creating a 5-year action plan, with metrics, to address some of the equity, diversity, and inclusion issues. We have two cohorts and are planning to for a full program. This presentation provides an overview of our past, what we have learned, and discussion for P/A SEA Change's future.

B8-02 (9:30 to 10:00 AM) | AAAS Self-Assessment of Diversity, Equity, and Inclusion for STEMM Professional Societies: Reflections and Future Actions at AAPT

Presenting Author: Beth Cunnigham, AAPT

The American Association of Physics Teachers participated in a pilot of the American Association for the Advancement of Science's Self-Assessment of Diversity, Equity, and Inclusion (DEI) for STEMM (Science, Technology, Engineering, Mathematics, and Medicine) Professional Societies[1] in late 2021 and early 2022. AAPT was one of four professional societies that participated in the pilot. The self-assessment is the first in an iterative process that professional societies can take in developing an action plan around DEI. AAPT completed three sections: Education, Professional Development, and Certification; Publishing; and Community Building. Completing these sections involved a strong collaboration between AAPT staff and members. The results of the self-assessment were used in the development of the DEI Roadmap and 2022 AAPT Strategic Plan. A summary of how the self-assessment has been leveraged, its future use, and the status of completing other sections of the self-assessment will be discussed.

Session B9: Ideas for HS and AP Physics

Monday, Jan. 16, 9 a.m.–10:30 p.m. Moderators: TBA

Sponsor: Committee on Physics in High Schools Skyline II

B9-01 (9:00 to 9:10 AM) | Contributed | QQTs with NTQs: Multiple Representation Questions from Next Time Questions

Presenting Author: Oather Strawderman, Lawrence Free State High School

On both the AP Physics 1 and AP Physics 2 exams, one of the types of Free Response Questions is the Qualitative Quantitative Translation question. This question type assesses student ability to translate between quantitative and qualitative justification and reasoning. The ability to not only utilize multiple representations, but to also relate one representation to another is a very challenging task model. A great source for creating your own Qualitative Quantitative Translation questions is Next Time Questions. During this talk, we will work through several Qualitative Quantitative Translation questions created using Next Time Questions. We will also practice creating some Qualitative Quantitative Translation questions so you can use this great resource to help your students prepare for one of the Free Response Questions found on both the AP Physics 1 and AP Physics 2 exams.

B9-02 (9:10 to 9:20 AM) | Contributed | Electrifying the Circuits Unit; Project-Based Circuits Instruction

Presenting Author: Alissa Sperling, Springside Chestnut Hill Academy

Co-presenting Author | Ellen Kruger, Springside Chestnut Hill Academy

Engage your students in the hands-on creation of circuit-based board games! Learn about the development and implementation of a project-based circuits unit for introductory ninth-grade physics. In this project, students work in small groups to design and construct tabletop board games that integrate electrical components like buzzers, motors, bulbs, and switches in creative gameplay. Throughout the game design and testing, students are challenged to put their conceptual knowledge of circuits into action and build the circuits that they've learned about through lectures and labs.

B9-03 (9:30 to 09:30 AM) | Contributed | Patterns Physics and Physics First: supporting the NGSS in Oregon

Presenting Author: Stephen Scannell, Gresham-Barlow School District

Co-presenting Author | Bradford Hill, Beaverton School District

There has been a significant shift over the past decade in how Physics is taught in Oregon's high schools. The convergence of the Next Generation Science Standards (NGSS), with its emphasis on 3D learning and Equity, and the development of the Patterns Physics, a physics-first curriculum that is teacher-developed and supported using a continuous improvement model through the Portland Metro STEM Partnership, has significantly changed the teaching of high school science in the state. It is estimated that over 50% of Oregon's 9th grade students are taking Patterns Physics and the number is increasing. This talk will provide key components of the Patterns Approach that illustrate how we build students' skills through four anchoring experiments that contextualize four common patterns in physics. We will show how we use phenomena to drive each unit, how this approach supports student learning, and how this approach has helped teachers be more effective.

B9-03 (9:20 to 10:10 AM) | Interactive (e.g. panel, round table discussion, hands-on activity) | Sharing Best Practices for AP Physics - New Approach

Presenting Author: Anjuli Ahooja, Appleby College, Oakville, Canada

The speaker has 20 years' experience of developing and implementing AP Physics program and teaching AP Physics courses with much success. The program has grown from three students to five SECIONS of AP Physics 1 and 2 in the school. The session will focus on sharing best practices and ideas for instruction, pedagogy, and usage of educational technology helpful for learning physics. During the session, the speaker will also share details of experiments/rubrics and two projects, namely, DEI/Global and Design Thinking projects.

Awards Session: 2023 Richtmyer Memorial Lecture Award, Jocelyn Bell Burnell

Monday, Jan. 16, 11 a.m.–12 p.m.

Moderator: Jan L. Mader Sponsor: AAPT Grand Ballroom I

AAPT PHYSICS EDUCATION®

We Are Made of Star Stuff

Starting with the Periodic Table of the chemical elements, I will explain how those chemical elements important for human life were created in the cosmos and then came to be in our bodies.

Jocelyn Bell Burnell is receiving the 2023 Richtmyer Memorial Lecture Award. She is recognized with the award for outstanding contributions to physics and for effectively communicating those contributions to physics educators. Jocelyn Bell Burnell is Dame of the British Empire, and a professor of Astrophysics at Oxford University. She graduated from the University of Glasgow with a Bachelor of Science degree in Natural Philosophy (physics) and obtained a PhD degree from the University of Cambridge. At Cambridge, she attended New Hall, Cambridge, and worked with Hewish and others to construct the Interplanetary Scintillation Array just outside Cambridge to study quasars, which had recently been discovered.

Session C1: 30 Demos and Building Things Monday, Jan. 16, 2:30–4 p.m.

Moderator: TBA Sponsor: AAPT Pavillion West

| Interactive (e.g. panel, round table discussion, hands-on activity) | Physics Demos Galore!

Presenting Author: Sean Lally, Jemicy School

Physics teachers of a certain age may remember Julius Sumner Miller or Mr. Wizard. Miller, in particular, was the first physics teacher I remember seeing (on public television). He captured my imagination immediately, and I was not only sold on physics, but also on the power of a good demonstration. In this talk, I will share some of my favorite demonstrations, largely learned from better and wiser teachers than myself. I will focus on demos that require only humble materials, as well as a few that are more elaborate.

| Interactive (e.g. panel, round table discussion, hands-on activity) | Building Things in Physics Classes

Presenting Author: Sean Lallly, Jemicy School

You might be surprised (and perhaps a little dismayed) to learn how few of your students have actually built things with their own hands. Physics teachers have a unique opportunity to allow students to build their own lab devices. In doing this, I have found that students usually take ownership of their learning and better understand how things work. In this workshop, I will describe many of the things I have students build (toy cars, mobiles, motors, microphones, speakers, musical instruments, pickups, etc.), discuss the physics being taught, and suggest useful tools and practices.

Session C2: Best Practices in Educational Technology Monday, Jan. 16, 2:30–4:30 p.m.

Moderator: Andrew Duffy Sponsor: Committee on Educational Technologies Broadway III/IV

C2-01 (2:30 to 3:00 PM) | Developing Physics Identity and Epistemology in Virtual Reality Labs

Presenting Author: Jared Canright, University of Washington

Additional Author | Suzanne White Brahmia, University of Washington

The Novel Observations in Mixed Reality (NOMR) project at the University of Washington uses virtual reality (VR) technology to create a space where students experience and investigate fictitious physical phenomena to develop their scientific modeling skills. NOMR is administered as a three-week freshman-level lab introducing students to multiple novel phenomena, and as a four-week lab emulating the experience of working within a scientific collaboration to iteratively create, test, and refine mathematical models for novel phenomena. We hypothesize that the latter form may facilitate students' development of science identity through a combination of VR's affordances as a medium for identity exploration and the pedagogical framing of the lab. In this talk we present both forms in detail, discuss how each creates a microcosm of the authentic practice of science, and present findings from a mixed-method study into its impacts on students' science identity and epistemology about experimental physics.

C2-02 (3:00 to 3:30 PM) | Searching for the Interconnected Web of Learning Objectives

Presenting Author: KC Walsh, Oregon State University

To build adaptive learning systems specific to physics the interconnected web of learning objectives needs to be mapped. Which questions predict success on which other questions and what features about the questions are driving the predictions? We have written over a 1500 Open Education Resource questions that students answer in homework. Machine learning is used to predict how students perform on a new question using the results of previous questions as inputs to the model. Using the prediction coefficients, alongside a set of question features such as Blooms taxonomy, degree of scaffolding, and fine grain learning objectives, the "genome" of learning can be studied and underlying patterns in the structure discovered.

C2-03 (3:30 to 4:00 PM) | Using Multimedia to Adapt Interactive Lecture Demonstrations for Home Use

Presenting Author: David Sokoloff, University of Oregon

As the pandemic thrust the need for distance learning upon us, hoped to retain active learning for our introductory physics students. I will describe the use of available multimedia (videos, simulations, photos, computer-based laboratory graphs, etc.) to adapt Interactive Lecture Demonstrations (ILDs) (1), (2), (3) to ones usable by students at home (4). Since some may find implementing small-group discussions and sharing to be difficult, these are not required. However, Home Adapted ILDs do retain the use of predictions to engage students. After reviewing the design features of ILDs, this talk will describe some of the multimedia resources that are freely available, and present some examples of Home Adapted ILDs that incorporate them.

(1) David R. Sokoloff and Ronald K. Thornton, "Using Interactive Lecture Demonstrations to Create an Active Learning Environment," Phys. Teach. 35: 6, 340 (1997).

(2) David R. Sokoloff and Ronald K. Thornton, Interactive Lecture Demonstrations (Hoboken, NJ, John Wiley and Sons, 2004).

(3) David R. Sokoloff, "Active Learning of Introductory Light and Optics," Phys. Teach. 54: 1, 18 (2016).

(4) https://pages.uoregon.edu/sokoloff/HomeAdaptedILDs.html

C2-04 (4:00 to 4:30 PM) | 3D Labs

Presenting Author: Lori Shaaban, Liberty High School / Portland State University

Additional Author | Ralf Widenhorn, Portland State University

We are making use of new technologies to quantitatively analyze three-dimensional motion. A standard webcam and Google MediaPipe can be used to infer 3D landmarks (e.g. the elbow) on the human body. As an example, this setup can be used to teach angular velocity, balance, and center of mass while tracking a person's motion. Another method to study 3D motion is the use of the Intel RealSense 435i Depth Camera to track multiple colored objects. Our software produces quick position, velocity, acceleration, and momentum graphs to automatically generate trendlines that allow students to describe the motion of three-dimensional systems quantitatively and qualitatively. Finally, we will provide examples of how the local position system Pozyx can be used to track objects in 1 to 3D space. Investigating these technologies for use in physics instruction provides research opportunities for multiple high school and college students from the Portland area.

Session C3: Data Visualization in a Planetarium Monday, Jan. 16, 2:30–3:30 p.m.

Moderator: Karrie Berglund Sponsor: Committee on Space Science and Astronomy Atrium Ballroom

C3-01 (2:30 to 3:30 PM) | Data Visualization in a 3D, Immersive Environment

Presenting Author: Karrie Berglund, Digitalis Education Solutions, Inc.

Co-presenting Author | Kat Hunt, Digitalis Education Solutions, Inc.

Co-presenting Author | Richard Gelderman, Western Kentucky University

NOTE: This session will be held in the Digitalis Portable Dome in the exhibit hall. It will be limited to 20 participants, first come-first seated. Audience members will be seated on the floor. How does an immersive, three-dimensional space such as a digital planetarium help people understand data and make connections? In this interactive session, we will explore three primary types of data visualization in the dome:

1. Earth Science visualizations, approximately 2:30 to 2:50 pm. Led by Karrie Berglund, Director of Education for Digitalis. We will look at tectonic plates and their relation to earthquakes and volcanic eruptions. Time permitting, we will explore recent global weather data.

2. Volumetric models of galaxies and nebulae, approximately 2:50 to 3:10 pm. Led by Kat Hunt, Education Specialist for Digitalis. We will fly around and even through some volumetric models to highlight how what we see depends on where we are.

3. Galaxy red shifts, approximately 3:10 to 3:30 pm. Led by Dr. Richard Gelderman of Western Kentucky University. Explore the Sloan Digital Sky Survey and the Million Quasar Survey. How do these surveys inform us about the expansion of the universe?

Session C4: Disability Justice and Physics Education: Dreaming of Liberatory Futures Monday, Jan. 16,

2:30–4 p.m. Moderator: Amy Robertson Sponsor: Committee on Diversity in Physics Grand Ballroom II

C4-01 | Overview of Session: Disability Justice and Physics Education

Presenting Author: Amy Robertson, Seattle Pacific University

Disability justice is a movement in response to the lived realities and material impacts of ableism on disabled and chronically ill people. This session will bring principles of disability justice – including intersectionality and the connectedness of all forms of liberation – into our thinking about physics education. In this brief (10 minute) talk, I will outline the session, introducing our speakers and sharing key terms and premises, including what is disability justice and how ableism has shaped law and higher education policy. This session will include pre-recorded talks from speakers and a live Q & A, as well as workshopping time for participants. Masks are required for in-person participants, with medical exceptions.

C4-02 | The Basics: Ableism & Disability Justice

Presenting Author: Rebekah Taussig

In this 10 minute, pre-recorded Q&A, we will start with the basics. Through first-hand experience as a disabled woman and training in disability studies, I will answer questions about ableism, disability justice, and my hopes for a future that abides by the principles of disability justice. Participants will have the chance to do paired/team work and engage in a share out and Q&A at the end of the session.

C4-03 | Developing Intersectional Consciousness in Physics Education

Presenting Author: Mildred Boveda, Penn State University

In this 10 minute, pre-recorded Q&A, I draw from intersectionality as conceptualized by Black feminst theorists,I will discuss the intersections of racism and ableism as it relates to P-12 schooling. WIth a disruptive examination of the P-12 to PhD pipeline, I will examine the various ways special education and inclusive education are implicated in the marginilization of youth with disabilities and their lack of representation in Physics and STEM fields.

C4-04 | Weighing In: Fat Justice and Disability Justice

Presenting Author: April Herndon, Winona State University

In this 10 minute, pre-recorded Q&A, I will explain how fatphobia and ableism are often co-constructed and how they so often intersect with other social locations, such as race, gender, and class in ways that further marginalize people who are already vulnerable in U.S. society. At its heart, this session will use a Disability Studies framework and a criticism of neo-liberalism to help participants understand the harmful–and often hidden– ideologies that underpin and support discrimination by suggesting that people can and should control their bodies and "health."

C4-05 | Ableism and Queerness – The Critical Body

Presenting Author: Daniel Oleynik, University of Central Florida

Beginning with a pre-recorded Q&A session, this discussion will attempt to bridge the conversation between disability and queerness. Both social identities involve the critical analysis of the body and its function, but differ in how the analysis occurs. As a Queer Dis. student, I will share my experiences, highlighting the connections between disability and queerness, such as those suggested by Butler and and answer questions about the intersectionality of Queer and Dis. identities.

Session C5: Group Work, Student Attitudes, and Impact of DEI Issues Monday, Jan. 16, 2:30–4 p.m. Moderator: TBA Sponsor: Committee on Diversity in Physics Broadway I/II

C5-01 (2:30 to 2:40 PM) | Contributed | Attending to Student Frustrations and Work in Education Research

Presenting Author: W. Blake Laing, Southern Adventist University

I've come to understand my role as being the tactful coach who comes to work to help students (during a particularly sensitive time in their life). Learning how typical scenarios in physics class represent a face threat has helped me to proactively guide frustrated students toward productive practices (rather than react defensively). I now start design decisions for a new course with (about two) research-validated techniques while keeping design elements modest for the first year, so that students do not experience the unnecessary frustrations inevitable when a teacher's ambitions are unrealistic for that term. I would never again give a test (in an introductory class) designed to allow a heavily-weighted low-F score with an otherwise decent test performance. Every time I have given students more agency in my classes, rather than micromanaging their class-time experience, I have been impressed with their ability to respond like intelligent humans.

C5-02 (2:40 to 2:50 PM) | Contributed | Adding Self-Regulated Learning Instruction to a Physics Class

Presenting Author: John Stewart, West Virginia University

This talk will present preliminary results of an effort to add explicit self-regulated learning instruction to a college calculus-based introductory physics class. Students received short instructional segments on general self-regulation strategies, the metacognitive and cognitive reasons those strategies were often successful, and specific strategies useful in the college physics environment. Students were encouraged to reflect on the success of their past strategies and to report their planned future study strategies through four surveys given monthly throughout the semester. Students rated which strategies were successful and which they intended to try in the future.

C5-03 (2:50 to 3:00 PM) | Contributed | Student Expectations of Teamwork in a Team-based Undergraduate Physics Course

Presenting Author: Isaura Gallegos, Harvard University

Working in groups, or collaborative teamwork is often a part of active learning strategies increasingly implemented in undergraduate physics classrooms (e.g. project-based learning, team-based learning, or peer instruction). Existing research suggests student learning outcomes are largely positive in classes that use pedagogical practices with collaborative teamwork components compared to direct instruction. In this presentation, I will discuss a mixed methods study of student teamwork expectations that reveals that while collaborative teamwork can promote conceptual physics understanding, it can also introduce student stressors, largely absent in lecture-based courses. I also analyze students' sense of psychological safety, the degree to which a person feels comfortable taking risks within a group. This analysis reveals that not all students feel equally psychologically safe contributing in a collaborative physics classroom context. This research has implications for how collaborative learning can be fostered to engage all students equitably within their teams in undergraduate physics courses.

C5-04 (3:00 to 3:10 PM) | Contributed | Grouping & Games: Intentionally Building Student Talk

Presenting Author: Becca Kreidler, Denver West High School

How do you get every student in your classroom to contribute to group work or group discussions? How do you increase equity by building on student strengths? This session will introduce strategies for functioning student groups and how to intentionally use quick games to prepare students for the communication/language tasks needed in classwork. Increase student engagement and help students learn how to collaborate; help the Physics go faster because kids are more comfortable speaking up and working together.

C5-05 (3:10 to 3:20 PM) | Contributed | Socio-metacognition: Exploring Students' Patterns When Engaged in a High-Stress Activity*

Presenting Author: Josephine Allen, CSU Chico
Additional Author | Jayson Nissen
Additional Author | Thahn Lê, Western Washington University
Additional Author | Carolina Alvarado, CSU Chico

Encouraging collaborative learning processes has become increasingly common in physics education. In a classroom for future k-8 teachers, students are presented tasks explicitly designed to trigger confusion and expected to resolve it as a group. At Chico State and Western Washington University, we are examining how students engage in these settings. We explore the activity reported with the highest levels of confusion and

stress by the students, which coincides with the highest amount of mathematical procedures in the course. This case study follows a group that had difficulties collaborating with each other. We use Borge's socio-metacognition framework which outlines communication patterns of collaborative knowledge building discourse amongst peers working towards synthesizing and negotiating new knowledge. We video recorded the classroom's interactions, and performed follow-up interviews to learn more about students' backgrounds and reflect on classroom video excerpts. We further explore the sources that impede students to engage in productive collaboration.

*This work is supported by the National Science Foundation under Grant Nos. DUE-2021547 and DUE-2021307.

C5-06 (3:20 to 3:30 PM) | Contributed | Improving the Student Experience in Calculus-Based Introductory Physics

Presenting Author: Kathy Shan, University of Toledo

I participated in a ongoing multi-semester, university wide effort whose purpose is to improve the student attitudes about college with the ultimate goal of increased retention and graduation rates among underrepresented students in STEM at an open enrollment, mid-sized public university. I will discuss the impact these interventions had on student perceptions of physics and on DFW (Drop, Fail, Withdraw) rates in a calculus based physics class (both physics 1 and physics 2) over the course of four semesters, as compared to previous semesters before the interventions were implemented.

C5-07 (3:30 to 3:40 PM) | Contributed | Physics Misconceptions and Implicit Bias

Presenting Author: Douglas Kurtze, Saint Joseph's University

Physics misconceptions and implicit biases share crucial characteristics: they come from (at best) casual and unscrutinized observations; though seldom if ever articulated, they are used as bases for reasoning and decisions; they are sustained by strong confirmation bias, and consequently are difficult to root out. I will discuss my experience making this connection explicit in my classes. Doing so makes it easier for students to consider that they may harbor implicit biases, by showing that biases do not necessarily originate from some moral failure. It can then motivate them to make the requisite effort to eradicate their misconceptions, thereby developing the mental tools needed to eradicate their implicit biases. This suggests a way to start discussing implicit bias with a larger population, by first introducing the idea in a context that is not emotive and has no moral dimension.

C5-08 (3:40 to 3:50 PM) | Contributed | Student Metacognitive Ability on Introductory Physics Assignments

Presenting Author: Olivia Miller, Harvard University

Research has indicated that students who are more metacognitive during physics problem solving are more likely to correctly solve physics problems. Metacognition is defined as the ability to reflect upon, understand, and control one's learning. Metacognitive skills enable individuals to monitor their knowledge and skill levels, plan and allocate learning resources efficiently, and evaluate their learning state. Evaluation, one of six subcomponents of metacognition, involves appraising the products and regulatory processes of one's learning. In this project, we investigate students' ability to evaluate their homework solutions in one semester of an introductory project-based physics course. We address whether students' ability to evaluate their solutions improves over the semester or whether it is dependent on the physics question. Through this work we hope to better understand the metacognitive ability of introductory physics students so future work can focus on promoting physics problem-solving skills.

C5-09 (3:50 to 4:00 PM) | Contributed | Socio-metacognition: Students Negotiating Data Collection and Analysis in Collaborative Groups*

Presenting Author: William Henriquez, CSU Chico
Additional Author | Jayson Nissen
Additional Author | Andrew Boudreaux, Western Washington University
Additional Author | Thanh Lê, Western Washington University
Additional Author | Carolina Alvarado, CSU Chico

In a science classroom setting, most of the experimentations are done in groups. In this research, we will be looking at the students' approach to data collection and analysis in order to understand how they confront and resolve the difference. Through a collaboration with CSU Chico and Western Washington University, we present a case study on how a group of three pre-service teachers has different perspectives on how to engage in an experiment. We use video recordings of the students' classroom interactions, and in-the-moment surveys recording their emotions (confusion, stress, frustration). We performed follow-up interviews where students look back at their interactions and reflect on their experiences. We use Borges's socio-metacognition framework to analyze students' interactions. We present how students engage in high-quality claims and explore alternative ideas.

*This work is supported by the National Science Foundation under Grant Nos. DUE-2021547 and DUE-2021307.

Session C7: Physics at Two Year Colleges and the OPTYCs Project Monday, Jan. 16, 2:30–4 p.m. Moderator: TBA Sponsor: Committee on Physics in Two-Year Colleges Skyline II

C7-01 (2:30 to 2:40 PM) | Contributed | About OPTYCs: The Organization for Physics at Two-Year Colleges

Presenting Author: Glenda Denicolo, Suffolk County Community College
Co-presenting Author | Dwain Desbien, Estrella Mountain Community College
Co-presenting Author | Kristine Lui, AAPT/OPTYCs

The newly-created Organization for Physics at Two-Year Colleges (OPTYCs), under the auspices of AAPT, will build on previous workshop series and programs for professional development, reduce isolation for TYC faculty through networking and mentoring opportunities, and create a culture of PER for TYCs nationally. In this talk, we will describe the vision for OPTYCs and outline the various programs that are planned in

the coming years. OPTYCs is a one-stop shop for physics at TYCs, and welcomes participation from all physics teachers. (Supported by NSF-DUE-2212807.)

C7-02 (2:40 to 2:50 PM) | Contributed | You Are Not Alone: OPTYCs New Faculty Development Series

Presenting Author: Krista Wood, University of Cincinnati Blue Ash

Co-presenting Author | Brooke Haag, Path Stream

Co-presenting Author | Dwain M Desbien, Estrella Mountain Community College

OPTYCs (Organization for Physics at Two-Year Colleges) and American Association of Physics Teachers (AAPT) present an 18-month experience designed specifically for Two-Year College (TYC) Physics Faculty in their first six years of TYC teaching. This New Faculty Development Series (NFDS) will support new full-time, part-time, and prospective TYC physics faculty incorporating student-centered active learning, and research-based instructional strategies for inclusive classroom practices. NFDS is an exceptional opportunity that provides new TYC Physics Faculty (1) a foundation in Physics Education Research (PER) with online discussions, (2) a 4-day Immersion Conference to engage in PER-based instructional and inclusive strategies, (3) online mentoring through the implementation phase, and (4) a 3-day Commencement Conference in conjunction with a National AAPT Conference.

This NSF-funded program provides a community to support you and travel funding for the Immersion and Commencement Conferences!

(Supported by NSF-DUE-2212807)

C7-03 (2:50 to 3:00 PM) | Contributed | Professional Development Workshops Provided by the OPTYCs Initiative

Presenting Author: Joe Heafner, Independent Scholar

Additional Author | Tom O'Kuma, Lee College (retired)

OPTYCs is The Organization for Physics at Two-Year Colleges OPTYCs.aapt.org, and is the culmination of decades of work by Mary Beth Monroe, Curtis Hieggelke, and many other TYC colleagues. Part of the OPTYCs mission is to provide Continuing Professional Development Workshops (CPDW) for TYC physics faculty across the country. In this talk, I will summarize workshops that have already occurred, workshops at the current meeting, future workshops, and the forthcoming tandem meeting in Sacramento. I will also invite TYC physics colleagues to submit ideas for workshop content. OPTYCs is supported by NSF-DUE-2212807.

C7-06 (3:00 to 3:10 PM) | Contributed | OPTYC Mentoring: Building Connections

Presenting Author: Renee Lathrop, Dutchess Community College

The Organization for Physics at Two Year Colleges (OPTYC) is a NSF grant project that has several aspects to encourage professional development opportunities and retention of faculty teaching at Two Year Colleges. One of these aspects is developing a network where faculty from Two Year Colleges can choose to build traditional and mutual mentoring relationships. This talk will focus on describing the benefits of mentoring relationships, defining the different types of mentoring relationships, introducing people to this service, and answering questions about how to apply to be a mentor or mentee.

C7-05 (3:10 to 3:20 PM) | Contributed | The Leadership Institute for Two-Year College Faculty

Presenting Author: Brooke Haag, PathStream

Co-presenting Author | Krista Wood, University of Cincinnati Blue Ash College

Co-presenting Author | Dwain Desbien, Estrella Mountain Community College

The Leadership Institute under the Organization for Physics at Two-Year Colleges and AAPT is a fellowship for two-year college physics faculty to help participants develop and apply leadership skills. Under the guidance of a team of TYC mentors, you will cover topics including effective communication, work-life balance, finding leadership strengths, understanding the national context for science education, framing challenges, leading change, and valuing diversity. You will have the chance to construct and implement an action plan to address a challenge or opportunity in your work. In this talk we'll discuss past iterations of the Leadership Institute as well as future plans for the next iteration of the program. (Supported by NSF-DUE-2212807.)

C7-06 (3:20 to 3:30 PM) | Contributed | The TYC PER-Interest Group*

Presenting Author: Karim Diff, Santa Fe College, FL

Co-presenting Author | Sherry Savrda, Seminole State College, FL (retd)

Co-presenting Author | Glenda Denicolo, Suffolk County Community College, NY

Large numbers of Two-Year college (TYC) faculty have been exposed to physics education research (PER) but there are low proportions of TYC authors and TYC-student data in PER publications. We will discuss this situation and present the vision of the Organization for Physics at TYCs (OPTYCs) on how to gradually develop and support a more widespread culture of knowledge and involvement in educational research within the TYC physics community. The TYC PER-Interest Group promotes monthly events that include journal club meetings; presentations by TYC practitioners of PER and by PER specialists from the greater community; tutorials on research-validated teaching strategies and assessments; mini-workshops on analysis tools; meetings to connect faculty with similar PER interests; and presentations on ways to disseminate TYC-PER results. OPTYCs will also have available financial aid to assist TYC PER practitioners in presenting their work at regional and national meetings.

*Supported by NSF-DUE-2212807.

C9-01 (2:30 to 2:40 PM) | Contributed | Modular Introductory Physics Labs with Active Engagement

Presenting Author: Robert Ekey, University of Mount Union

Over the past decade, faculty at the University of Mount Union have developed a modular introductory physics curriculum that applies activity-based pedagogies. During the weekly laboratory rather than focus on a singular topic, students work on four tasks: a set of concept questions and three different experiments. This allows for a larger number of topics to be covered while only requiring one setup of a given experiment. The focus and outcomes of each experiment can be varied to tune the student learning experience or the desired learning outcomes. Post-lab, students complete a short writing assignment answering specific questions related to their experience to put into their own words the concepts, experimental process or extensions to other ideas. The Force Concept Inventory and Brief Electricity and Magnetism Assessment pre- and post-tests are used to measure the success of student learning and to influence the fine tuning of the next experience.

C9-02 (2:40 to 2:50 PM) | Contributed | Introductory Mechanics in Parallel

Presenting Author: Jennifer Klay, Cal Poly San Luis Obispo
Additional Author | Pete Schwartz, Cal Poly San Luis Obispo

Parallel Pedagogy is a novel introductory physics curriculum developed by Pete Schwartz at Cal Poly San Luis Obispo. Students explore the four lenses of mechanics (momentum, energy, dynamics, kinematics) in parallel and learn how to apply them to investigate, explain, and solve problems they've never seen before. Instead of learning concepts in isolation from each other, we introduce all four concepts together in the first unit. Starting out simply with one-dimensional motion, we build in complexity week by week. A recent article evaluating the effectiveness of the curriculum in improving concept application by students will be reviewed. In addition, freely available course materials provided through Canvas Commons, including comprehensive video lectures, textbook modules, problem sets, and more will be presented. Through this talk we hope to build collaboration with others interested in making the leap to Parallel Pedagogy.

The Physics Teacher 60, 508 (2022); https://doi.org/10.1119/5.0053341
The Physics Teacher 55, 280 (2017); https://doi.org/10.1119/1.4981034

C9-03 (2:50 to 3:00 PM) | Contributed | Teaching Quantum Mechanics in the 21st Century

Presenting Author: Jean-Francois Van Huele, Brigham Young University

The quantum world made its appearance in the 20th century and led to a standard curriculum of modern physics and quantum mechanics courses in America. The occurrence of a second quantum revolution at the end of the twentieth century and the birth and remarkable growth of quantum information science has opened new ways to teaching quantum science. For physics faculty, the pedagogical question remains what content and how much physics graduates need to be prepared for the quantum world they will encounter. In this presentation, I will review the developments of quantum science and its teaching from 1922 to 2022. I will look at new developments in the teaching of quantum mechanics based on current textbooks and beyond. I will combine curricular data and my own teaching experience to speculate on likely scenarios and on the best course of action for teaching quantum mechanics in the 20th century.

C9-04 (3:00 to 3:10 PM) | Contributed | Gauging Student Conceptions on What Makes for Productive Collaboration

Presenting Author: Angela Reisman, Western Washington University
Additional Author | Thanh Le, Western Washington University
Additional Author | Carolina Alvarado, California State University, Chico
Additional Author | Andrew Boudreaux, Western Washington University

Physics classes are becoming more collaborative and group work based. However, students have different conceptions of collaboration which can pose challenges for students groups to engage in productive collaborative work. In this talk, we explore students' conceptions of collaboration. At Western Washington University and CSU Chico in a studio-based physics class designed for elementary preservice teachers, we interviewed 25 students who we also recorded classroom video while they worked in their groups for several activities. Using a stimulated recall protocol, we used classroom video to initiate discussions about their group dynamics. We analysed their responses using Borge's socio-metacognitive framework, which describes how students collaborate to negotiate and build knowledge. The talk will present tentative themes from responses to the interview questions that specifically focused on group dynamics.

C9-05 (3:10 to 3:20 PM) | Contributed | Teaching Orbital Mechanics and Rocket Aerodynamics

Presenting Author: Charles Couch, St. Thomas Episcopal School

I published a book *Physics for Space Travel*. Endorsed by NASA legends. Book includes relevant physics, relevant math to plan and fly missions to the moon, ISS and other planets. Book was written to interface with free simulators.
A summary of the book is provided via this youtube video I put together.
Physics for Space Travel - First Book of its Kind - YouTube
https://www.youtube.com/watch?v=gg0CryhwU_E
I've been teaching this for several years to my students - 11th grade and AP Physics.

C9-06 (3:20 to 3:30 PM) | Contributed | Pilot STEM High School Tutoring/Mentoring Program by STEM College Undergraduates

Presenting Author: JERRY ARTZ, HAMLINE UNIVERSITY
Additional Author | John Alchemy, Rate-Fast Corporation

Additional Author | Andrew Banker, West Coast Clerical LLC

Additional Author | Bruce Bolon, Hamline University

Additional Author | Sarah Hick, Hamline University

We have initiated a pilot program in which a cohort of STEM undergraduate college students from Hamline University are serving as mentors to and providing free tutoring for interested STEM high school students. The program goal is to catch students before they self-identify as "not a math/science person" and instill some confidence in their ability to succeed in STEM classes and careers. By building connections with local schools, we can elaborate on the tutoring relationships we build with high school students by doing class visits in students' schools, inviting students for lab-tours at Hamline, and getting students involved in other STEM opportunities that Hamline hosts, such as Hamline's summer physics workshop experiences. The long-term goal is to develop a virtual tutoring platform that can be extended nationwide should there be need and scalability. Current progress along with opportunities and challenges of this program will be discussed.

C9-07 (3:30 to 3:40 PM) |Contributed | Crowd-Sourcing Video Analysis

Presenting Author: Christian Gehman, Trinity Valley School

Create graphable data from a video in a short time by having each student contribute a small portion of the work. Students get to participate in data generation but contribute only a small portion of the overall data set. All students working together construct a large data set quickly, which they then can graph an analyze, all in one class period.

C9-08 | Contributed |Converting Legacy Apps to JavaScript

Presenting Author: Wolfgang Christian, Davidson College

Additional Author | Robert M. Hanson, St. Olaf College

Additional Author | Douglas Brown, Cabrillo College

The lack of Java support in browsers, on mobile devices, and on Chromebooks was a major setback for education because thousands of Java simulations developed and used by teachers are no longer usable. To solve this problem, the Open Source Physics (OSP) team partnered with Bob Hanson's group at St. Olaf College to convert OSP Java programs to JavaScript using St. Olaf's SwingJS transpiler. This conversion allows us to republish many legacy apps as platform-independent web pages in the AAPT-ComPADRE OSP collection. This talk describes the conversion process and shows examples of converted favorites.

Session C10: Talking about Sustainability and Space Science to Foster Inclusivity Monday, Jan. 16, 2:30–4 p.m. Moderator: TBA Sponsor: AAPT Galleria South

C10-01 (2:30 to 2:40 PM) | Contributed | Description of a Capstone Sustainability Course

Presenting Author: Blane Baker, William Jewell College

Sustainability is now a crucial global priority due to ongoing problems such as climate change, limited resources, and vulnerable ecosystems. To engage students in the science of sustainability and its challenges, we have designed and implemented a capstone course, Physics of Sustainability, focusing on the major themes of sustainability, climate change, and sustainable energy. Our course is taught within the physics department and is required for all physics and civil engineering majors. This talk will provide an overview of goals for the course and show how class sessions are structured. In addition, we will discuss classroom assignments and projects.

C10-02 (2:40 to 2:50 PM | Contributed | Teaching Sustainable Design with Solar-Powered Arduinos

Presenting Author: Tim Gfroerer, Davidson College

The Arduino microcontroller is finding its way into labs throughout the undergraduate physics curriculum. At Davidson College, we use Arduinos in a gateway course for students who are interested in energy and the environment. Students learn to build simple circuits and write the accompanying Arduino code to control the temperature in solar-powered model buildings. To make the models fully solar-powered, we replace the battery that is usually used to power an Arduino by a small commercially available solar panel connected in parallel with a capacitor. Using the CLASS for assessment, we observe an overall favorable shift in student attitudes about science in this class. We have seen a significant decrease in unfavorable responses relating to conceptual understanding and a significant increase in favorable responses related to personal interest.

C10-03 (2:50 to 3:00 PM) | Contributed | Climate Science Lessons That Support Your Curriculum

Presenting Author: Frank Lock, Climate Reality Project

This presentation is an introduction to the Climate Science workbook developed by Dr. Jerry Bell at the Wisconsin Initiative for Science Literacy (WISL). The workbook is freely available online and includes 14 Activity sections so-titled to reinforce the idea that each would incorporate one or more hands-on activities to be carried out and analyzed by students. Examples from the workbook will be introduced and information about accessing the activities will be provided.

Session TOP08: Using Amateur Radio Support with Physics Topics/Easy Bake Ovens Monday, Jan. 16,

2:30–4 p.m. Moderator: Linda Fox Sponsor: Committee on Physics in High Schools Pavillion East

TOP08 (2:30 to 3:30 PM) | Using Amateur Radio Support with Physics Topics

Presenting Author: Linda Fox

"Many topics in Physics (EM radiation, Electricity, Sound) have applications in Amateur Radio. Bringing in local resources to show students practical uses of their knowledge makes the coursework more accessible to all. The session will include discussion of using local radio operators/clubs as resources, how the operators are used in weather spotting, emergency assistance in disasters, and introducing their hobby to the general public. Information about the ARRL (American Radio Relay League, the national organization), and the Teacher's Institutes that they hold every year, will be available."

TOP08 (3:30 to 4:00 PM) | Interactive (e.g. panel, round table discussion, hands-on activity) | Easy Bake Ovens: Modeling Thermal Equilibirum with Cookies

Presenting Author: Spencer Perry, Indiana University – Bloomington

Thermal equilibirum is a key principle in understanding climate change and is helpful in many other areas of phsyics. In this workshop, we will design, build, and test our own Easy Bake Ovens in order to model thermal equilibrium. We will also conduct a qualitiative analysis and a quantitative analysis of our ovens as far is mathematicaly feasible in a high school classroom.

Awards Session: Hans Christian Oersted Medal, S. James Gates, Jr. Monday, Jan. 16, 4:30–5:30 p.m.

Moderator: Jan L. Mader Sponsor: AAPT Grand Ballroom I

AAPT PHYSICS EDUCATION®

A Half Century of a Mathematically Enabled Physicist's Life

A personal reflection about 'discovering' science at age four to solving string theory problems past age seventy is recounted. The domains of research, teaching, service, and living a life are reviewed.

Dr. Sylvester James Gates, Jr. has been named as the 2023 recipient of the prestigious Hans Christian Oersted Medal, presented by the American Association of Physics Teachers (AAPT). The Oersted Medal recognizes his outstanding, widespread, and lasting impact on the teaching of physics through his national leadership in physics education, his exceptional service to AAPT, and his mentoring of students and in-service teachers. The year of 2022 marks the fifty-first consecutive year of his service as a university instructor in mathematics and physics.

Come to the K-12 Resource Room! Parlor A/B

Sunday, Jan. 15

2 p.m Topical Discussion: Making Physics Accessible for All Students
3 p.m. Topical Discussion: Engaging students with Physics in Afterschool Clubs
4 p.m. Topical Discussion: Teacher Leadership in Schools
5 p.m. AAPT K12 Taskforce Feedback Session

Monday, Jan. 16

9 a.m Make and Take with PTRA (Tommi & Jan)
10 a.m. Topical Discussion: Building Mentoring Relationships with New (to Physics) Teachers
11 a.m. Topical Discussion: Teaching Modern Physics in High Schools
1 p.m. Physics and CTE in Your School
2 p.m. AAPT Energy and Equity Workshop with In-class Materials
3 p.m. ORAAPT Section Meet - Up
4 p.m. Topical Discussion: AP/IB Physics: Balancing Investigation with Test Prep
5 p.m. AAPT K12 Taskforce Feedback Session

Session D1: Can Online Labs Effectively Serve Undergraduates Post-COVID? Tuesday, Jan. 17, 8–9:30 a.m. Moderator: Toby Dittrich Sponsor: Committee on Laboratories Pavillion East

D1-01 (8:00 to 8:30 AM) | Authentic Physics Lab Experiences Delivered Online

Presenting Author: Wolfgang Bauer, Michigan State University

Physics laboratory courses are supposed to teach setting up valid experiements, conducting measurements, data analysis, determining validity of the measurements including estimating error bars and statistical and systematic uncertainties, drawing conclusions, and comparing to a set of hypotheses. We have attempted to create a two-semester sequence of lab courses, which are conducted online in their entirety, and which we think accomplish all of the learning expereiences that in-class hands-on laboratory courses can achieve.

D1-02 (8:30 to 9:00 AM) | Remote Labs Post Covid

Presenting Author: Matt Vonk, Pivot Interactives

The COVID pandemic catalyzed many changes to education including an increased reliance on internet resources. While some of the changes were (thankfully) temporary, many of the changes will last. This talk will highlight some of the advantages of cloud-based active-learning and explore which features of online resources should be used and exploited even when education is face-to-face.

D1-03 (9:00 to 9:10 AM) | Contributed | Remote Access: Redesigning Physics Laboratory to Enhance Accessibility and Equity

Presenting Author: Klebert Feitosa, James Madison University

Additional Author | Masoud K Baghbadorani, James Madison University

The pandemic unwantedly introduced higher education to online teaching. However, this otherwise unwelcome experience has unlocked previously untapped opportunities to reach underserved students struggling to succeed within the traditional path. Here we report on a two-semester remote introductory physics laboratory course we designed to provide authentic scientific training on par with traditional in-person laboratory instruction. The class centers on hands-on experiments performed by the students at home with instruments and supplies from a low-cost reusable laboratory kit we assembled. Activities have been thoughtfully designed to facilitate interactions among students and between students and instructors. We aim to provide a sound alternative to the in-person lab especially for at-risk and transfer students who face greater challenges to fulfill their academic requirements. Since its inception, the class has been on high demand, and the students have consistently cited flexibility as a reason for taking it.

D1-04 (9:10 to 9:20 AM) | Contributed | Mixing Online with Traditional Physics Labs in the Post-COVID World

Presenting Author: Andy Gavrin, Indiana University Purdue University Indianapolis

Additional Author | Gautam Vemuri, Indiana University Purdue University Indianapolis

For over two decades, the authors and their colleagues resisted pressure to shift our labs online. The pandemic changed our conclusions, but not for the reasons one might guess. The pandemic didn't change our perceptions about what students can and cannot learn online. The role of the pandemic was to give us the space we needed to change our goals for students' learning in lab. Previously, we had emphasized conceptual understanding of physics, coupled with admittedly vague ideas about the value of hands-on interaction with "real" equipment. The pandemic shifted our focus to experimental design, data analysis, and professional communication. Our students now alternate face-to-face experiences with at-home experiments including computational exercises, labs using smartphone sensors, and labs conducted in online simulations. This talk will focus on the learning goals and evidence of student achievement. We will highlight one or two of the simulation-based labs as examples.

D1-05 (9:20 to 9:30 AM) | Contributed | Remote Learning Kinematics Experiments Using an Ultrasonic Sensor

Presenting Author: Matthew Brynteson, University of Lynchburg

Among the common challenges to online physics experiments is the need to access equipment that students likely do not have the capability of accessing. Furthermore, performing a remote experiment, whether virtual or hands-on, can be difficult without a lab partner when multiple sets of hands or eyes are needed to make measurements. In this talk, I would like to discuss the use of an Arduino uno-ultrasonic sensor combination that enables students to perform a series of first-semester, undergraduate level kinematics experiments. Using an ultrasonic sensor, the student can take time-dependent distance measurement enabling the measurement of speed and acceleration of objects. Such experiments can allow remote-learning students directly collect data on linearly moving objects, objects in harmonic motion, and more without the need for a lab partner. Despite being able to perform sophisticated, undergraduate-level experiments, the equipment expenses are quite low and easily managed via a low-cost lab fee.

D1-06 (9:30 to 9:40 AM) | Contributed | Student Perception of Learning in a Remote Physics Laboratory Course

Presenting Author: Paul DeStefano, Portland State University

Additional Author | Ralf Widenhorn, Portland State University

Over the past two years, the Physics Education Research (PER) group at Portland State University (PSU) has been conducting a study of students' perceptions of their own learning in online physics laboratory courses. Part of this study was conducted using a survey containing closed-response, Likert-scale questions. We present our analysis of this data set accumulated between Fall 2020 and Summer 2022. We found that a small to medium-sized and statistically significant increase was detected in participants' perceptions of their own ability to choose the appropriate analysis methods for laboratory work, and that this effect was consistently detected in the last term of the sequence, which contains a unique, remote design-your-own experiment curriculum.

Session D2: Frontiers in Space Science

Tuesday, Jan. 17, 8–9:30 a.m. Moderator: David Klassen Sponsor: Committee on Space Science and Astronomy Grand Ballroom II

D2-01 (8:00 to 8:30 AM) | Mars Global Climate Modeling

Presenting Author: Melinda Kahre, NASA Ames Research Center

Scientists use Global Climate Models (GCMs) to better under the current and past climate states of terrestrial (solid surface) bodies in our solar system and beyond, and the physical processes that control them. GCMs are complex, multi-dimensional computer codes that can generally be divided into two parts: the geophysical fluid dynamics (GFD) framework, which represents accelerations and spatially resolved processes, and the physics routines, which provide the forcing functions for the circulation. Producing a GCM that is appropriate for a particular body—Mars, for example—requires implementing the appropriate physics routines (e.g., radiative transfer, planetary boundary layer physics, dust lifting physics to generate dust storms, etc.) for that body. In this talk, I will give an overview of the components of the NASA Ames Mars GCM and discuss some of the scientific questions we address with this state-of-the-art numerical model.

D2-02 (8:30 to 9:00 AM) | Life in Seven Numbers: The Drake Equation Revealed

Presenting Author: Kaitlin Rasmussen, University of Washington

Frank Drake's famous equation tells us how many civilizations—that humans could talk to at this very moment—are out there in the Milky Way. But even today, the precise values of its variables are a mystery that remains largely unsolved. In this talk, I will break down each of the seven ingredients necessary to find and study extraterrestrial life in the universe.

Session D3: Ideas for Upper Division Physics Courses

Tuesday, Jan. 17, 8–9:30 a.m. Moderator: TBA Sponsor: AAPT Galleria North

D3-01 (8:00 to 8:10 AM) | Contributed | Mathematica Based Calculations of A to Facilite Electromagnetics Teaching

Presenting Author: John Adams, Merrimack College

Additional Author | Christopher Duston, Merrimack College

This work explores the use of the magnetic vector potential, A, in visualizing, teaching, and numerically modeling electromagnetic phenomena. To lay the groundwork for the discussion of A, we first report on calculations using the scalar potential, comparing a simple closed form calculation with a numerical modelling approach. We then introduce a system comprised of a hollow, positively charged sphere Q interacting with two parallel, current carrying wires for which A is determined as a function of position. We compare two calculations determining the total field momentum of the system: QA compared to the integration over all space of the interaction momentum density. We analyze a trajectory of Q near the wires, establishing a visual connection between particle motion and A, and include a discussion of relativistic implications. Computational and teaching implications are discussed.

D3-02 (8:10 to 8:20 AM) | Contributed | Labor-Based Contract Grading in the Physics Classroom

Presenting Author: Jeremy Wachter, Skidmore College

Labor-based contract grading (LBCG) is an assessment framework where the time and effort, or labor, invested by the student in assignments is what determines their grade. The contract component enters through student-designed projects with clearly-defined goals and deliverables which must be completed in order to earn credit. The framework is intended to promote student agency and involvement, as well as reduce inequities associated to traditional grading schemes. I describe a specific instance of LBCG as applied to an upper-level mathematical and computational methods course.

D3-03 (8:20 to 8:30 AM) | Contributed | Getting Started with Spatial Light Modulators

Presenting Author: Gabriel Spalding, Illinois Wesleyan University

A Spatial Light Modulator allows students to encode phase profiles onto a laser beam, beginning with uniform arrays ("Piston" offsets for an interferometer). A linear phase gradient, in cylindrical coordinates, along the radial direction yields a Bessel beam. A linear phase gradient, in cylindrical coordinates, along the azimuthal direction yields "Orbital Angular Momentum" (OAM) states. Combinations of OAM and Bessel phase profiles yield Higher-Order Bessel Beams. Learning about such beams can unify some Modern Physics and Quantum topics. A linear phase gradient along a cartesian direction yields a plane wave deflected to some angle (such plane waves = basis set for Fourier Optics). A quadratic phase gradient yields a spherical wave (spherical waves = basis set for Huygens-Fresnel Optics). What might a cubic phase gradient yield?The ability to impose superpositions of such basis states offers a tantalizing array of outcomes.

D3-04 (8:30 to 8:40 AM) | Contributed | Ray Optics Using a Smartphone Camera

Presenting Author: Matthew Sullivan, Ithaca College

Most students in physics courses experience ray optics using a single lens, some work with two-lens systems, and few students outside of optics courses see systems with more than two lenses. A smartphone camera is a complex optical system with multiple lenses, yet the camera obeys the thin-lens equation for a single lens remarkably well. This can be verified using images taken at multiple distances of an object of known height. The experimental setup is simple enough that it can be conducted in person or remotely. More advanced students can explore when the thin lens

equation fails for a smartphone camera, using the failure to explore the limits of the model used to represent the system, and using the failure as a springboard to explore the more complex optics of systems of multiple lenses.

D3-05 (8:40 to 8:50 AM) | Contributed | New Course to Retain Physics Majors: Physics of Contemporary Challenges

Presenting Author: Ethan Minot, Oregon State University
Additional Author | Corinne A Manogue, Oregon State University
Additional Author | Elizabeth Gire, Oregon State University

We have developed a new course that serves as a bridge from introductory physics courses to the physics major. The class is integrated into the Paradigms in Physics curriculum at Oregon State University. In the class, we emphasize physical reasoning skills, such as estimating the order of magnitude of physical phenomena, and identifying fundamental limits on physical processes. These reasoning skills are applied to challenges such as power generation, energy efficiency, space exploration and global warming. The structure of the course naturally motivates the introduction of concepts from thermal physics and quantum physics. The overall narrative of the course is designed to motivate students with real-world applications of exciting physics concepts. Additionally, the course learning outcomes are designed to give students key skills required to succeed in upper-division physics classes.

D3-06 (8:50 to 9:00 AM) | Contributed | Organizing Thermodynamics with Information Theory to Increase Learning

Presenting Author: Kendall Mallory, University of Northern Colorado

Many physics departments offer a single course in classical and statistical thermodynamics. This requires a combination of two very different sets of concepts which are awkwardly combined into a single course. The result often appears abstract and disorganized to students. It's also difficult to find time for modern research topics because they are widely disparate from classical approaches. As an alternative, we can reorganize this material around an information theoretical approach to entropy like that developed by Ludwig Boltzmann, Ralph Hartley, Claude Shannon, and Alan Turing. We can easily branch off from here into other important topics both classical and modern. This also allows for the use of a broader set of concepts to enhance student's understanding and organizes important topics into a more uniform presentation. I will present outlines for this approach and give some examples for developing important topics in thermodynamics.

D3-08 (9:10 to 9:20 AM) | Contributed | Condensed Matter Physics with Masses and Springs

Presenting Author: Scott Carr, Coastal Carolina University

Condensed matter physics is traitionally an upper division elective reserved for students in their last year of study following completion of quantum mechanics. The application of Schrodinger's Equation to crystalline systems is mathematically demanding which often obscures the physical proesses occuring of the systems it describes. However, since Schrodinger's Equation is a wave equation at heart, many quantum systems can be qualitatively reproduced on a benchtop using waves ie, a system comprised of masses an springs. Over the last several years, I have worked with undergraduate students to develope macroscopic demonstrations of phenomena important in condensed matter physics. In this talk, I will present several of the systems we have designed to showcase band formation, the phonon dispersion relation,and Anderson localization.

Session D4: K12 Research/Teacher Prep

Tuesday, Jan. 17, 8–9:30 a.m. Moderator: TBA Sponsor: Committee on Physics in High Schools Pavillion West

D4-01 (8:00 to 8:10 AM) | Contributed | Teaching Science for Elementary Education Majors in a Physics Department

Presenting Author: Joseph Ganem, Loyola University Maryland
Additional Author | Inge Heyer, Loyola University Maryland
Additional Author | Randall S Jones, Loyola University Maryland

We have developed, and teach in the physics department, a two-semester course sequence that provides 8 of the 12 credit hours of science content that the State of Maryland mandates for students majoring in and seeking certification for elementary education. The courses –Integrated Science I & II – use a hands-on, activity-based pedagogy to engage the students in science experiments while learning foundational ideas in physics, chemistry, biology, earth science, and astronomy. Our experience is that physics instructors do possess enough background from their professional training to teach multi-disciplinary science at a basic level. We will present the organization and structure of the course and describe some of the activities along with the resources and materials needed for implementation. Our long-term goal is to improve science literacy in the United States by increasing the knowledge and reducing the fears surrounding science that many elementary school teachers bring to their classrooms.

D4-02 (8:10 to 8:20 AM) | Contributed | Case Study – Value Creation via a Faculty Online Learning Community

Presenting Author: Tamar More, University Of Portland
Additional Author | Mohammad Ahmadibasir , University of Central Missouri
Additional Author | Steven Maier, Northwestern Oklahoma State University
Additional Author | Fred Goldberg, San Diego State University
Additional Author | Edward Price, Cal State San Marcos

We present highlights from a case study examining the value members gain from their participation in a Faculty Online Learning Community (FOLC) focused on the Next Generation Physics for Everyday Teaching (NGPET) curriculum. We analyzed 5 value creation stories told by FOLC members. The stories describe a range of ways that participants gain value related to changing their practice. We illustrate our methodology using

one of these value creation stories as an example. We discuss some of the specific values derived from the FOLC and features of the FOLC that seemed to facilitate the value creation.

D4-03 (8:30 to 8:40 AM) | Contributed | Building a Recruitment Pipeline for Future Physics Teachers

Presenting Author: Sara Callori, Department of Physics, California State University San Bernardino

Additional Author | Carol Hood, Department of Physics, California State University San Bernardino

The department of physics at California State University San Bernardino has developed a recruitment pipeline for students interested in teaching careers. This provides students with opportunities to learn about and experience teaching at all points in their time as physics majors, from their first departmental course through entry into a credential program. One highlight of this effort is the Tools for Physicist seminar, a required class for all new students that explicitly discusses careers in physics. In this context, Get the Facts Out is used to present local information on teaching professions to highlight their benefits and ensure all students have encountered at least some information on the path. As students further explore their interest in teaching, there are a number of resources and programs that give them early experience and provide financial support as they work towards a credential and eventual employment as a teacher.

D4-04 (8:40 to 8:50 AM) | Contributed | Investigating Stress and Confusion in Next Gen PET

Presenting Author: Peter Bagdovitz, Western Washington University

Additional Author | Jayson Nissen, ER&D

Additional Author | Thanh Lê, Western Washington University

When students experience confusion, resolving that confusion can lead to deeper understanding and engagement. Persistent unresolved confusion, however, can lead students to frustration and disengagement. Our research explores confusion and other emotions associated with learning as students work through elicit confront resolve (ECR) activities in Next Generation Physical Science and Everyday Thinking (Next Gen PET) Courses for future elementary teachers. We used the experience sampling method (ESM) to measure student's subjective experiences during seven particularly confusing activities. The ESM asked about confusion, self-efficacy, engagement, and stress, which we designed to align with D'Mello and colleagues' model of learning (L&I, 2014). After some revision, our model fit the data quite well using confirmatory factor analysis. The activity that required the greatest use of mathematics produced the highest levels of confusion and stress for students. We will discuss the implications of these results for understanding confusion in Next Gen PET courses.

Session D5: Share-out from the Inclusive Physics Curriculum Workshop Series

Tuesday, Jan. 17, 8–9:30 a.m.

Moderator: Mel Sabella / Co-Organizer: Alexis Knaub Sponsor: Committee on Diversity in Physics Broadway III/IV

D5-01 (8:00 AM to 8:10 AM) | Introduction and Background on Inclusive Physics Workshop Series

Presenting Author: Mel Sabella and Alexis Knaub

Introduction and Background on Inclusive Physics Workshop Series.

D5-02 (8:10 to 8:30 AM) | Decolonizing Physics Curricula

Presenting Author: Elissa Levy, Hunter College High School (New York)

Co-presenting Author | Angela Flynn, Moses Brown School (Providence, RI)

A group of 11 physics teachers from various US states and teaching contexts meets monthly to talk about decolonizing physics - that is, decentering the white, male, Western narrative of the field. Which topics in physics need to be prioritized or added to a curriculum arc? How do we rethink the names of our laws and units of measure, which are connected to structures of privilege? How can the physics we teach connect with students' personal and cultural histories and the sociopolitical dynamics therein? Our group has developed and piloted lesson arcs on climate change, electromagnetism and mining, and laws of motion (generally attributed to Newton). We develop, pilot, and reflect on lessons. Although it is impossible for us to completely decolonize physics given our privilege and the institutional structures we inhabit, our aim is to move towards a curriculum that opens the conversation and addresses previously buried histories. The Inclusive Curriculum in Physics - Workshop Series was made possible through a grant from the American Institute of Physics Diversity Action Fund. It was organized by the National Society of Black Physicists, the National Society of Hispanic Physicists, and the American Association of Physics Teachers.

D5-03 (8:30 to 8:50 AM) | Don't Go It Alone: How Peer Support Improves Inclusive Teaching

Presenting Author: Katie Devine, The College of Idaho

Additional Author | Katie Ansell, University of Illinois, Urbana Champaign

Additional Author | Sara Mueller, Brown University

A colleague support network can be an invaluable asset when developing new course elements. In 2021, a collaboration between AAPT, NSBP, and NSHP ran an "Inclusive Curriculum in Physics" workshop series that brought together experts in equity, diversity, and inclusion (EDI) to support physics educators in developing more inclusive teaching practices. During the second and third workshops, educators formed small groups to focus on topics and projects selected by the group. My small group focused on inclusion in lab spaces, developing more fair and equitable assessments, and managing the time and emotional demands created by our new teaching strategies. I will discuss the changes my group members and I have made to our curricula as a result of our collaboration. I will highlight the role that support from my group members played in both mo-

tivating and improving the changes I have implemented in my courses. The Inclusive Curriculum in Physics - Workshop series was made possible through a grant from the American Institute of Physics Diversity Action Fund. It was organized by the National Society of Black Physicists, the National Society of Hispanic Physicists, and the American Association of Physics Teachers. Funded by the College of Idaho.

D5-04 (8:50 to 9:10 AM) | Bringing Diverse Faces to Our Courses in a Simple Way

Presenting Author: Kristen Recine, Swarthmore College

Additional Author | Federica Bianco, University of Delaware

Additional Author | Beatriz Burrola Gabilondo, The Ohio State University

Additional Author | Philip Cole, Lamar University

Additional Author | Merideth Frey, Sarah Lawrence College

The development of physics has been, and continues to be, shaped by a diverse group of scientists, yet many of their names and faces are not represented in our curricula. The Inclusive Physicist Project is working to change that by developing a series of slides highlighting scientists from the past and present that have historically been underrepresented in physics and astronomy curricula. Any instructor can search by country of origin, ethnicity, physics topic, etc. to find a scientist that connects with that day's content and quickly read notes in order to introduce students to these scientists. Our goal with this growing resource is to aid instructors (especially those with large courses, fixed curricula and limited time) in easily integrating more representation into their lectures, beginning to send the message to all students that not only does everyone belong, but that these fields are already more diverse than they may think. Supported by funding from Swarthmore College. The Inclusive Curriculum in Physics - Workshop Series was made possible through a grant from the American Institute of Physics Diversity Action Fund. It was organized by the National Society of Black Physicists, the National Society of Hispanic Physicists, and the American Association of Physics Teachers.

D5-05 (9:10 to 9:30 AM) | | Panel Discussion with Speakers

Presenting Author: Mel Sabella and Alexis Knaub

Panel discussion with speakers.

Session D6: Science Literacy & Public Understanding of Science

Tuesday, Jan. 17, 8–9:30 a.m.

Moderator: Chuck Winrich Sponsor: Committee on History & Philosophy of Physics Galleria South

D6-01 (8:00 AM to 8:30 AM) |Activating Science Identity with Museum Exhibits

Presenting Author: Elizabeth Andanen, Oregon Museum of Science and Industry

Co-presenting Author | Jennifer Powers, Oregon Museum of Science and Industry

Science centers are free-choice learning environments where people can engage with science phenomena in a way wholly different from classrooms. The Oregon Museum of Science and Industry (OMSI) is a leader in designing and building interactive exhibits that are fun, accurate, and help people identify as science participants. In this session, we will explore the exhibit development process in two areas of OMSI: the Featured Exhibit Hall, where OMSI creates locally relevant galleries to accompany temporary exhibitions; and the Innovation Stations, where visitors learn about global challenges from a local perspective and design and test solutions to these challenges. We'll share how we work closely with community partners and content experts to make experiences that empower action and foster science identity in people of all ages. You'll have a chance to put this learning to use as you consider how to frame a science topic for people in your community.

D6-02 (8:30 to 9:00 AM) | OMSI Science Communication Fellowship: STEM Professionals Engaging Public Audiences

Presenting Author: Jennifer Crayne, Oregon Museum of Science and Industry (OMSI)

The Science Communication Fellowship at the Oregon Museum of Science and Industry (OMSI) brings together STEM professionals and public audiences through face-to-face conversations facilitated by hands-on activities. This program emerged from the nationwide Portal to the Public program in 2014; since then, OMSI has engaged over 230 Science Communication Fellows, from disciplines ranging from physics to forestry. Fellows participate in a series of trainings to develop practical skills related to science communication. Each fellow then develops a hands-on science activity based on their own STEM-related work and facilitates that activity with museum visitors at OMSI. In this interactive conference session, we will share approaches and tools used in our science communication trainings and reflect on lessons learned and future aspirations related to engaging public audiences at OMSI.

Session D7: Interactive Lecture Demonstrations: Whats New? ILDs Using Clickers, Video Analysis and Home-Adapted ILDs

Tuesday, Jan. 17, 8–9:30 a.m. Moderator: David Sokoloff Sponsor: AAPT Broadway I/II

D7-01 (8:00 to 8:30 AM) | Interactive Lecture Demonstrations: Whats New? ILDs Using Clickers, Video Analysis and Home-Adapted ILDs

Presenting Author: David Sokoloff

The results of physics education research and the availability of computer-based tools have led to the development of active learning materials for the introductory physics course. Some of these materials are designed for hands-on learning in the lab, for example the student-centered laboratory curriculum, RealTime Physics (1), (2). One reason for the success of these materials is that they encourage students to take an active part in their learning. This interactive session will demonstrate through active audience participation materials designed to implement active learning in lecture, Interactive Lecture Demonstrations (ILDs) (3) including those using clickers and video analysis. Online versions of these ILDs, developed during the pandemic for home use, will also be demonstrated.

1. David R. Sokoloff, Ronald K. Thornton and Priscilla W. Laws, "RealTime Physics: Active Learning Labs Transforming the Introductory Laboratory," Eur. J. of Phys., 28 (2007), S83-S94. 2. David R. Sokoloff, Ronald K. Thornton and Priscilla W. Laws, RealTime Physics: Active Learning Laboratories, 3rd Edition (Hoboken, NJ, John Wiley and Sons, 2011). 3. David R. Sokoloff and Ronald K. Thornton, Interactive Lecture Demonstrations (Wiley, Hoboken, NJ, 2004).

D7-02 (8:30 to 9:00 AM) | Interactive Lecture Demonstrations: Effectiveness in Teaching Concepts

Presenting Author: Ron Thorton

The effectiveness of Interactive Lecture Demonstrations (ILDs) in teaching physics concepts has been studied using physics education research based, multiple-choice conceptual evaluations.(1,2) Results of such studies will be presented, including studies with clicker ILDs. These results should be encouraging to those who wish to improve conceptual learning in their introductory physics course.

Plenary: Dr. Michael Landry, LIGO Hanford Observatory

Tuesday, Jan. 17, 9:30–10:30 a.m.. Moderator: Toni Sauncy Sponsor: AAPT Grand Ballroom I

Presenting Author: Michael Landry, LIGO Hanford Observatory

LIGO, Virgo, and KAGRA will soon embark on O4, the fourth observation run of terrestrial gravitational-wave detectors. To date, 90 sources have been observed including mergers of binary black holes, binary neutron stars, or one of each of those compact objects. In this talk we will review the status of detectors as they are commissioned for the spring 2023 O4 start of that ~year-long observation run, and prospects for detection. Furthermore, we will sketch plans for O5 and beyond, and survey ideas for next-generation detectors, particularly Cosmic Explorer. Michael Landry is the Head of LIGO Hanford Observatory (LHO) in Richland , WA, and a physicist with the California Institute of Technology. He received his PhD from the University of Manitoba in 2000, with experimental studies in strange hadronic matter at the Brookhaven AGS and TRIUMF accelerators. Michael started with Caltech as a postdoc at LHO in 2000, working his way through a series of science roles on the interferometers in Initial and Advanced LIGO phases. He was Detection Lead Scientist at the time of the first direct detection of gravitational-waves, GW150914, and was named LIGO Hanford Observatory Head in 2016.

Awards Session: Doc Brown Futures Award; Homer L Dodge Distinguished Service Citations, Fellows and AAPT Presidential Transfer

Tuesday, Jan. 17, 10:30–11:30 a.m.. Moderator: Jan L. Mader Sponsor: AAPT Grand Ballroom I

2023 Doc Brown Futures Award - Darsa Donelan

Presenting Author: Darsa Donelan

A member of AAPT since 2014, they earned a B.S. in Physics and B.A. in Mathematics at Massachusetts College of Liberal Arts and a Ph.D in Physics at the University of Florida. Donelan is Continuing Assistant Professor at Gustavus Adolphus College in Saint Peter, Minnesota. In 2019 Donelan joined the AAPT/NASA collaboration to produce space science themed educational supplements supported by a grant from NASA. Their scientific background in planetary science and obvious skill in teaching and working with students made for an ideal addition to the team. Our team is an eclectic group with a range of skills and background, and Donelan fit right in. At the time, we had received instructions from the project leadership at Goddard Space Flight Center that we could expand of context area beyond heliosphysics to include subjects like planetary science. This led to the development of tutorials on Habitable Zones, Exoplanet Atmospheres, and Stellar Spectra. Donelan was essential not only to the development of these materials but also in the professional development that we provide to teachers around their use. Moreover, they have increasingly played a leadership role, attending meetings of the Space Science and Astronomy committee, representing our team.

Homer L. Dodge Distinguished Service Citations Awarded to:

Glenda Denicolo, Associate Professor at Suffolk County Community College

Alice Flarend, Physics Teacher, Bellwood-Antis High School

AAPT Fellowship Awarded to:

Richard Gelderman

AAPT Presidential Transfer:

Toni Sauncy, Texas Lutheran University to Duane B. Merrell, Brigham Young University

Session E1: Assessment and Grading in Intro Labs and Courses

Tuesday, Jan. 17, 11:40 a.m.–1:40 p.m.

Moderator: TBA Sponsor: Committee on Laboratories Grand Ballroom II

E1-01 (11:40 to 11:50 AM) | Contributed | Are Introductory Physics Exam Grades Bimodal?

Presenting Author: Jason Hyatt, Massachusetts Maritime Academy

Do two distinct groups of students appear statistically in introductory physics exam grades? Anecdotal evidence supports this idea. This could be a result of different levels of preparation in high school physics and/or math. If so, one could identify the underperforming group early on and intervene. In summary, across 238 exams in all of my courses from Fall 2006 to Fall 2021, only 14, or 5.9%, were statistically bimodal, or had two groups. It was not bimodal! So why do so many instructors have this idea?

E1-02 (11:50 AM to 12:00 PM) | Contributed | Weekly Quizzes as an Alternative to Midterm Exams

Presenting Author: David Johnston, Oregon Institute of Technology

Traditionally, student learning in introductory physics classes is assessed using summative tools such as midterm and final exams. As we well know, students will often only study before some type of assessment in their class. Hence, if exams are administered only two or three times a term, many students might only be reviewing material that many times, which, of course, is not ideal. However, administering Weekly Quizzes instead of Midterm Exams can incentivise students to study regularly, leading to better understanding of class material. I will share my personal experience using weekly quizzes and feedback I have received from students, as well as different ways that Weekly Quizzes can be administered depending on your class structure.

E1-03 (12:00 to 12:10 PM | Contributed | Effective Framing for Oral Presentations

Presenting Author: Bradley McCoy, Azusa Pacific University

The effectiveness of assignments focused on communication orally or in writing largely depends on the assignment prompt providing a compelling task while also providing sufficient detail for students to know what is expected of them, as well as clear evaluation criteria. In this session, I will discuss how writing pedagogy that I learned in a role of special assistant to our campus writing program has been transferred to group presentations in our intro labs, which have been newly redesigned to emphasize scientific thinking skills, including communication.

E1-04 (12:10 to 12:20 PM | Contributed | Progressive Quizzes

Presenting Author: Brad Huff, California State University Fresno

Formative assessment is easily obtained using this technique. Instead of handing out copies of a quiz, I reveal the questions one part at a time, give a reasonably short time for students to arrive at an answer, and ask for volunteered answers. If the answer is correct, I ask how many got that answer. If it is incorrect, I ask how many students got that answer. Then I ask if anyone got a different answer. Did anyone get that answer? This takes longer than a traditional pencil and paper quiz, but provides detailed information on students' understanding. I reveal the correct answer and tell the students to award themselves points. There is the possibliity of cheating, but that catches up to them on a regular test. Then I move on to the next question.

E1-05 (12:20 to 12:30 PM) | Contributed | Pedagogies that Engage the Extramural Community

Presenting Author: Nelson Coates, University of Portland

Community-engaged learning projects combine course learning outcomes with off-campus activities to provide students with opportunities to contribute their labor and expertise in solving unscripted, authentic problems. In this talk I will discuss my experience with incorporating community-engagement projects in both introductory and advanced physics courses, and describe the assessment structures that can boost their success.

E1-06 (12:30 to 12:40 PM) | Contributed | Proposing and Testing Mechanistic Models to Construct Descriptions of Resonance

Presenting Author: Robert Davis, Brigham Young University
Additional Author | Nathan Powers, Brigham Young University
Additional Author | Adam Bennion, Brigham Young University
Additional Author | Richard Vanfleet, Brigham Young University

We have developed laboratory units for sophomore level physics students that focus on modelling in a way that incorporates prior physics knowledge from freshman level courses. In these units they are required to apply and synthesize this knowledge in describing new phenomenon. In one of these units, students propose potential mechanistic models to describe resonance phenomenon in a particular physical system. They have autonomy in choosing a physical system that exhibits resonance, but to avoid simplistic "verification" experiments, they are instructed to choose a resonant system that they have not learned about previously (no low amplitude pendulum or simple mass/spring systems). They then design and carry out experimental tests of model predictions and have time given to revise models and carry out additional tests. Student challenges have included: confusion over constructing a "mechanistic model", development of experiments capable of measuring predicted effects, and leaving sufficient time for redesign and retesting.

Session E2: Highlights from the Journals: TPT and the AJP

Tuesday, Jan. 17, 11:40 A.M.–1:40 P.M.
Moderators: Gary White and Beth Parks Sponsor: AAPT Pavillion West

E2-01 (11:40 AM to 12:05 PM) | Balloon-borne Infrared Photometer for Observation of Greenhouse Effect by Undergraduates

Presenting Author: Gerard Blanchard, Southeastern Louisiana University

I present the design and results of an investigation into the atmospheric greenhouse effect performed by two successive groups of undergraduate physics majors. The student-built infrared photometers were carried to an altitude of 30 km using a weather balloon and returned to Earth by parachute. The experiment demonstrates that the Earth radiates heat to space in the infrared region but that the radiation at the top of the atmosphere has a much lower effective radiation temperature than at the surface of the Earth, which is the essence of the greenhouse effect. The experiment also demonstrates that the greenhouse effect is much more pronounced in the H20 and CO2 molecular absorption bands than in the "infrared window", where the gasses do not absorb. Finally, the experiment demonstrates the downwelling infrared radiation in the atmosphere. All of these results are compared numerically to an atmospheric radiation transfer simulation.

E2-02 (12:05 to 12:30 PM) | Gravitational Effects of Ice Sheets on Sea Level

Presenting Author: Douglas Kurtze, Saint Joseph's University

When ice melts from a large ice sheet and the melt water runs into the ocean, global-mean sea level rises -- but local sea level near the ice sheet may well drop. This is largely because the loss of mass reduces the gravitational pull of the ice sheet. I present a sequence of analytically tractable models to illustrate this effect, beginning with a flat earth with a single circular continent, with a point mass at its center that represents the ice sheet. Next, I set the model on a (rigid, non-rotating) spherical earth. Finally, with a bit more mathematical sophistication, I account for the additional gravitation of the displaced sea water itself, and show how the calculations could be extended to more realistic ice distributions.

E2-03 (12:30 to 12:55 PM) | All About Polytropic Processes

Presenting Author: Randall Knight, California Polytechnic State University

Of all the conceivable ideal-gas processes, almost all introductory physics textbooks as well as more advanced texts on thermodynamics emphasize only four: isochoric, isobaric, isothermal, and adiabatic (isentropic). These are processes in which a state variable – volume, pressure, temperature, or entropy – remains constant. It turns out that these four processes are examples of a more general ideal-gas process, called a polytropic process, in which the specific heat remains constant. These processes have interesting properties (such as, in some cases, negative specific heat), they are easily accessible at the introductory physics level, and they expand the range of examples and problems that can be explored in thermodynamics.

E2-04 (12:55 to 1:20 PM) | | Not Quite Like the Movies: Teaching the Realities of Space Exploration

Presenting Author: Shannon Willoughby, Montana State University

Additional Author | Bahereh A. Samie, Temple University

Space exploration is quite common in US films and books, so it is not surprising that many students taking introductory Astronomy courses think that these fictional events mirror real life. Of course, experts realize that human space travel is incredibly rare beyond the International Space Station. Indeed, human travel to the moon is several years away, as is human travel to Mars. The NASA Heliophysics Education Activation Team has been developing and testing classroom materials for college students using space sciences as a springboard to teach physics and astronomy concepts. Two recent activities we have developed include one related exploring some of the difficulties of attempting a human mission to Mars and another activity that explores different types of rockets compared to solar sails. In this talk, i will discuss some of the scant research that has been done on student understanding of space travel, and talk about the development and implementation of these two activities in an introductory level astronomy course.

E2-05 (1:20 to 1:40 PM) | Panel Discussion about Publishing in the AAPT Journals

Presenting Author: Gary White, Beth Parks

Panel Discussion about publishing in the AAPT Journals

Session E3: Honoring Lillian Christie McDermott

Tuesday, Jan. 17, 11:40 A.M.–1:40 P.M.

Moderator: Paula Heron Sponsor: Committee on Women in Physics Broadway III/IV

E3-01 (11:40 AM to 12:10 PM) | Experiment and Theory: A Productive Tension in PER

Presenting Author: Edward Redish, University of Maryland

In 1992, I turned my career from Nuclear Theory to PER. Spending that academic year with Lillian and her group, I learned a huge amount. I also learned that Lillian and I had distinctly different perspectives: experiment vs theory. Over the next 20 years, we collaborated, shared podia, and butted heads. The tension between our distinct perspectives was immensely productive. I'll reminisce some and briefly discuss how I see experiment and theory in PER today

E3-02 (12:10 to 12:40 PM) | A Teacher's Reflections on the Impact of Lillian C. McDermott

Presenting Author: Michael O'Byrne, Interlake High School and UW PEG

Lillian C. McDermott is well known in the international physics community for her lifetime investment in research, curriculum development, and instruction to improve student learning in physics. One of the programs Professor McDermott built was the Summer Institute for Physics and Physical Science; I enrolled after my second year of teaching when I realized how underprepared I was to teach high school physics. Over my three summers as a participant the Physics by Inquiry curriculum exposed my misconceptions and helped me build solid conceptual understanding in physics. The nature of the curriculum, which relied on guided inquiry, continues to have an impact on my students and colleagues, while the nature of the instruction, which employed "checkouts" with the instructors, shaped the teacher I am today. Subsequently I spent over 10 years working with teachers in the Summer Institute. Over my career, no professional development has been more impactful.

E3-03 (12:40 to 1:10 PM) | Lillian McDermott as Mentor, Model, and Inspiration

Presenting Author: David Meltzer, Arizona State University

Co-presenting Author | Valerie K. Otero, University of Colorado, Boulder

Lillian McDermott had an enormous influence on both of our professional lives and outlooks from the time we first became involved with physics education research. Her focus on using research to inform and guide the development of curricular materials as the basis of improved physics instruction became a central theme of our own work. Her insistence on rigorous assessment of instructional effectiveness and continual iterative improvement served as a standard by which we have measured our own success and that of others. Her pointed question regarding educational research endeavors of "Where is the physics?" has helped direct our attention to the areas in which we as physicists may most effectively marshal our unique knowledge and perspective to advance the teaching and learning of physics. By epitomizing the highest standards of quality and rigor in physics education research, she provided a model to guide and inspire future efforts in the field.

E3-04 (1:10 to 1:40 PM) | Honoring Lillian McDermott's Enduring Legacy of Research and Curriculum Development

Presenting Author: Paula Heron, University of Washington

Like many others in PER, my initial introduction to the field was through an inspiring colloquium by Lillian McDermott. After completing a PhD in physics, I joined her group as a postdoc, and eventually transitioned from mentee to colleague with a faculty appointment in the UW physics department. My current research program, while diverging from Lillian's in many ways, still reflects many of the fundamental principles and practices she pioneered. In this talk I'll trace some of these connections, and argue that many of her insights are just as relevant today as ever.

Session E4: Mindfulness and Inquiry in K12 Classrooms

Tuesday, Jan. 17, 11:40 A.M.–1:40 P.M.

Moderator: TBA Sponsor: Committee on Physics in High Schools Pavillion East

E4-01 (11:40 to 12:30 PM) | Interactive (e.g. panel, round table discussion, hands-on activity) | Mindfulness and Empathy in the Physics Lab

Presenting Author: NADENE KLEIN, Daniel C Oakes High School

For some students, science is a high stress class, especially when math is involved. It can be for the teacher too. This workshop will share some strategies to use mindfulness and elicit empathy from students that can be interwoven in the science classroom. The goal is to help reduce stress and refocus your class.

E4-02 (12:30 to 1:20 PM) | Interactive (e.g. panel, round table discussion, hands-on activity) | Learning vs Becoming - Developing Professional Identity in Physics Classroom

Presenting Author: Honorata Grzeszczuk, Felician University

"Reason has wilted under the weight of so much knowledge and little by little has lost the capacity to lift its gaze to the heights, not daring to rise to the truth of being." My interpretation of that statement leads to a question of knowledge integration, that seems to be overlooked in undergraduate physics courses. Little or no time and effort is reserved for students to integrate their knowledge. In effect, science becomes merely equivalent to facts and theories and does not lead to growth toward "becoming" a physicist (a scientist). How do we help young people in an introductory physics class (lecture/lab) to integrate knowledge so they can see beyond facts, and develop their identity as scientists? I will propose and discuss mindfulness and reflection (semi-journaling) as tools of knowledge integration. Examples of mindfulness exercises and guided reflection that accompany a science laboratory will be presented and discussed.

Session E5: Engaging Physics Majors with Outreach & Careers

Tuesday, Jan. 17, 11:40 A.M.–1:40 P.M.

Moderator: Tatiana Erukhimova Sponsor: Committee on Science Education for the Public Broadway I/II

E5-01 (11:40 AM to 12:10 PM) | Purposeful Manipulation: Putting physics Demonstrations in Student Hands for "ROI"

Presenting Author: Toni Sauncy, Texas Lutheran University

Most physics educators realize the value of visual demonstrations sprinkled throughout the curriculum. And physics demonstration "shows" are a mainstay of many public outreach programs around the country, aimed at generating interest in physics among younger students or the general public. The educators know that classroom/lab demonstrations can pique interest in what might otherwise be deemed a bit 'boring', and most would agree that many of the demonstrations typically seen in public outreach work are 'fun and exciting'. In this talk, the real benefits of investing the time, energy, and resources required to teach students how to present physics in demonstration form will be presented as a matter of "return on investment". The investment is in finding demonstrations for which students can claim ownership, with the goal of building student persistence and enthusiasm. The big returns using this investment scheme are the focus of this talk. Special acknowledgment to the Society of Physics Students, the alumni, past and present directors, and the tireless chapter advisors who march to the beat of the same physics outreach drum.

E5-02 (12:10 to 12:40 PM) | Feral Physics: Inspiration and Demonstration on the Road Less Traveled

Presenting Author: Dani

Tremendous potential exists for partnerships and exchange outside the traditional lab or classroom, whether presenting to the public, participating in virtual communities or live festivals and events, or collaborating with institutions and professionals of other backgrounds. While such opportunities can present challenges due to varying environments, resources, norms, and approaches, they are also valuable in acquiring new skills and perspectives as well as building identity, community, resilience, and adaptability.
Having chosen an eclectic and often tenuous career path spanning lightning research, moonlighting as a dance instructor, informal science education in a museum, and lecture demonstrations in academia, I'll relay lessons from trying to foster exchange between groups with common interests but distinct identities, a few demos with common and not-so-common items, as well as tips to prepare for, improvise, and find inspiration in atypical circumstances.

E5-03 (12:40 to 12:50 PM | Contributed | Utilizing the Art of Demonstration at an Undergraduate Level

Presenting Author: Carlee Garrett, Texas A&M University

Additional Author | Tatiana Erukhimova, Texas A&M University

Implementing outreach programs has proven to be effective at improving the quality of education for both event attendees and volunteers. Prior literature has shown the importance of hands-on learning for content knowledge development, as well as the impact of outreach on a student's overall education. Here, we present the impact of using the art of demonstration at an undergraduate level. Experiences from various undergraduate students from the Society of Physics Students were used to illustrate how using hands-on demonstrations as part of outreach has further developed their physics content knowledge and professional skills. Several factors were considered, including students' physics identity, sense of belonging, professional skills, and the influence of the ongoing COVID-19 pandemic. Additionally, we hope to encourage other institutions and organizations to have their students get involved with hands-on demonstrations to facilitate similar developments.

E5-05 (1:00 to 1:10 PM) | Contributed | Supporting Belonging and Leadership through the Learning Assistant Model*

Presenting Author: Mel Sabella, Chicago State University

Additional Author | Jacquelyn Benchik-Osborne, Chicago State University

Additional Author | Andrea G. Van Duzor, Chicago State University

The Learning Assistant (LA) Model leverages undergraduate students (LAs) as facilitators of learning in active engagement classes. At CSU, the LA Model began in Physics and is now implemented in three colleges: Arts and Sciences, Education, and Business with planned expansion in the College of Health Sciences. LAs work with instructors and are often in positions where they collaborate on instructional material development and implementation. LAs often have complementary expertise and develop leadership skills that inform our instructional practice and can support their career and academic pathways. We explore LA-faculty partnerships and describe student leadership development, fostered by engagement in the Model. Through leadership development and collaborative partnerships, LAs become part of instructional teams and play pivotal roles in our programs. *Funded by The Partnership for College Completion, the Department of Education (CSER, RECESS), and the National Science Foundation DUE# 1524829, 1911341.

E5-06 (1:10 to 1:20 PM) | Contributed | Career Moments in Physics

Presenting Author: Erin De Pree, Bates College

With over a decade of developing, maintaining, and passing the curriculum along to others to teach, I reflect on the work and results of teaching students about their career options. I will present the curriculum structure and assignments (to help students engage with the material) as well as discuss increased student participation in summer internships. By setting aside approximately 15 minutes weekly, students will understand the wide variety of career options and the many resources available to them to explore those options. A link to all the slides and assignments will be shared with the audience.

Session E6: Research on Diversity, Equity, and Inclusion in Physics Teaching

Tuesday, Jan. 17, 11:40 a.m.–1:40 p.m.

Moderator: TBA **Sponsor: TBA** **Galleria South**

E6-01 (11:40 to 11:50 AM) | Contributed | Whose Work Matters? Identifying and Developing more Inclusive Physics Textbooks

Presenting Author: Tai Xiang, Pomona College

Additional Author | Will Gray, Pomona college

Additional Author | Janice Hudgings, Pomona college

The lack of representational diversity and role models in physics, including in curricular materials, is a contributing factor to the dramatic underrepresentation of women and people of color in physics. We have developed an automated Python-based tool for identifying the names and demographics of scientists mentioned in indices and chapters of physics textbooks, enabling authors, publishers, and users of physics textbooks to perform rapid analysis. The tool is used to examine the demographics of mentioned scientists in the entire collection of textbooks in a representative four-year undergraduate physics-major curriculum and ten popular introductory physics textbooks. Our results show that the studied textbooks focus on work attributed to White men of European, British, and North American descent. This points to a need for the physics education community, including textbook publishers, authors, and adopters, to broaden our portrayals of physics to better reflect the diversity of scientists working in this field.

E6-02 (11:40 to 11:50 AM) | Contributed | Does NGSS Based Curriculum Improve Equity? Study Design and Observations

Presenting Author: Jolene Johnson, University of Wisconsin River Falls

Additional Author | Amanda Sheehan, Edison High School

Additional Author | Claire Hypolite, Edison High School

Next Generation Science Standards (NGSS) is a set of K-12 science standards developed by states to improve science education for all students. These science standards focus on learning to do science like a scientist instead of route memorization of scientific facts. Minnesota is in the middle of switching to new standards based on NGSS. Minnesota is also known to have one of the largest opportunity gaps for students of color. In our study we are designing and adopting curriculum that meets these new standards and studying how switching to these standards affects equity in the high school science classroom. We will present our study design and initial observations of student engagement with new 9th grade NGSS based physical science curriculum.

E6-03 (11:50 AM to 12:00 PM) | Contributed | Disentangling the Web: A look into emotions within physics classrooms

Presenting Author: Alia Hamdan, University of Arizona

Additional Author | Sanlyn Buxner, University of Arizona

In both public and scholarly discourse, there is a growing interest in diversity and inclusion in STEM fields. Physics is no stranger to this problem and is statistically one of the worst STEM fields at obtaining and retaining students from diverse socio-economic backgrounds. One cannot continue to do the same thing and expect different results, as such there have been growing calls to rethink these problems. As teachers, we have all witnessed moments of joy and despair within our students and can acknowledge that emotions are an important part of learning. This talk will give an overview of the role of emotions in education research and identify important emotions students experience in introductory physics courses. Looking at students through an emotional lens has the potential to understand varying affective measures and could potentially be an important avenue to understanding student retention, interests, and identities of physics students.

E6-04 (12:00 to 12:10 PM) | Contributed | STEM Instructors Need Additional Support to Address Discrimination*

Presenting Author: Charles Henderson, Western Michigan University

Additional Author | Melissa Dancy, Western Michigan University

Additional Author | Naneh Apkarian, Arizona State University

Additional Author | Estrella Johnson, Virginia Tech

Discrimination is common in higher education and is a primary reason for the lack of diversity. In this talk, we use surve results from 1,023 physics, chemistry, and math instructors to highlight three barriers to addresssing discrimination. First, while most respondents believe it is important to address inequities in their field, they were more likely to favor passive strategies, such as diversity training, over active ones, such as affirmative action policies. Second, respondents felt that the over-representation of white men in science fields could be at least partially explained by lower levels of interest among some demographic groups. Finally, while white men were the demographic group most likely to be satisfied after reporting discrimination, they were also least likely to notice discrimination. Based on these findings, we argue that institutions must reconceptualize how they confront discrimination in a way that requires individuals to see, acknowledge, and address discrimination.

*This material is based upon work supported by the National Science Foundation under DUE Grant Nos. 1726042, 1726281, 1726126, 1726328, & 1726379. 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.

E6-05 (12:10 to 12:20 PM) | Contributed | Recruiting and Supporting Underrepresented Students

Presenting Author: Jennifer Blue, Miami University

Miami University is making efforts to improve the diversity of our students in the sciences and beyond. We have programs for high school students, early arrival programs for students from traditionally excluded populations, and support for students while they are in school. Come learn about CIQS Day, Bridges, Discover the Sciences, MADE at Miami, the LSAMP Program, and more – and stay to share what your school is doing!

Calculus-Based Introduction to Physics: Workshop on Interactive Learning Resources

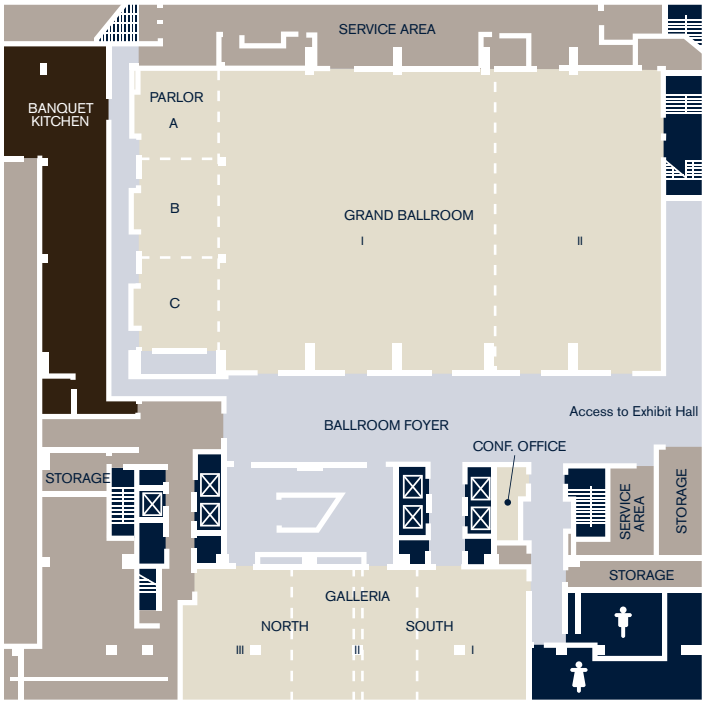
Saturday, Jan. 14, 3:00 PM to 4:00 PM Pavillion West

Moderator: McGraw Hill Higher Education Physics / Co-Organizer: Wolfgang Bauer

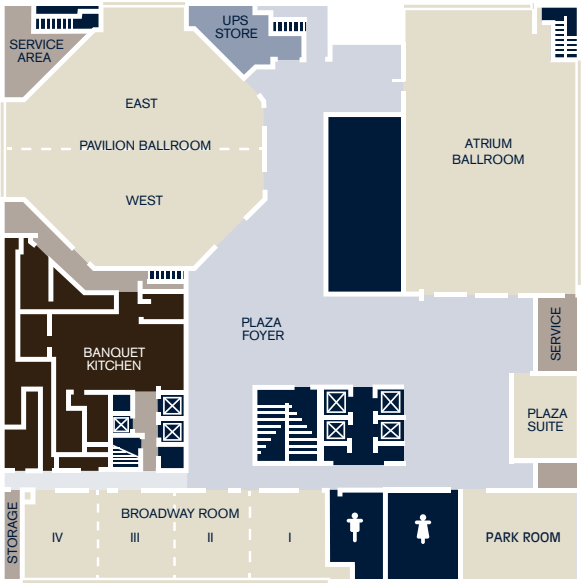
Dr. Wolfgang Bauer from Michigan State University will demonstrate interactive tools that are being developed to help university and community college students learn physics by actively engaging with the material. These resources can be used inside or outside the classroom for active learning &/or assessment. The goal is to get students to apply the information they have learned and develop critical thinking skills. Your input plays a critical role to ensure we develop tools students need to be successful. Participants of the workshop will also be able to provide feedback to guide development of these resources

FLOOR PLAN

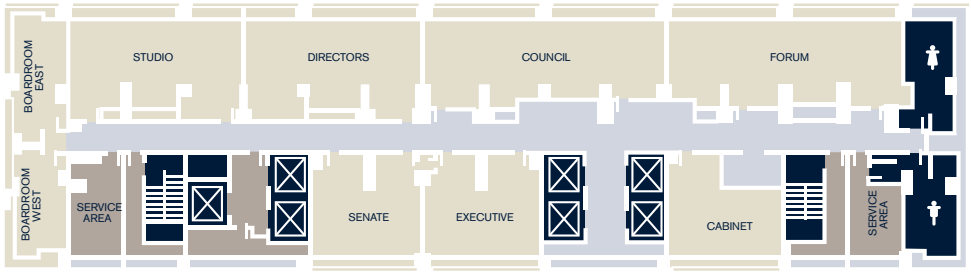
Ballroom Level



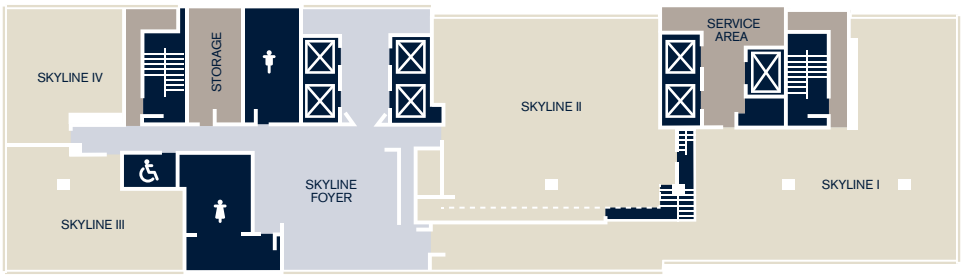
Plaza Level



3rd Floor Conference Level



23rd Floor Skyline Level



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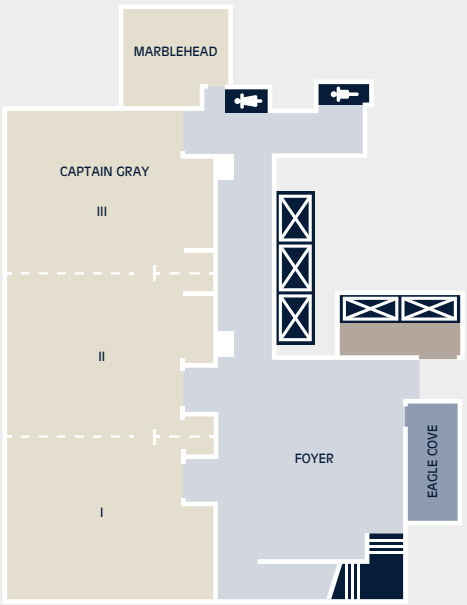

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