AAPT Summer Meeting Program

July 13-17, 2013

AAPT
PHYSICS EDUCATION

aapt.org

2013 AAPT Summer Meeting

going green with Portland 2013 AAPT

Portland, OR
July 13-17, 2013

Hilton Portland & Executive Tower

American Association of Physics Teachers
One Physics Ellipse
College Park, MD 20740
301-209-3333
www.aapt.org

Going Green with Portland!

With memories of a very successful meeting in Portland in the summer 2010, the American Association of Physics Teachers will be returning to Portland for its Summer Meeting July 13-17, 2013. The theme for this meeting is "Going Green with Portland." Portland State University will be host to our AAPT workshops conducted during the first two days of the meeting. The AAPT Two-Year College Community will host a one-day Tandem Meeting preceding the AAPT meeting. In addition, the AAPT meeting will host a High School Teachers Day.

Our 18 area committees have organized a Portland program rich in sessions and workshops, which address a diversity of topics and interests for our group of physics teachers ranging from pre-college through research universities. I mention here just a few: the teaching of online courses, the authoring of interactive textbooks, the Next Generation Science Education Standards, best practices in educational technology, research in math education and education research at the boundary between biology and physics, green labs and activities, and a role-playing workshop on the Pluto Debate. A special event with invited panelists will celebrate the 50th anniversary of *The Physics Teacher*.

During the past year, the physics education community and AAPT lost one of our leaders, Robert G. Fuller, Univ. of Nebraska, Lincoln. We will pause to remember and honor some of his many contributions during the Robert G. Fuller Memorial Session.

Dr. Alan M. Nathan, Prof. Emeritus, University of Illinois at Urbana, Champaign will give a plenary presentation entitled "'You Can Observe a Lot by Watching'...Yogi Berra." Following Yogi's advice, Dr. Nathan will use high-speed video clips to highlight some of the interesting physics underlying the game of baseball. The talk will focus on the subtleties of the baseball-bat collision, the intricacies of the flight of a baseball, and many other things. Dr. Nathan will also lead a workshop, "Major League Physics – Using Baseball to Teach Physics." Additional plenaries will be given by our award recipients and invited scientists.

The Summer Picnic has long been considered a favorite networking activity for physics faculty and their families. Christine and David Vernier will again sponsor an exciting evening beginning with the traditional picnic spread along a city block. The Vernier picnic of 2010 is still being talked about and this one promises to be just as entertaining and filling. A demonstration show will follow and will be held within a charming old theater.

I have highlighted only a few of the special events planned for our Summer 2013 meeting. In addition, Portland has many attractions to entertain visitors, from tax-free shopping in its malls to outdoor activities such as hiking the many trails and seeing the local natural wonders.

Mary Beth Monroe

Mary Beth Monroe
American Association of Physics Teachers
2013 Program Chair

AAPT Sustaining Members

The American Association of Physics Teachers is extremely grateful to the following companies who have generously supported AAPT over the years:

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Special Thanks

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

Local organizers:

Ralf Widenhorn, Portland State University
Elliot Mylott, Portland State University

Paper sorters:

Andy Gavrin (UG Ed)
David Sturm (Apparatus)
Geraldine Cochran (Minorities)
Mac Stetzer (RiPE)
Mary Mogge (as incoming program chair for Orlando)
Toni Sauncy (SPS contributions)
Mary Beth Monroe (program chair)

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Facebook/Twitter at Meeting

We will be tweeting and posting updates to Facebook, before, during, and after the meeting to provide you with details and helpful tips. Participate in the conversation by reading the latest tweets at ***http://twitter.com/AAPTHQ*** or search the ***hashtag #aaptsm13***. Don't forget to include that hashtag in your tweets! Make sure to check social media for any changes to the schedule, cancellations, and general announcements during the meeting.

Follow us to stay up to the minute!

Like us on Facebook at ***http://facebook.com/AAPTHQ*** and follow us at ***@AAPTHQ*** on Twitter

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Portland – the "City of Roses"

Portland has been called the most environmentally friendly or "green" city in the United States. Known especially for its many rose gardens—the most famous one is the International Rose Test Garden, Portland lies at the northern end of the Willamette Valley. The Willamette River runs north through the city center, separating the east and west sections before veering northwest to join with the Columbia River at the Washington state border.

History

The city of Portland was founded in 1843 on the Willamette River in what was then called "Oregon Country." In 1845 the name of Portland was chosen and on Feb. 8, 1851, the city was incorporated. Portland actually started as a spot known as "the clearing." The city was named for Portland, ME, after a famous coin toss. In 1843 the two owners of the claim, Asa Lovejoy of Boston and Francis W. Pettygrove of Portland, ME, each wanted to name the new city after his respective home town; thus the coin toss, which Pettygrove and Portland, ME, won.

At the time of its incorporation in 1851, Portland had more than 800 inhabitants, a steam sawmill, a log cabin hotel, and a newspaper, the Weekly *Oregonian*.

In 1905, Portland was the host city of the Lewis and Clark Centennial Exposition. This event contributed to a doubling of the population, from 90,426 in 1900 to 207,214 in 1910.

Portland's location, with access to the Pacific Ocean via the Willamette and the Columbia rivers, and access to the agricultural Tualatin Valley via the "Great Plank Road" (the route of current-day U.S. Route 26), gave it an advantage over nearby ports. It remained the major port in the Pacific Northwest for much of the 19th century, until the 1890s, when Seattle's deepwater harbor was connected to the rest of the mainland by rail, affording an inland route without the treacherous navigation of the Columbia River.

Education

The largest institutions of higher education include Portland Community College, Portland State University, and Oregon Health & Science University. Private colleges and universities include Lewis & Clark College, Reed College, Warner Pacific College, Linfield College, and Concordia University.

Things to do in Portland:

➤ **Forest Park:** Extensive system of trails, fire lanes, and roads provide excellent opportunities for hiking, walking, running, and simply escaping the urban atmosphere. On the west side of the city. *forestparkconservancy.org*

➤ **Portland Saturday Market:** Operating since 1974, the Portland Saturday Market is the largest continually operating outdoor arts and crafts market in the nation. Centered in Portland's historic Old Town, the Market is one of the most popular shopping destinations for local handcrafted goods. *Sat. 10 a.m.– 5 p.m. Sun: 11 a.m.–4:30. portlandsaturdaymarket.com/*

➤ **Pittock Mansion:** High in the West Hills of Portland, Pittock Mansion soars 1000 feet above the city's skyline. A century-old symbol of Portland's dramatic transformation from a small lumber town to a bustling city, it's an architectural wonder. With picture-perfect views of rivers, forests, bridges, and mountaintops—and 23 storied rooms teeming with treasures—no other place in town offers a more breathtaking view or a more revealing glimpse of Portland's past. *pittockmansion.org/*

➤ **Oregon Museum of Science and Industry** (OMSI): Planetarium, OmniMax Theater. Five unique halls include a hands-on Science Playground for visitors six and under and Earth Hall featuring Science on a Sphere. Build your brainpower with over 200 interactive exhibits and labs for all ages in renewable energy, global climate, health and wellness, chemistry, engineering, technology, and more. *Daily, 9:30 a.m.–5:30 p.m.* LOCATION: 1945 SE Water Ave., Portland, OR 97214-3354; *www.omsi.edu*

➤ **International Rose Test Garden**: The International Rose Test Garden in Portland is among the most beautiful Portland attractions. Fountains, statues, and public art pepper the gardens with culture and beauty visitors will find hard to resist. LOCATION: 400 SW Kingston Ave., Washington Park, Portland, OR 97205

➤ **Gov. Tom McCall Waterfront Park:** A breezy stroll along the Willamette River, Waterfront Park is a must visit. Lovely views of the Willamette River and perspective on Portland's many bridges. Running nearly the whole distance of downtown Portland, it is easily accessible and also makes for a relaxing lunch or picnic stop. LOCATION: 1020 Southwest Naito Parkway.

Meeting-at-a-Glance

Meeting-at-a-Glance includes sessions, workshops, committee meetings, and other events, including luncheons, Exhibit Hall hours and snacks, plenary sessions, poster sessions, and receptions. All rooms will be in the Hilton Portland & Executive Tower, or the Nines Hotel. All workshops on Saturday and Sunday will be held at Portland State University, except for W35 and W40, which will be held at Vernier Software & Technology.

FRIDAY, July 12

7 a.m.–6 p.m.		PTRA Summer Institute	Salon Ballroom III
8 a.m.–9:30 p.m.		TYC Leadership Institute	Vernier Software & Technology
4–7 p.m.		**REGISTRATION**	**Plaza Foyer**

SATURDAY, July 13

7 a.m.–4 p.m.		**REGISTRATION**	**Plaza Foyer**
7 a.m.–6 p.m.		PTRA Summer Institute	Salon Ballroom III
8 a.m.–12 p.m.	W06	Tablets in the Physics Classroom	SRTC 247
8 a.m.–12 p.m.	W07	Simple Experiments for Learning the Strategies that Mirror Scientific Practice	SRTC 161
8 a.m.–12 p.m.	W08	LivePhoto Physics: Video-based Motion Analysis for Homework and Classroom	SRTC B1-82
8 a.m.–12 p.m.	W11	Using Invention to Promote Mathematical Thinking	SRTC 101
8 a.m.–5 p.m.	W01	Learn Physics While Practicing Science: Introduction to ISLE	SRTC 155
8 a.m.–5 p.m.	W03	Real LHC Data for the Classroom	SB1 409
8 a.m.–5 p.m.	W04	AP Physics 1 and 2	SRTC 113
8 a.m.–5 p.m.	W12	Physics of Energy	SRTC 149
8:30 a.m.–4:45 p.m.		TYC Tandem Meeting	Vernier Software & Technology
10 a.m.–5 p.m.		Columbia Gorge Tour	Offsite
1–5 p.m.	W14	Arduino Applications in the Lab and Classroom	SB1 201
1–5 p.m.	W15	Introductory Laboratories	SB1 424
1–5 p.m.	W16	Introduction to Interactive Laboratory Experience (ILE) – A Hands-on Approach	SRTC 161
1–5 p.m.	W18	Physics and Toys I: Force, Motion, Light, and Sound	SB1 304
1–5 p.m.	W19	Standards-based Grading	SRTC B1-82
1–5 p.m.	W21	Designing Courses with Moodle	SRTC B1-41
2–5:30 p.m.		AAPT Executive Board I	Forum Suite
6:30–8:30 p.m.		Melba Newell Phillips Medal Fundraiser and Dinner	Pavilion Ballroom

SUNDAY, July 14

7 a.m.–4 p.m.		**REGISTRATION**	**Plaza Foyer**
7:30–10 a.m.		Publications Committee	Studio Suite
7:30–10 a.m.		Meetings Committee	Forum Suite
8 a.m.–10 p.m.		High School Physics Photo Contest Viewing and Voting	Plaza Foyer
8 a.m.–12 p.m.		Focused Discussion: Development of Effective Assessment to Inform Instruction	Broadway I
8 a.m.–12 p.m.	W26	PIRA Lecture Demonstrations I	SRTC 101
8 a.m.–12 p.m.	W28	Research-based Tools for Teaching Quantum Mechanics	SRTC 108
8 a.m.–12 p.m.	W29	Green Labs and Activities	SRTC 247
8 a.m.–12 p.m.	W30	Getting Started with eBooks	SRTC B1-82
8 a.m.–12 p.m.	W31	Activities and Apparatus for Teaching About Climate and Climate Change	SRTC 155
8 a.m.–12 p.m.	W32	Ways to Teach Sound and Music	SRTC 166
8 a.m.–12 p.m.	W33	Major League Physics – Using Baseball to Teach Mechanics	SB1 304
8 a.m.–12 p.m.	W34	Heliophysics	SRTC 162
8 a.m.–12 p.m.	W35	Activity-based Physics in the Advanced Physics High School Classroom	Vernier Software & Technology
8 a.m.–5 p.m.	W24	Teaching Physics for Life Science and Pre-Health Students: Lab Activities	SRTC 161
8 a.m.–5 p.m.	W25	Arduino Microcontrollers and Underwater ROVs	SB1 201
10 a.m.–2 p.m.		AAPT Executive Board II	Council Suite
12–1:30 p.m.		Physics Bowl Advisory Committee	Studio Suite
12:30–1:30 p.m.		Nominating Committee I (closed meeting)	Forum Suite
1–5 p.m.	W27	Measuring of Learning in the Astronomy Classroom	SRTC 166
1–5 p.m.	W36	Advanced Lab Workshop	SB1 424
1–5 p.m.	W37	Strategies to Help Women Succeed in Physics Related Professions	SRTC 108
1–5 p.m.	W38	LEAP: Learner-Centered Environment for Algebra-based Physics	SRTC 149
1–5 p.m.	W40	New RTP and ILD Tools and Curricula: Video Analysis, Clickers, and E&M Labs	Vernier Software & Technology
1–5 p.m.	W41	Interactive Engagement in the Upper Division: Methods and Materials from CU-Boulder	SB1 304
1–5 p.m.	W42	Skepticism in the Classroom	SRTC 247
1–5 p.m.	W43	Physics TIPERs and Ranking Tasks	SRTC 155
1–5 p.m.	W44	Modeling Applied to Problem Solving with Associated Free Online Course	SRTC 104

1–5 p.m.	W45	PIRA Lecture Demonstrations II	SRTC 101
1–5 p.m.	W46	Exoplanets	SRTC 162
2–4 p.m.		Strategic Planning Workshop	Broadway I/II
4–5:30 p.m.		Programs Committee I	Broadway III/IV
4–5:30 p.m.		SI Units and Metric Education Committee	Forum Suite
5–8 p.m.		Section Representatives	Broadway I/II
6–8 p.m.		High School Share-a-Thon	Broadway III/IV
7:30–9 p.m.		**REGISTRATION**	**Plaza Foyer**
8–10 p.m.		**Exhibit Hall Opening / Welcome Reception**	Exhibit Hall
8–10 p.m.		SPS Undergraduate Research and Outreach Poster Session / Reception	Exhibit Hall
MONDAY, July 15			
7 a.m.–5 p.m.		**REGISTRATION**	**Plaza Foyer**
7–8 a.m.		First Timers' Gathering	Skyline III
7–8:30 a.m.		PTRA Oversight Committee	Council Suite
8–10 a.m.		Poster Session I Setup	Exhibit Hall
8–9:10 a.m.	AA	Apparatus for Beyond the First Year of Instruction	Parlor A/B
8–9:40 a.m.	AB	Broader Perspectives: Students' Understanding	*Nines Hotel* – Gallery 1
8–10 a.m.	AC	Implementing Competency-based Grading in a Variety of Physics Classroom Settings	Broadway I/II
8–9:30 a.m.	AD	Introductory Physics for Life Science Majors	Salon Ballroom II/III
8–10 a.m.	AE	Panel – Seeking Employment In Academia	Broadway III/IV
8–9:40 a.m.	AF	Modern Physics in the High School Classroom	Galleria II
8–9:20 a.m.	AG	Teachers in Residence and Master Teachers in Teacher Preparation	Salon Ballroom I
8–9:50 a.m.	AH	PER: Classroom Strategies and Problem Solving Using Online Tools	Pavilion West
8–9 a.m.	AI	If They Make it, They Will Learn	Skyline IV
8–10 a.m.	AJ	Labs and Activities for Sustainability	*Nines Hotel* – Gallery 2
8–10 a.m.	AK	Frontiers in Astronomy and Space Science	Pavilion East
8 a.m.–5 p.m.		High School Physics Photo Contest Viewing & Voting	Plaza Foyer
8 a.m–5 p.m.		TYC Resource Room	Grand Ballroom II
8 a.m–5 p.m.		PIRA Resource Room	Exhibit Hall
9–10 a.m.	**CW01**	**Perimeter Institute: Beyond the Atom: Particle Physics, Comm. Workshop**	Galleria III
9–10 a.m.	**CW02**	**WebAssign: Using Online Homework to Achieve Pedagogical Goals, Workshop**	Galleria I
10 a.m.–5 p.m.		**Exhibit Hall Open (coffee break, 10–10:30 a.m.)**	Exhibit Hall
10–11:30 a.m.		Spouses/Guest Big Pink Sightseeing	Offsite
10–10:30 a.m.		World's Tallest Barometer Tour	PSU – Engineering Bldg.
10:15 a.m.		Monday Amazon Kindle Drawing	Exhibit Hall
10:30 a.m.–12 p.m.	**Awards**	**Welcome, AAPT Excellence in Teaching Awards, DSCs**	**Grand Ballroom I**
11:30 a.m.–1 p.m.	**CW03**	**Perimeter Institute: Classroom Activities for Dark Matter, Comm. Workshop**	**Galleria III**
11:30 a.m.–1:30 p.m.		International Attendee Luncheon	Offsite
12–1 p.m.	**CW04**	**PASCO scientific: A New Era for Computerized Physics Labs, Comm. Workshop**	**Pavilion West**
12–1 p.m.	**CW05**	**Pearson: Eugenia Etkina, Commercial Workshop**	**Pavilion East**
12–1 p.m.	**CW13**	**Electron Investigation with 3B Scientific Teltron® Tubes, Comm. Workshop**	**Parlor A/B**
12–1:30 p.m.		Early Career Professional Speed Networking Event	Skyline IV
12–1:30 p.m.		Retired Physicists' Luncheon	Parlor C
12–1:30 p.m.		**High School Physics Teachers Day Luncheon**	**Skyline III**
12–1:30 p.m.	CKRL01	Crackerbarrel: Physics and Society	Broadway I/II
12–1:30 p.m.	CKRL02	Crackerbarrel: Web Resources for Astronomy	Broadway III/IV
12–1:30 p.m.		Committee on Physics in Two-Year Colleges	Council Suite
12–1:30 p.m.		Committee on Physics in Pre-High School Education	Directors Suite
12–1:30 p.m.		Committee on Apparatus	Galleria I
12–1:30 p.m.		Committee on History & Philosophy in Physics	Studio Suite
12–1:30 p.m.		Committee on Research in Physics Education (RiPE)	Salon Ballroom II/III
12:30–1:30 p.m.		Membership and Benefits Committee	Forum Suite
1:30–3:30 p.m.	**Special**	Special Session to Honor Bob Fuller's Contributions to Physics Education	**Grand Ballroom I**
3:30–4 p.m.		World's Tallest Barometer Tour	PSU – Engineering Bldg.
3:30–4 p.m.		**Exhibit Hall: Afternoon Break**	Exhibit Hall
3:45 p.m.		Monday Gift Card Raffle Drawing	Exhibit Hall
4–6 p.m.	BA	Panel: Curriculum, Assessment, & Student Outcomes in Undergraduate Program	Pavilion East
4–6 p.m.	BB	Demo and Lab Ideas for the H.S. Physics Classroom	Galleria II
4-5:40 p.m.	BC	Engineering in the Physics Classroom	Galleria I
4–6 p.m.	BD	Panel – Massively Open Online Courses	Broadway III/IV

4–5:20 p.m.	BE	PER: Teacher Preparation and Professional Development	Pavilion West
4–6 p.m.	BF	Education Research at the Boundary of Physics and Biology	Skyline IV
4–5:30 p.m.	BG	Teaching Physics Around the World	Parlor A/B
4–5:30 p.m.	BH	Implementations of Modeling Instruction for Different Audiences	Salon Ballroom II/III
4–6 p.m.	BI	Panel – Teaching Controversial Topics	Broadway I/II
4–5:30 p.m.	BJ	Evolving Practices of Teacher Preparation to Meet Next Generation Science Standards	Galleria III
6:10-7:10 p.m.	**Awards**	**Millikan Medal – Harvey Gould**	**Grand Ballroom I**
7:10–8:30 p.m.	CKRL03	Crackerbarrel: Graduate Students	Broadway I/II
7:10–8:30 p.m.	CKRL04	Crackerbarrel: Writing in the Laboratory	Broadway III/IV
7:10–8:30 p.m.	CKRL05	Crackerbarrel: Vidshare: Motivating and Elucidating Short Videos You Can Use!	Pavilion West
7:10–8:30 p.m.		PIRA Business Meeting	Galleria I
7:10–8:30 p.m.		Committee on Governance Structure (COGS)	Studio Suite
7:10–8:30 p.m.		Committee on Physics in High Schools	Pavilion East
7:10–8:30 p.m.		Committee on International Physics Education	Council Suite
7:10–8:30 p.m.		Committee on Minorities in Physics	Forum Suite
7:10–8:30 p.m.		Committee on Professional Concerns	Directors Suite
7:10–8:30 p.m.		Committee on Space Science and Astronomy	Galleria II
7:10–8:30 p.m.		New Faculty Workshop Reunion	Galleria III
8:30–10 p.m.		SPS Undergraduate Awards Reception	Skyline III
8:30–10 p.m.	PST-1	Poster Session 1	Grand Ballroom II

TUESDAY, July 16

6:30–7:30 a.m.		AAPT Fun Run/Walk	Offsite
7 a.m.–4:30 p.m.		**REGISTRATION**	**Plaza Foyer**
7:30–8:40 a.m.	CA	PIRA Session: Managing Instructional Resources in an Era of Increasing Enrollments	Broadway I/II
7:30–9 a.m.	CB	Using Simulations and Models for Pre-High School Teaching	Broadway III/IV
7:30-8:40 a.m.	CC	Teaching Physics Online	Skyline III
7:30-8:50 a.m.	CD	Teaching Assistants and Learning Assistants	Skyline IV
7:30-8:50 a.m.	CE	Student Attitudes, Confidence, Self-Efficacy, and Motivation	Salon Ballroom II/III
7:30–9 a.m.	CF	Research in Undergraduate Mathematics Education	Galleria II
7:30–9 a.m.	CG	Assessment of Informal Science Education	Parlor A/B
7:30–9 a.m.	CH	What Does Success Mean in Graduate School?	Pavilion East
7:30–8:50 a.m.	CI	Gender and Sexual Diversity Issues in Physics	Pavilion West
8 a.m.–5 p.m.		High School Physics Photo Contest Viewing & Voting	Plaza Foyer
8 a.m–5 p.m.		TYC Resource Room	Grand Ballroom II
8 a.m–5 p.m.		PIRA Resource Room	Exhibit Hall
9–10 a.m.	**PLENARY**	**The Physics of Baseball – Alan Nathan**	**Grand Ballroom I**
9:30–10:30 a.m.	**CW06**	**Perimeter Institute: Curved Spacetime and the Global Positioning System**	Galleria III
9:30–10:30 a.m.	**CW07**	**Physics2000.com, Commercial Workshop**	Galleria I
9:30–10:30 a.m.	**CW08**	**Pearson: MasteringPhysics**	Salon Ballroom I
10–10:30 a.m.		World's Tallest Barometer Tour	PSU – Engineering Bldg.
10 a.m.–4 p.m.		**Exhibit Hall Open (coffee break, 10 a.m.)**	Exhibit Hall
10:15 a.m.		**Tuesday Gift Card Raffle Drawing**	Exhibit Hall
10:30 a.m.–12:30 p.m.	DA	***The Physics Teacher:* Celebrating 50 Years**	**Pavilion East**
10:30 a.m.–12:20 p.m.	DB	Introductory Courses	Parlor A/B
10:30 a.m.–12:30 p.m.	DC	Best Practices in Educational Technology	Broadway I/II
10:30 a.m.–12:30 p.m.	DD	Methodologies for Identifying and Investigating Cognitive 'Resources' in Physics	Broadway III/IV
10:30 a.m.–12:30 p.m.	DE	Teaching Physics to the Liberal Arts Major	Galleria II
10:30–11:20 a.m.	DF	Innovations in Teaching High School Astronomy	Skyline IV
10:30 a.m.–12:30 p.m.	DG	Introductory Course Laboratories and Hands-on Activities for Life Science Majors	Pavilion West
10:30 a.m.–12:30 p.m.	DH	Investigating Classroom Strategies	Galleria I
10:30 a.m.–12:30 p.m.	DI	Learning Assistants and Supplemental Instructors in TYCs	Salon Ballroom II/III
10:30–11:40 a.m.	DJ	Physics Preparation of Preservice Elementary Teachers	Skyline III
12:30–2 p.m.	CRKL06	Crackerbarrel: Planning Future TYC Meetings	Broadway I/II
12:30–2 p.m.	CKRL07	Crackerbarrel: There's an App for That	Broadway III/IV
12:30–2 p.m.		PTRA Institute Followup	Senate Suite
12:30–2 p.m.		Committee on Laboratories	Executive Suite
12:30–2 p.m.		Committee on the Interests of Senior Physicists	Directors Suite
12:30–2 p.m.		Committee on Teacher Preparation	Council Suite
12:30–2 p.m.		Committee on Physics in Undergraduate Education	Studio Suite
12:30–2 p.m.		Committee on Women in Physics	Forum Suite
12:30–2 p.m.	**CW09**	**Perimeter Institute: Hands-on Wave-Particle Duality, Comm. Workshop**	Galleria III
12:30–2 p.m.	**CW12**	**Learn How Expert TA's Assignable Tutorials Can Help Improve Learning**	Skyline III

12:30–2 p.m.		Past Officers' Luncheon	Skyline II
12:30–2:30 p.m.	**CW10**	**Vernier Software: Data Collection Tools for Physics, Comm. Workshop**	Pavilion East
1–2 p.m.	CKRL08	Crackerbarrel: Bringing Apparatus to Conferences and Organizations Nationally	Galleria II
1–2 p.m.	**CW11**	**PASCO scientific: A New Era for Computerized Physics Labs, Comm. Workshop**	Skyline IV
2–2:30 p.m.		World's Tallest Barometer Tour	PSU – Engineering Bldg.
2–3:30 p.m.	**Plenary**	**APS Plenary on Superheavy Elements**	Grand Ballroom I
3:45 p.m.		**Tuesday Kindle Raffle Drawing**	Exhibit Hall
4–5 p.m.	EA	Science and Society	Galleria I
4–4:40 p.m.	EB	Physics Majors: High School to Doctorate	Galleria III
4–5 p.m.	EC	Panel – Fighting Over Lab Goals	Broadway I/II
4–4:40 p.m.	ED	Introductory Courses II	Broadway III/IV
4–5 p.m.	EE	Physics Students' Identity and Community Building	Salon Ballroom II/III
4–5 p.m.	EF	Interactive Lecture Demonstrations, What's New? ILDs Using Clickers & Video Analysis	Parlor A/B
4–5 p.m.	EG	Posters on Apparatus	Pavilion West
4–4:40 p.m.	EH	High School	Galleria II
4–5 p.m.	EI	PER: Reasoning, Mathematics, and Representations	Pavilion East
5–6:30 p.m.		Bauder Fund Committee	Senate Suite
5–6:30 p.m.		Awards Committee (closed)	Executive Suite
5–6:30 p.m.		ALPA Meeting	Studio Suite
5–6:30 p.m.		Committee on Graduate Education in Physics	Council Suite
5–6:30 p.m.		Committee on Science Education for the Public	Forum Suite
5–6:30 p.m.		Committee on Educational Technologies	Directors Suite
6:30–8 p.m.		AAPT Summer Meeting Picnic	Portland Center for
8-9:30 p.m.		AAPT Demo Show – Physics Center Stage	Performing Arts
WEDNESDAY, July 17			
7–8:30 a.m.		Programs Committee II	Skyline III
8 a.m.–3 p.m.		**REGISTRATION**	**Plaza Foyer**
8 a.m.–4 p.m.		TYC Resource Room	Grand Ballroom II
8:30–10 a.m.	PST-2	Poster Session 2	Grand Ballroom II
9 a.m.–3 p.m.		High School Physics Photo Contest Winners Posted	Plaza Foyer
10–11 a.m.	**Awards**	**Melba Newell Phillips Medal – Lillian C. McDermott**	**Grand Ballroom I**
10–10:30 a.m.		World's Tallest Barometer Tour	PSU– Engineering Bldg.
11 a.m.–12:30 p.m.	CRKL09	Crackerbarrel: The State of the Instructional Lab	Pavilion East
11 a.m.–12:30 p.m.	CKRL10	Crackerbarrel: Next Generation Science Education Standards	Pavilion West
11 a.m.–12:30 p.m.	CKRL11	Crackerbarrel: For Solo PER	Galleria II
11 a.m.–12:30 p.m.		Nominating Committee II (closed)	Council Suite
11 a.m.–12:30 p.m.		PERLOC	Galleria III
12–12:30 p.m.		Great Book Giveaway	Plaza Foyer
12:30–2:20 p.m.	FA	Affective Issues and How They Impact Equity in the Classroom	Parlor A/B
12:30–2:20 p.m.	FB	PER: Upper-Division Courses	Pavilion East
12:30–2:30 p.m.	FC	Pre-college PER	Salon Ballroom I/II
12:30–2:30 p.m.	FD	The AIP Career Pathways Project	Broadway III/IV
12:30–2:30 p.m.	FE	Panel – A Modern Approach to Teaching Quantum Mechanics	Broadway I/II
12:30–2:10 p.m.	FG	ALPhA Labs in the Classroom	Galleria I
12:30–2:30 p.m.	FH	PER: The Birth of a Subdivision of Physics	Pavilion West
12:30–2:30 p.m.	FI	Physics & Society	Galleria III
12:30–2 p.m.	FJ	Teacher Recruitment	Galleria II
2–2:30 p.m.		World's Tallest Barometer Tour	PSU – Engineering Bldg.
2:40–4:20 p.m.	GA	PER: Problem Solving	Pavilion West
2:40–4:20 p.m.	GB	Quantum & Condensed Matter Labs Beyond the First Year	Broadway I/II
2:40–4:40 p.m.	GC	Facilitating Faculty Change Through Research	Broadway III/IV
2:40–4:20 p.m.	GD	PER: Student Reasoning and Topical Understanding	Pavilion East
2:40–4 p.m.	GE	Upper Division and Graduate	Salon Ballroom II/III
2:40–4:10 p.m.	GF	Lessons from Successful Professional Development for Successful Teacher Prep.	Parlor A/B
2:40–4:30 p.m.	GG	Best Practices in Educational Technology II	Galleria II
2:40–3:30 p.m.	GH	Other	Galleria I
2:40–4:40 p.m.	GI	Post-Deadline Papers	Galleria III
2:40–4:30 p.m.	GJ	Post-Deadline Papers II	Skyline III
4:30–6:30 p.m.		Portland Walking Tour	Offsite
4:30–8:30 p.m.		AAPT Executive Board III	Council Suite
4:30–8:30 p.m.	PERC	PERC Bridging Session	Grand Ballroom I
8:30 p.m.		PERC Conference & Banquet	Pavilion Ballroom

Special Events at 2013 AAPT Summer Meeting

Friday, July 12

❒ **TYC Leadership Institute** 8 a.m.–9:30 p.m. at Vernier Software & Technology

Saturday, July 13

❒ **TYC Tandem Meeting** 8:30 a.m.–4:45 p.m. at Vernier Software & Technology (fee)

❒ **Columbia Gorge Tour** 10 a.m.–5 p.m. Depart the Hilton Portland and Executive Tower for the beautiful and scenic Columbia Gorge National Monument east of the city of Portland. (fee)

❒ **Melba Newell Phillips Medal Fundraiser and Dinner** 6:30–8:30 p.m. Join us for an elegant reception in honor of the life and legacy of Melba Phillips, AAPT's first female president (fee) Pavilion Ballroom

Sunday, July 14

❒ **Development of Effective Assessment to Inform Instruction** 8 a.m.–12 p.m. (free) Broadway I

❒ **Welcome Reception and Exhibit Hall Opening** 8–10 p.m. (free) Exhibit Hall

Monday, July 15

❒ **First Timers' Gathering** 7–8 a.m. This is the best time to learn about AAPT and the Summer Meeting, as well as meet fellow attendees. Skyline III

❒ **Spouses/Guest Gathering/Tour** 10–11:30 a.m. Big Pink Sightseeing Tour: You are not only entertained by the amazing tour guides; but the Big Pink bus also supports Breast Cancer research.

❒ **H.S. Physics Teachers' Day Luncheon** 12–1:30 p.m. (fee) Skyline III

❒ **International Attendee Luncheon** 11:30 a.m.–1:30 p.m. Offsite

❒ **Early Career Professionals Speed Networking Event** 12–1:30 p.m. (free) Skyline IV

❒ **Retired Physicists' Luncheon** 12–1:30 p.m. (fee) Parlor C

❒ **Monday Raffles** Kindle Drawing: 10:15 a.m. Gift Card Drawing: 3:45 p.m. Exhibit Hall

Tuesday, July 16

❒ **AAPT Fun Run/Walk** 6:30–7:30 a.m. Come enjoy the 6th Annual AAPT Fun Run/Walk along the Willamette River in the heart of Portland. Meet in the Hilton lobby at 6:15 and walk to the Salmon Street Springs water fountain in Tom McCall Waterfront Park, with views of Mt. Hood and Mt. St. Helens. (fee)

❒ **Tuesday Raffles** Gift Card Drawing: 10:15 a.m. Kindle Drawing: 3:45 p.m. Exhibit Hall

❒ **Summer Picnic & Demo Show** 6:30–8 p.m. (fee) Thanks to Vernier for sponsoring this event again. After the picnic, enjoy **Oregon Ballet Theatre** in ***Physics Center Stage,*** 8–9:30 p.m., Portland Center for Performing Arts, Newmark Theatre

Wednesday, July 17

❒ **Great Book Giveaway** 12–12:30 p.m.

❒ **Portland Walking Tour** 4:30–6:30 p.m. (fee)

❒ **PER Conference & Banquet** July 17-18

❒ **World's Tallest Barometer Tour** The Portland State University Tall Barometer and Demonstration Tour examines the barometer from the reservoir to the top vacuum cap. A demonstration of the Earth's atmosphere pushing the working fluid up 12 m (40') will be shown. Located at Maseeh College of Engineering & Computer Science Atrium, 1930 SW 4th Ave.; lower level to 2nd floor. (Photos allowed.)

Monday: 10–10:30 a.m., 3:30–4 p.m.
Tuesday: 10–10:30 a.m., 2–2:30 p.m.
Wednesday: 10–10:30 a.m., 2–2:30 p.m.

Physics2013

start here

Vacuum Fluctuations & Galaxies

Physics2000

Quantum Mechanics

Atoms

Bohr - deBroglie

Photons

Hubble Expansion Doppler Effect

Diffraction Light waves

Maxwell E & M Fluids & Fields

Energy Newton Vectors

Special Relativity

degenerate matter

Physics2013

Inflationary Universe

Newtonian Cosmology

Vacuum Energy Universe

Vacuum (Dark) Energy

Type 1a Supernovas

Chandrasekhar White Dwarf Stars

Size of Universe Variable stars

Paralax & Parsecs

Physics2000.com Free Workshop
Tuesday 9:30 – 10:30 am
in Galleria I

The eight new astronomy chapters are written like short TPT papers. (The last four will appear in *The Physics Teacher* magazine this fall.) In the Physics2000 workshop, we will discuss how we have included expanding space, provided a clear model of dark energy, and used Newtonian mechanics to introduce the basic concepts of modern cosmology. Explicitly we explain how vacuum energy, with negative pressure, expands the universe.

Harvey Gould
Clark University
Research Professor of Physics
Worcester, MA

New Challenges for Old Physics Departments

Monday, July 15

6:10 –7:10 p.m.

Grand Ballroom I

Robert A. Millikan Medal

The Robert A. Millikan Medal for 2013 is presented to **Harvey Gould** for his notable and creative contributions to the teaching of physics. Gould has been a pioneer in computational and statistical physics education. Throughout his career, he has worked to develop collaboration and communication among his colleagues while supporting the common good, making unique and important contributions to the community of physicists and physics educators.

He earned his AB and PhD in physics at the University of California, Berkeley and did postdoctoral work at the National Bureau of Standards (now NIST). After four years at the University of Michigan, he began teaching at Clark University, Worcester, MA, in 1971. In the early 1980s he made important contributions in the development of computer simulations for undergraduate physics lecture and laboratory courses, and, in particular, developed a laboratory-based course on computer simulation at the undergraduate and graduate levels. For the last three decades he has done research in condensed matter physics, statistical physics, and computational physics. Most recently his research has focused on the dynamics of first-order phase transitions with a particular interest in nucleation, as well as critical slowing down and earthquake fault systems.

Gould has shared his knowledge of the use of computers and computer simulations in physics education. In the '90s he participated in the Consortium for Upper-level Physics Software (CUPS) Project, which led to the publication of *Thermal and Statistical Physics Simulations,* coauthored with Lynna Spornick and Jan Tobochnik. Of particular note are his undergraduate textbooks, *Introduction to Computer Simulations Methods*, coauthored with Wolfgang Christian and Jan Tobochnik, and *Statistical and Thermal Physics*, coauthored with Tobochnik. As co-editor with Jan Tobochnik of the Computer Simulation column in Computers in Physics and Computing in Science and Engineering for over 10 years, Gould has had a positive impact on many physics teachers. As Associate Editor of the *American Journal of Physics* for 10 years, he edited approximately 1000 articles and played an active and effective role in improving manuscripts to make them more accurate, readable, and understandable.

The first Gordon Research Conference on Physics Research and Education, which brings together research scientists, faculty, physics education researchers, and students around a specific topic, was initiated and co-chaired by Gould and Tobochnik. These conferences were followed by the 1999 launch of theme issues of *American Journal of Physics* that are tied to the Gordon Conferences.

The Robert A Millikan Medal, established in 1962, recognizes teachers who have made notable and creative contributions to the teaching of physics. The recipient is asked to make a presentation at the Ceremonial Session of an AAPT Summer Meeting. A monetary award, The Millikan Medal, an Award Certificate, and travel expenses to the meeting are presented to the recipient.

Lillian C. McDermott
University of Washington
Professor of Physics
Seattle, WA

DBER – A View from Physics

Wednesday, July 17

10–11 a.m.

Grand Ballroom I

Melba Newell Phillips Medal

The Melba Newell Phillips Medal for 2013 is presented to **Lillian Christie McDermott,** PhD, Professor of Physics at the University of Washington, in recognition of her creative leadership and dedicated service that have resulted in exceptional contributions within AAPT.

A long-time AAPT member, McDermott's foundational work in physics education research has strengthened the association's programs and benefited the overall physics education community. Her service began with a commitment to improve physics education for future elementary school teachers and later included high school teachers as well. The establishment and growth of the University of Washington Physics Education Group, the longest-lived U.S. teacher education program based in a university physics department, is just one of the many significant achievements resulting from her commitment to physics education. Her graduate students have gone on to prominence in AAPT and in faculty positions across the country.

On being recognized with this award, Lillian McDermott said: "I am greatly honored to have my name become associated with Melba Phillips in this way. She was a great role model for women in physics. I first met her at an AAPT meeting many years ago. I was impressed then and still am by her accomplishments in research and teaching, her political courage, and her service to the physics academic community. On a more personal level, although I barely knew her, I remember that she did not appear to be too busy to spend a few moments talking to a new member of AAPT."

McDermott received her PhD in experimental nuclear physics from Columbia University in 1959. After teaching at City College of New York, Seattle University, and the University of Washington, she collaborated with Arnold Arons who had come to the University of Washington to establish a program in the Department of Physics for the preparation of pre-college teachers. Her systematic research on learning difficulties was the genesis of a new field of scholarly inquiry for physicists: Physics Education Research (PER). Under McDermott's guidance, the University of Washington Physics Education Group has served as a model for discipline-specific educational research and curriculum development, and produced numerous trail-blazing articles. Similar physics education research PhD programs have been set up at several other universities in the U.S. The UW Physics Education Group has developed two widely distributed sets of instructional materials, "Physics by Inquiry" and "Tutorials in Introductory Physics."

As the first chairperson of the AAPT's Research in Physics Education Committee, McDermott organized the first invited session at AAPT on PER in the early 1980s, and over the years has planned many high-quality and very well received invited sessions.

The Melba Newell Phillips Medal honors Phillips for her leadership and dedicated service to physics education. The first woman president of the AAPT and a founder of the Federation of American Scientists, Phillips' research was in nuclear physics. She served on the faculty of Brooklyn College and the University of Chicago and was a champion of physics education throughout her life. This Award is given only occasionally to subsequent AAPT leaders who display similar achievements and exceptional contributions.

David Halliday and Robert Resnick Award for Excellence in Undergraduate Physics Teaching

Michael Jackson
Central Washington University, Department of Physics, Professor and Chair, Ellensburg, WA

Teaching Physics and Its Role in the Survival (and growth) of a Physics Program

Monday, July 15
10:30 a.m.–12 p.m.
Grand Ballroom I

The 2013 David Halliday and Robert Resnick Award for Excellence in Undergraduate Physics Teaching is presented to **Michael Jackson,** in recognition of his contributions to undergraduate physics teaching and his extraordinary accomplishments in communicating the excitement of physics to students. John Wiley & Sons is the principal source of funding for this award. Jackson earned his BS in Physics and Mathematics at the State University of New York, Oswego and his PhD in Physics at New Mexico State University. He taught at the University of Wisconsin-La Crosse and State University of West Georgia-Carrolton before going to Central Washington University, where he is currently Professor and Chair of the Department of Physics.

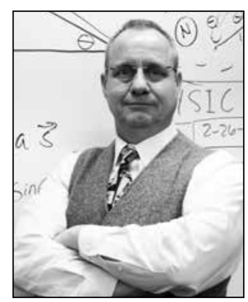
During his career Jackson has established an exceptional record of accomplishments in all three key aspects of a faculty member's responsibilities (instruction, scholarship, service). He is an excellent and popular teacher who has accumulated a superior record of peer-reviewed scholarship while carrying out sustained contributions to the university, profession, and community, all while serving as a transformative chair for CWU's physics department during a particularly challenging and demanding period for the department and the university.

While serving as the chair of his department, Jackson typically teaches a full load of undergraduate courses at both the introductory and upper division levels as well as teaching in and contributing to CWU's NSF funded Science Talent Expansion Program (STEP), and teaching a range of other credit bearing courses. He is highly regarded by the faculty and staff in the department and the college for his commitment to, success in, and championing of highly effective teaching. Qualitative and quantitative Student Evaluation of Instruction survey results and other assessments of his teaching have consistently portrayed Jackson as an exceptional and dynamic instructor who is deeply invested in student learning and is constantly seeking out and applying best practices techniques. In addition to classroom instruction, Jackson has maintained an outstanding record of mentoring undergraduate research projects including mentoring students in CWU's competitive and demanding Science Honors Research Program.

Beyond the classroom, Jackson has engaged the general public and K-12 students through a variety of outreach programs. From rockets and solar observing to the construction of kaleidoscopes, these programs were designed to spark an interest in physics and science.

Established as the Excellence in Undergraduate Teaching Award in 1993; it was renamed and substantially endowed in 2010 by John Wiley & Sons. Named for David Halliday and Robert Resnick, authors of a very successful college-level textbook in introductory physics, the award recognizes outstanding achievement in teaching undergraduate physics.

Paul W. Zitzewitz Award for Excellence in Pre-College Physics Teaching



Thomas F. Haff
Issaquah High School
Issaquah, WA

Creating an Environment that Lets Learning Occur

Monday, July 15
10:30 a.m. –12 p.m.
Grand Ballroom I

The Paul W. Zitzewitz Excellence in Pre-College Physics Teaching Award for 2013 is presented to **Thomas F. Haff** in recognition of his career-long concern for and attention to quality education at the pre-college level. A high school physics teacher from Seattle, WA, Haff earned his BA and MEd from the University of Washington. He began teaching in 1976 at Mercer Island High School. He taught at several high schools and at Edmonds Community College before taking a position at Issaquah High School in 1996. He is a National Board Certified Teacher.

The Washington Section of the American Association of Physics Teachers honored Haff with an Outstanding High School Teacher Award Oct. 9, 2010, at its state meeting. This is the first time the chapter has given the award, and it will now be called the Tom Haff award, in honor of its first recipient.

Haff epitomizes the qualities most desired in a teacher. He is an enthusiastic, expert teacher; he explains physics so the subject comes alive for students, inspiring them to seek and grasp a deeper level of understanding. He truly understands that his job is not only to teach science concepts to his students; rather to instill in them a curiosity and enthusiasm for learning science. He is an effective mentor, providing opportunities for students to interact with physics educators and physicists at local and national meetings. He immerses himself in his physics classes. He ran his AP Physics for nine years after school hours so all students in the district would have an opportunity to participate. His passing rate was well over 98% on the AP exam and his students did exceptionally well on the college level.

He consistently applies for grants so that he can keep the curriculum up-to-date with new textbooks and supplies, supports his students with personal letters in their college applications, and supports their efforts to obtain summer internships after graduation. Haff noted, "When it is all said and done….the bottom line…whether we build a new building or buy a pencil…. It is about the kids….bottom line."

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

2013 Homer L. Dodge Citations for Distinguished Service to AAPT

Monday, July 15, 10:30 a.m.–12 p.m. • Grand Ballroom I

Daniel H. Phelps
University of British Columbia

Daniel H. Phelps

Daniel H. Phelps is a retired physics teacher, having taught physics at the University of British Columbia, St. Georges School, and Columbia College.

A member of AAPT since 1956, Phelps has been active in the British Columbia Section ceaselessly working to encourage the teaching of physics and to build up the organization. He served as a Section officer (Vice President, President, and Past President) from 2008-2011 and still serves as a section executive member.

His drive and enthusiasm brought the results of current research in the teaching of physics to physics educators at all levels. He has given numerous talks at local BCAPT meetings, college articulation meetings, and science teacher conferences. He has also arranged workshops for teachers, inviting some of AAPT's leading physics faculty, which were very successful. Colleagues note that he has been the driving force providing the energy, enthusiasm, and organization to make these events happen.

Phelps was also instrumental in moving the local organization from one that dealt largely with the interests of university and college teachers to one that includes and serves those teaching at all levels, especially including high school teachers of physics, to bring awareness of new and better methods to teachers at all levels.

Bob Powell
University of West Georgia, Department of Physics

Bob Powell

Bob Powell is Professor and Chair of Physics and Director of the Observatory at the University of West Georgia, where he is completing his 46th year of teaching.

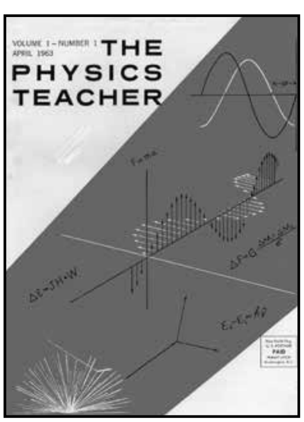
As a member of AAPT since 1968, Powell was active in forming the Southern Atlantic Coast Section and served as its first Secretary-Treasurer. He has served two terms as President and is currently serving as Section Representative.

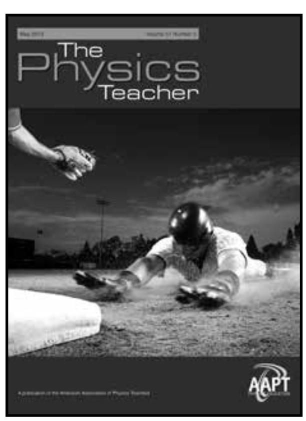
Powell is a strong supporter of AAPT and its programs. He has provided physics training for teachers across Georgia through the AAPT/PTRA program and continued to find funding for those programs through MSP and Teacher Quality grants after the Rural PTRA funding was diminished. In addition to administering these grants, he is very involved in training teachers by attending and teaching at all workshop sessions. Powell is also concerned about the relatively few undergraduates receiving degrees in physics with certification and is leading his department in recruiting and graduating more qualified high school physics teachers.

Established in 1953 and renamed in recognition of AAPT founder Homer L. Dodge in 2012, the Homer L. Dodge Citation for Distinguished Service to AAPT is presented to members in recognition of their exceptional contributions to the association at the national, sectional, or local level.

"*The Physics Teacher*: Celebrating 50 Years"

Special Session: ***Tuesday, 10:30 a.m–12:30 p.m. Pavilion East***





Come and listen to five invited speakers who have been closely associated with *TPT* who will share their experiences with the journal that has influenced their professional lives, as well as how their contributions have affected the journal.

Cake will be served at a reception after the program.

The Physics of Baseball

Tuesday, July 16, 9–10 a.m. • Grand Ballroom I

Alan M. Nathan
University of Illinois at Urbana-Champaign

"You Can Observe a lot by Watching" –*Yogi Berra*

Alan M. Nathan, Prof. Emeritus, University of Illinois at Urbana-Champaign, will give a plenary presentation entitled " 'You Can Observe a Lot by Watching' – Yogi Berra." Following Yogi's advice, Nathan will use high-speed video clips to highlight some of the interesting physics underlying the game of baseball. The talk will focus on the subtleties of the baseball-bat collision, the intricacies of the flight of a baseball, and many other things. Nathan will also lead a workshop, "Major League Physics – Using Baseball to Teach Physics." After a long career doing things like measuring the electric and magnetic "polarizabilities" of the proton and studying the quark structure of nucleons, he now devotes his time and effort to the physics of baseball. He maintains an oft-visited website devoted to that subject: http://go.illinois.edu/physicsofbaseball.

APS Plenary: Producing Superheavy Elements

Tuesday, July 16, 2–3:30 p.m. • Grand Ballroom I

Walter Loveland
Oregon State University, Corvallis, OR

1. The Quest for Superheavy Elements: *W. Loveland*, Oregon State University

Walter Loveland, Professor of Chemistry, Oregon State University, Corvallis, OR, received his SB in Chemistry at MIT in 1961, his PhD in Nuclear Chemistry at Univ. of Washington in 1966. He is chair of the ACS Div. Of Nucl Chemistry and Technology, Users Executive Committee NSCL, 88-Inch Cyclotron. Awards: NSF Fellow (Washington), Sigma Xi, N.L. Tartar Fellow (Oregon State), Sigma Xi Award for Research, Oregon State. F.A. Gilfillan Award for Research, Beaver Champion Award.

He will examine the current status of heavy element research. Among the questions addressed are: Why are heavy elements important? What is their unique role in chemistry? How has the Periodic Table evolved with time and what are the limits of the Periodic Table? How do you make new heavy nuclei? How does one do chemistry one atom at a time? What are the prospects for the synthesis of new heavy nuclei? What are the new ways of studying the atomic physics and chemistry of the heaviest elements?

Mark A. Stoyer
Lawrence Livermore National Laboratory

2. Exploring the Limits of Nuclear Stability: Glimpsing the Island of Stability: *Mark A. Stoyer,* Lawrence Livermore National Laboratory

Mark A. Stoyer obtained a BS in Chemistry from Purdue University in December 1984. He worked as Undergraduate Research Assistant at LLNL Jan. 1985–Aug. 1985. he obtained a PhD in Chemistry (Nuclear) from University of California, Berkeley in November 1990. Staff scientist at LLNL 1995-present. Senior staff scientist at LLNL from 2003-present. Current position (Feb. 2007-present).

The Dubna/LLNL collaboration has been investigating the nuclear and chemical properties of the heaviest elements since 1989. Elements 113-118 have been synthesized and characterized using fusion-evaporation nuclear reactions of 48Ca beams on actinide targets (237Np, 242,244Pu, 243Am, 245,248Cm, 249Bk, and 249Cf, respectively) at the U400 cyclotron located at the Flerov Laboratory of Nuclear Reactions in Dubna, Russia. This talk will discuss the ramifications of the experimental work during the last 1015 years on the synthesis of elements 113–118, including the recent IUPAC acceptance of element names for 114 (flerovium) and 116 (livermorium). Prediction of the heaviest element possible is highly uncertain because of the complex interplay of strong nuclear forces, Coulomb forces, surface/volume effects, and shell corrections. For some combination of protons ($Z > 118$) and neutrons, the strong nuclear force which binds nucleons together will not be able to counter the Coulomb repulsion of the protons in a nucleus, and thus nuclei will cease to exist. Experimental and theoretical efforts to locate and access the next region of doubly-magic spherically-shaped nuclei, the Island of Stability, will be presented.

(This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.)

Committee Meetings

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

Sunday, July 14

Publications Committee	7:30–10 a.m.	Studio Suite
Meetings Committee	7:30–10 a.m.	Forum Suite
Executive Board II	10 a.m.–2 p.m.	Council Suite
Physics Bowl Advisory Board	12–1:30 p.m.	Studio Suite
Nominating Committee I (Closed)	12:30–1:30 p.m.	Forum Suite
Programs Committee I	4–5:30 p.m.	Broadway III/IV
SI Units and Metric Education Committee*	4–5:30 p.m.	Forum Suite
Section Representatives	5–8 p.m.	Broadway I/II
High School Share-a-Thon	6–8 p.m.	Broadway III/IV

Monday, July 15

PTRA Oversight Committee	7–8:30 a.m.	Council Suite
Committee on Physics in Two-Year Colleges*	12–1:30 p.m.	Council Suite
Committee on Apparatus*	12–1:30 p.m.	Galleria I
Committee on History & Philosophy in Physics*	12–1:30 p.m.	Studio Suite
Committee on Physics in Pre-High School Ed.*	12–1:30 p.m.	Directors Suite
Committee on Research in Physics Education*	12–1:30 p.m.	Salon II/III
Membership and Benefits Committee	12:30–1:30 p.m.	Forum Suite
PIRA Business Meeting	7:10–8:30 p.m.	Galleria I
COGS (Governance Structure)	7:10–8:30 p.m.	Studio Suite
Committee on Physics in High Schools*	7:10–8:30 p.m.	Pavilion East
Committee on International Physics Education*	7:10–8:30 p.m.	Council Suite
Committee on Minorities in Physics*	7:10–8:30 p.m.	Forum Suite
Committee on Professional Concerns*	7:10–8:30 p.m.	Directors Suite
Committee on Space Science and Astronomy*	7:10–8:30 p.m.	Galleria II

Tuesday, July 16

Committee on Laboratories*	12:30–2 p.m.	Executive Suite
Committee on Interests of Senior Physicists*	12:30–2 p.m.	Directors Suite
Committee on Teacher Preparation*	12:30–2 p.m.	Council Suite
Committee on Physics in Undergraduate Ed.*	12:30–2 p.m.	Studio Suite
Committee on Women in Physics*	12:30–2 p.m.	Forum Suite
PTRA Institute Followup	12:30–2 p.m.	Senate Suite
Bauder Endowment Committee	5–6:30 p.m.	Senate Suite
Awards Committee (Closed)	5–6:30 p.m.	Executive Suite
ALPhA Meeting	5–6:30 p.m.	Studio Suite
Committee on Graduate Education in Physics*	5–6:30 p.m.	Council Suite
Committee on Science Education for Public*	5–6:30 p.m.	Forum Suite
Committee on Educational Technologies*	5–6:30 p.m.	Directors Suite

Wednesday, July 17

Programs Committee II	7–8:30 a.m.	Skyline III
Nominating Committee II (Closed)	11 a.m.–12:30 p.m.	Council Suite
PERLOC	11 a.m.–12:30 p.m.	Galeria III
Executive Board III	4:30–8:30 p.m.	Council Suite

First time at an AAPT meeting?

Welcome to the 2013 AAPT Summer Meeting in Portland! Everyone at AAPT hopes you fulfill all the goals you have for attending this meeting. To help you plan your meeting activities, the following information and suggestions have been developed.

- Being at your first National Meeting can be a lonely experience if you don't know anyone. AAPT members are friendly people, so do not hesitate to introduce yourself to others in sessions and in the hallways. It is fun and rewarding to establish a network of other physics teachers with whom you can talk and share experiences. This is especially true during lunch and dinner.

- Area Committee meetings are not only for members of the committee, but also for friends of the committee. You are welcome to attend any Area Committee meeting. You should be able to find one or two committees that match your interests. Their meeting times are listed on page 20 in this guide. Area Committee meetings are often relatively small and are a great place to meet other people with interests similar to yours.

- Be sure to attend the First Timers' Gathering from 7–8 a.m. on Monday in Skyline III. It is a wonderful way to learn more about the meeting and about AAPT.

- You can still sign up for the annual 5K Fun Run/Walk on Tuesday morning. We will run along the river and see a lot of Portland sights.

- Awards and other plenary sessions have distinguished speakers and are especially recommended. Invited speakers are experts in their fields and will have half an hour or more to discuss their subjects in some depth. Posters will be up all day and presenters will be available during the times indicated in the schedule. Contributed papers summarize work the presenters have been doing. You are encouraged to talk to presenters at the poster sessions or after the contributed paper sessions to gain more information about topics of interest to you. Informal discussion among those interested in the announced topic typically will follow a panel presentation, and crackerbarrels are entirely devoted to such discussions.

- Be sure to make time to visit the exhibits in the Exhibit Hall. This is a great place to learn what textbooks and equipment are available in physics education.

Free Commercial Workshops

CW01: Perimeter Institute: Beyond the Atom: Particle Physics

Location: Galleria III
Date: Monday, July 15
Time: 9–10 a.m.
Sponsor: Perimeter Institute

Leader: Damian Pope

On July 4, 2012, researchers at CERN announced the discovery of a new particle. This announcement was the culmination of decades of work and billions of dollars invested in the Large Hadron Collider. It is the latest step in our journey toward understanding the fundamental building blocks of our universe. Come explore Beyond the Atom, a classroom resource designed by educators in collaboration with researchers from Perimeter Institute and CERN to introduce high school students to some of the fundamental ideas in particle physics. Participate in activities that engage your students in the journey from Rutherford scattering through to the LHC.

CW02: WebAssign: Using Online Homework to Achieve Your Pedagogical Goals

Location: Galleria I
Date: Monday, July 15
Time: 9–10 a.m.
Sponsor: WebAssign

Leader: Matt Kohlmyer

Since 1997, WebAssign has been the online homework system of choice for the introductory physics lecture courses. Through our partnerships with every major publisher, WebAssign supports more than 160 introductory physics textbooks with precoded, assignable questions, and advanced learning tools. In addition to textbook-specific questions and resources, WebAssign has question collections authored by experienced physics educators, designed to strengthen student skills and conceptual understanding. Learn about research-based additional resource collections (free to WebAssign adopters) that stress physics education research principles. We will also introduce a new question collection that features both feedback designed to address student misconceptions; tutorials designed to step students through complex problems and concepts; and a personal study plan designed to improve students' prerequisite math skills.

CW03: Perimeter Institute: Classroom Activities for Dark Matter

Location: Galleria III
Date: Monday, July 15
Time: 11:30 a.m.–1 p.m.
Sponsor: Perimeter Institute

Leader: Damian Pope

Are you looking for ways to connect your students with current physics research? Join us as we use a standard uniform circular motion lab to introduce students to dark matter. Learn about the latest theories and find out what experimental results are telling us about this mysterious phenomenon. Come explore the Mystery of Dark Matter, a classroom resource designed by educators in collaboration with Perimeter Institute researchers. See how high school physics concepts reveal the need for dark matter. Gain insight into the process of science as you listen to researchers discussing whether dark matter actually exists, what it might be, and how it could be detected.

CW04: PASCO scientific: A New Era for Computerized Physics Labs

Location: Pavilion West
Date: Monday, July 15
Time: 12–1 p.m.
Sponsor: PASCO scientific

Leaders: Ann Hanks and Jon Hanks

Join us to see how PASCO Capstone software can revolutionize how you do labs. You have to try it to believe it and now is your chance! As you build your own PASCO Capstone electronic workbook from scratch, you will see the great advantages of having an "undo" operation, taking sample data within the workbook while writing the lab, and being able to add on extras like video analysis. Whether you use DataStudio or another type of interfacing software or have never used any interfacing before, you will benefit from this workshop. We will also have hands-on demonstrations of the new 850 Universal Interface which is called "Universal" because it works with all types of PASCO sensors (both the blue PASPORT and the black ScienceWorkshop sensors). One workshop participant will win a free PASCO Capstone Site License.

CW05: Pearson: Eugenia Etkina

Location: Pavilion East
Date: Monday, July 15
Time: 12–1 p.m.
Sponsor: Pearson Education

Leader: Eugenia Etkina

Eugenia Etkina (Rutgers University, Graduate School of Education—GSE) was born and educated in Russia, where she was awarded her PhD in Physics Education from Moscow State Pedagogical University. She has 30 years of physics teaching experience (teaching middle school, high school, and university physics). In 1993 she developed a system in which students learn physics using processes that mirror scientific practice. That approach was enriched when she began collaborating with Alan Van Heuvelen in 2000 and now is known as Investigative Science Learning Environment (ISLE). Since 2000, Professors Etkina and Van Heuvelen have developed curricula based on ISLE, conducted over 60 workshops for physics instructors, and published *The Active Learning Guide*. Please join Dr. Etkina for a discussion on the ISLE method and how it can be put into practice in your classroom using the new textbook, *College Physics*, by Etkina, Gentile, and van Heuvelen.

CW06: Perimeter Institute: Curved Spacetime and the Global Positioning System

Location: Galleria III
Date: Tuesday, July 16
Time: 9:30–10:30 a.m.
Sponsor: Perimeter Institute

Leader: Damian Pope

What is Gravity? Newton pictured gravity as an invisible force while Einstein pictured it as the curving of spacetime. Does it matter which model we use? Are there any predictions that determine which model is better? The Revolutions in Science classroom resource was designed by educators in collaboration with Perimeter Institute researchers to engage high school students in the process of building scientific models. In this workshop, we consider models for gravity and explore Einstein's curved spacetime model for gravity using masking tape and balloons. We will discover that Newton was wrong and that Einstein's model predicts time dilation which is verified daily by the Global Positioning System. The Global Positioning System (GPS) is a technology used by millions of people. The GPS & Relativity resource will introduce the basic operation of the GPS and will discuss how relativistic time dilation plays a vital role in every position calculation.

CW07: Physics2000.com

Location: Galleria I
Date: Tuesday, July 16
Time: 9:30–10:30 a.m.
Sponsor: Physics2000.com

Leader: Elisha Huggins

Come to the popular Physics2000 workshop where you learn how to include 20th century physics in the basic Introductory Physics course.

CW08: Pearson: MasteringPhysics

Location: Salon Ballroom I
Date: Tuesday, July 16
Time: 9:30–10:30 a.m.
Sponsor: Pearson Education

Leader: Will Moore

Please join Will Moore from Pearson Education for a demonstration and discussion about MasteringPhysics, Pearson's online homework and tutorial system. MasteringPhysics is designed to improve results by helping students quickly master concepts. Students benefit from wrong-answer specific feedback, hints, and a huge variety of educationally effective content while unrivaled gradebook diagnostics allow an instructor to pinpoint the weaknesses and misconceptions of their class.

CW09: Perimeter Institute: Hands-On Wave-Particle Duality

Location: Galleria III
Date: Tuesday, July 16
Time: 12:30–2 p.m.
Sponsor: Perimeter Institute

Leader: Damian Pope

Quantum physics describes the subatomic world with amazing accuracy but it also introduces some very strange ideas about the universe. Wave-particle duality is one of the deepest, most powerful, mysteries of quantum physics. Come explore the Challenge of Quantum Reality, a classroom resource designed by educators in collaboration with Perimeter Institute researchers to introduce senior physics students to the wonder and power of quantum physics. Experience the electron double-slit experiment as you participate in a hands-on classroom activity that will introduce the fundamental concepts involv3 the wave-particle duality.

CW10: Vernier Software: Data Collection Tools for Physics, including LabQuest2, Graphical Analysis for iPad, and Vernier Data Share for IOS and Android

Location: Pavilion East
Date: Tuesday, July 16
Time: 12:30–2:30 p.m.
Sponsor: Vernier Software & Technology

Leaders: David Vernier, Matt Anthes-Washburn, and John Gastineau

Attend this hands-on workshop to learn about LabQuest 2 and other new data collection tools from Vernier Software & Technology. We will start with an interactive presentation to show you how Vernier data collection works with both LabQuest and computer, and how the data can be shared with iPad or Android tablets, phones, and other computers. Then, we will make available a variety of new and interesting Vernier apparatus for you to investigate individually.

a) Use the LabQuest 2 interface, and see its large color touch screen with the updated LabQuest App.
b) Collect and analyze data on an iPad, Android tablet, or phone.
c) View sensor data on your own phone, tablet, or computer with no software installation.
d) Collect data in a browser, with a LabQuest 2 serving its data, and then analyze the data right in the browser. The browser can be on an Android tablet, or even your own smart phone.
e) Collect data with the new Vernier Diffraction Apparatus, and see just how easy it is to map out intensity for single-slit and double-slit patterns.
f) Inspect the rest of our optics system, including apparatus for doing thin lens or mirror experiments, color mixing, and polarization.
g) Fire the new Vernier Projectile Launcher and use the new Time of Flight pad.
h) Collect radiation data using our new low-cost Vernier Radiation Monitor.
i) Page through the new "Advanced Physics with Vernier-Beyond Mechanics" book.
j) Do some video analysis using Vernier Video Physics on an iPad.

CW11: PASCO scientific: A New Era for Computerized Physics Labs

Location: Skyline IV
Date: Tuesday, July 16
Time: 1–2 p.m.
Sponsor: PASCO scientific

Leaders: Jon Hanks and Ann Hanks

Join us to see how PASCO Capstone software can revolutionize how you do labs. You have to try it to believe it and now is your chance! As you build your own PASCO Capstone electronic workbook from scratch, you will see the great advantages of having an "undo" operation, taking sample data within the workbook while writing the lab, and being able to add on extras like video analysis. Whether you use DataStudio or another type of interfacing software or have never used any interfacing before, you will benefit from this workshop. We will also have hands-on demonstrations of the new 850 Universal Interface which is called "Universal" because it works with all types of PASCO sensors (both the blue PASPORT and the black ScienceWorkshop sensors). One workshop participant will win a free PASCO Capstone Site License.

CW12: Learn How Expert TA's Assignable Tutorials Can Help Improve Learning and Deter Cheating

Location: Skyline III
Date: Tuesday, July 16
Time: 12:30–2 p.m.
Sponsor: Expert TA

Leader: Jeremy Morton

Expert TA is a commercial online homework and tutorial system for introductory-level physics. It grades problems the way instructors do, considering more than just the final numeric answer. Expert TA has multi-step problems that involve more aspects of physics problem solving; such as symbolic equations, FBDs, algorithmic numeric answers, etc. The majority of our problems involve symbolic answers and our sophisticated math engine grades them in detail. It identifies detailed mistakes within an equation, deducts points, and provides specific feedback. Join us and learn about our highly customizable "Assignable Tutorials." You can decide whether students have access to hints and feedback, change deduction amounts and the number of submission attempts allowed, and select the style in which feedback is delivered. We will also demonstrate how you can monitor grades and student progress real-time; this includes being able to review detailed work as it happens. Expert TA has partnered with talented professors, leaders in physics education, to develop a rich library of original problems. We have mapped our library to the major textbooks so that you can always find the problems you are looking for, and we're working to keep solutions to our problems off the web to deter cheating.

CW13: Electron Investigation with 3B Scientific Teltron® Tubes

Location: Parlor A/B
Date: Monday July 15
Time: 12–1 p.m.
Sponsor: American 3B Scientific

Leader: Danny Mashburn

Electrons are a fundamental particle, but basic principles can be difficult to conceptualize. In our 3B workshop we will demonstrate how our Teltron® Tubes provide a quick and easy way to evaluate the properties and interactions of electrons. We will cover topics ranging from the wave like nature of electrons to their interactions with electric and magnetic fields. Come join us and learn how you can incorporate these experiments into your curriculum. Experiment guides and manuals will be available for all participants.

AAPT Exhibitor Information

American Association of Physics Teachers

Booths #301, 303, 305
One Physics Ellipse
College Park, MD 20740
301-209-3300
rrosier@aapt.org
www.aapt.org

Welcome to Portland! Join us at the AAPT booth and spin the wheel for your chance to win some awesome prizes! We'll have a large selection of educational resources available to meet the needs of everyone from students to faculty. Pick up brochures on some of AAPT's leading education programs such as PTRA and the U.S. Physics Team. Find out about some of our fun online physics demos and lessons from ComPADRE (**Booth #305**). Check out the latest and greatest items from the Physics Store catalog including publications, AAPT-branded merchandise, especially our new t-shirts, and as always, a limited collection of Member-Only items. Items will be available for purchase at the Booth and many at a significant savings. Lastly, do not forget to get your ticket for the Great Book Giveaway!

American Physical Society

Booths #201, 203
One Physics Ellipse
College Park, MD 20740
301-209-3297
khatib@aps.org
www.aps.org

The American Physical Society has resources for every physics educator! Faculty can learn about APS education and diversity programs. Teachers can register for our middle school science adventure, adopt physicists for your high school class, learn about minority scholarships, pick up free posters, and much more.

American 3B Scientific

Booth #304
2189 Flintstone Drive, Unit O
Tucker, GA 30084
678-405-5606
anna.wittig@a3bs.com
www.A3BS.com

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www.arborsci.com

Arbor Scientific shares the same passion for physics as you, and has for over 25 years. We love finding all the gadgets, lab equipment, and toys that will help you get your students excited about learning physics. Whether you're a veteran educator or just starting out as a science teacher, we have loads of cool tools to help you feel confident in what you're teaching!

A.U. Physics Enterprises

Booth #205
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269-471-3724
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www.physicsenterprises.com

Physics Enterprises designs and manufactures high-quality teaching equipment for science classes. Our products are mainly represented by Vernier Software & Technology, PASCO scientific, VWR, American 3B Scientific, and TEL-Atomic. Visit our Booth to see our latest projects and share your ideas of what your class needs. More information on **www.physicsenterprises.com.**

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Southfield, MI 48033
248-996-8422
rchaase@derbymagic.com
www.derbymagic.com

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San Jose, Costa Rica 2050
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Engineering & Scientific Services (ESS) develops Scientific Modeling, SciMOD. SciMOD is a science-oriented, math-based, full-featured application. It could be thought of being a crossover between a math app, FEM program, database access tool and the most intuitive widget- or visual-programming module imaginable. Think of it as an "all-in-one" scientific application whose purpose is to bring the best solving techniques to every scientist or engineer at the most affordable price!

Expert TA

Booth #401
624 South Boston Avenue, Suite 220
Tulsa, OK 74119
877-572-0734
main@theexpertta.com
www.theexpertta.com

The Expert TA is an online homework and tutorial system for introductory physics courses. Expert TA's proprietary math engine performs partial credit grading of the most complex problems. It analyzes the steps used to solve equations, identifies detailed mistakes, and deducts the appropriate points.This method allows instructors to accurately evaluate the mastery of student knowledge and provides students with consistent grading and quality feedback on their work. Stop by Booth 401 for a demonstration.

Klinger Educational Products Corp.

Booth #306
112-19 14th Road
College Point, NY 11356
718-461-1822
klinger_ed@prodigy.net
www.KlingerEducational.com

Klinger Educational will be exhibiting the LEYBOLD X-ray machine and Tomography module. Both now have an available locking, storage drawer that fits directly under the main units. Also featured is the HD upgrade for the Goniometer, enabling a 10X higher resolution achieved through narrower apertures and software. An Electron Diffraction tube will be on display as well as a Franck-Hertz Ne experiment.

Laser Classroom

Booth #104
1419 Main Street NE
Minneapolis, MN 55413
763-234-0692
colette@laserclassroom.com
www.laserclassroom.com

Laser Classroom creates resources, partnerships, and products to make teaching and learning about Light, Lasers, and Optics clear, easy, and affordable. Home of LASER Blox, the stackable laser designed just for teaching and learning.

Modus Medical

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London, ONT Canada N6H 5L6
519-438-2409
ryarnell@modusmed.com
www.deskcat.com

The Modus DeskCAT™ Multi-slice Optical CT Scanner is ideal for safely teaching the physics and principles of medical imaging in a classroom or laboratory setting. DeskCAT™ uses cone beam geometry, a CMOS camera, and an LED light source to acquire, reconstruct, and display 3D CT images. The portable apparatus comes complete with 4 phantoms, 6 hours of lab exercises and an unlimited software license. Additional intermediate and advanced lab exercises as well as phantoms are available.

PASCO scientific

Booths #212, 214
10101 Foothills Blvd.
Roseville, CA 95747
800-772-8700
droofner@pasco.com
www.pasco.com

Join us to see how PASCO Capstone software can revolutionize how you do labs. You have to try it to believe it and now is your chance! Drop by our Booth or attend one of our Workshops. We will also demonstrate the new powerful 850 Universal Interface which works with all types of PASCO sensors (both the blue PASPORT and the black ScienceWorkshop sensors). One workshop participant will win a free PASCO Capstone Site License.

Pearson

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1 Lake Street
Upper Saddle River, NJ 07458
201-236-5885
margaret.oko@pearson.com
www.pearsonhighered.com

Pearson is the world's leading learning company. We partner with faculty and institutions to create innovative solutions to improve student achievement and institutional effectiveness. We support learning from the time a child enters school throughout their educational journey. We aim to help students get to college and succeed there, enter the workforce, and attain their professional goals. We create and connect content, technology, assessment, and services to create unique learning solutions. We also deliver services that can help schools and academic institutions achieve their goals.

Perimeter Institute for Theoretical Physics

Booth #210
31 Caroline Street N.
Waterloo, ONT Canada N2I 2Y5
519-569-7600
twilliams@perimeterinstitute.ca
www.perimeterinstitute.ca

Perimeter Institute for Theoretical Physics is an independent, non-profit charity, research institute whose mission is to make breakthroughs in our understanding of our universe and the forces that govern it. Such breakthroughs drive advances across the sciences and the development of transformative new technologies. Located in Waterloo, Ontario, Canada, Perimeter also provides a wide array of research, training, and educational outreach activities to nurture scientific talent and share the importance of discovery and innovation.

Physics2000.com

Booth #213
29 Moose Mt. Lodge Road
Etna, NH 03750
603-643-2877
lish.huggins@dartmouth.edu
www.physics2000.com

Vacuum energy (dark energy) and inflation is the subject of our four papers to be published in *The Physics Teacher* magazine this fall. We are modifying the Physics2000 textbook to include this material in the new Physics2013 introductory text. We are doing this by including an optional astronomy section to provide a background for the new cosmology equivalent to the historical background that textbooks provide for Newtonian mechanics. Our workshop will be on the new structure for the Physics2013 text.

Piazza

Booth #208
541 Cowper Street, Suite D
Palo Alto, CA 94301
650-485-1150
josh@piazza.com
www.piazza.com

Piazza is a free online Q&A platform built to replace less effective discussion boards commonly adopted in classrooms. It was made popular by widespread use at Stanford, Harvard, Princeton, and MIT. Today it is used by hundreds of thousands of students every term. Piazza saves you time and improves your interactions with students.

Quality Educational Demonstrations

Booth #110
108 110th Ave., Court E
Edgewood, WA 98372
253-952-0493
brettc@earthlink.net
www.qedsci.com

Quality Educational Demonstrations is an innovative new company, producing unique and exceptional physics demonstration equipment. QED demonstrations will energize your classes and ignite your students' passion for physics. To check out our latest product line, stop by and see us at Booth 110!

Sapling Learning

Booth #400
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512-323-6565
stephanie.capps@saplinglearning.com
www.saplinglearning.com

Sapling Learning provides the most effective interactive homework and instruction that improves student learning outcomes for the problem-solving disciplines. We offer an enjoyable teaching and effective learning experience that is distinctive, easy-to-use; targeted, instructional content, unsurpassed service and support by PhD- and Masters-level colleagues, and textbook independent.

Society of Physics Students

Booth #300
One Physics Ellipse
College Park, MD 20740
301-209-3008
lydia@aip.org
www.spsnational.org

The Society of Physics Students (SPS), along with Sigma Pi Sigma, the national physics honor society, are chapter-based organizations housed within the American Institute of Physics. SPS strives to serve all physics students and their mentors with a chapter in nearly every physics program in the country and several international chapters. Sigma Pi Sigma, with nearly 80,000 historical members, recognizes high achievement among outstanding students and physics professionals. SPS and Sigma Pi Sigma programs demonstrate a long-term commitment to service both within the physics community and throughout society as a whole through outreach and public engagement. Partnerships with AIP member societies introduce SPS student members to the professional culture of physics and convey the importance of participation in a professional society. SPS and Sigma Pi Sigma support scholarships, research awards, physics project awards, outreach/service awards for undergraduate students, and a Summer Science Research Clearinghouse, where thousands of summer research positions are listed (**www.the-nucleus-org**).

Spectrum Techniques

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106 Union Valley Road
Oak Ridge, TN 37830
865-482-9937
sales@spectrumtechniques.com
www.spectrumtechniques.com

Spectrum Techniques, the leading supplier of nuclear GM counting equipment, Exempt Quantity radioisotopes, and nuclear spectrometers is now showing our new 8K ADC for high-resolution gamma spectroscopy with nuclide identification software. All of our current instruments are now compatible with the latest Windows and Macintosh operating systems including Windows 8. Visit us at Booth 221.

TEL-Atomic

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www.telatomic.com

TEL-Atomic, Inc. provides advanced undergraduate laboratory equipment to institutions around the globe. We offer equipment to explore atomic and nuclear physics, including the TEL-X-Ometer, an x-ray diffractometer which is used to determine the structure of simple crystals. We also offer an affordable Cavendish torsion balance for measuring the gravitational constant. Please visit our Booth to see these and other products.

Texas Instruments

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Supporting each educator's vision of student success in math and science, TI's versatile education technology, curricular support materials, and professional development can help enhance teaching and learning. Learn how the latest TI-Nspire™ handhelds and software can deepen understanding and how the wireless TI-Nspire™ Navigator™ system enables real-time assessment. Visit **education.ti.com**.

The Science Source

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800-299-5469
KateTaylor@thesciencesource.com
www.thesciencesource.com

The Science Source, the Maine-based manufacturer enhancing science literacy by creating and providing high-quality, high-value science teaching materials, is featuring its Physics lines DAEDALON (Booth #209) and **PHYWE** (Booth #211). **The Science Source** is the U.S. distributor for **PHYWE**, the 100+ year science education apparatus manufacturer in Gottingen, a German town with rich scientific knowledge and culture and an impressive history of Physics Nobel laureates.

Vernier Software & Technology

Booths #100, 102
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888-837-6437
aharr@vernier.com
www.vernier.com

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212-576-9400
jseltzer@bfwpub.com
www.whfreeman.com/physics

W.H. Freeman & Company Publishers works with instructors, authors, and students to enhance the physics teaching and learning experience. We proudly announce the publication of *College Physics*, 1/e (Roger Freedman, Todd Ruskell, Philip Kesten, David Tauck) and the release of smartPhysics 3.0 in Summer 2013. Visit Booth No. 215 or **www.whfreeman.com/physics** to learn more.

Ward's Science

Booths #404, 406
P. O. Box 92912
Rochester, NY 14692
800-962-2660
noel.vache@vwr.com
www.wardsci.com

Serving science educators since 1862, Ward's Science focuses on the details that make teachers' lives easier, so they have more time to focus on what they do best—inspiring their students to connect with science and with the real world. With unique products that are developed by in-house scientists and former educators, standards-based activities organized to meet teachers' needs, cutting-edge digital science resources, and personalized technical support, Ward's Science provides teachers with the tools they need to turn science lessons into science connections.

WebAssign

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1791 Varsity Drive, Suite 200
Raleigh, NC 27606
919-829-8181
aknight@webassign.net
www.webassign.net

Since 1997, WebAssign has been the online homework system of choice for the introductory physics lecture courses. Through our partnership with every major publisher, WebAssign supports over 160 introductory physics textbooks with precoded, assignable questions and advanced learning tools. In addition to textbook-specific questions and resources, WebAssign has question collections authored by experienced physics educators, designed to strengthen student skills and conceptual understanding. Learn about research-based additional resource collections (free to WebAssign adopters) that stress physics education research principles. We will also introduce a new question collection that features both feedback designed to address student misconceptions; tutorials designed to step students through complex problems and concepts; and a personal study plan designed to improve students' prerequisite math skills.

Wiley

Booth #112
111 River Street
Hoboken, NJ 07030
201-748-5851
info@wiley.com
www.wiley.com

Stop by Booth #112 for your personal tour of WileyPLUS. It's not just another homework system...come see why! WileyPLUS helps convert more students from passive to active learners by providing instructors with gradable assessment consisting of not just homework but also reading and other content-related activities and by providing students with a more engaging study experience including integrated reading activities (concept, example, and practice) along with homework and other more interactive features like math help, simulations and videos as well as a student initiated progress check.

SHARED BOOK EXHIBIT

Rutgers University Press:
• *Physics, The First Science,* by Peter Lindenfeld and Suzanne White Brahmia

AAPT PHYSICS EDUCATION

Monday, July 15, 2013 – Session Schedule

Rooms are at the Hilton Portland & Executive Tower – Poster Session I is in Grand Ballroom II, 8 to 9:30 p.m.

	Parlor A/B	Nines Hotel – Gallery 1	Broadway I/II	Salon Ballroom II/III	Broadway III/IV	Galleria II	Salon Ballroom I	Pavilion West	Skyline IV	Nines Hotel – Gallery 2	Pavilion East	Galleria I	Galleria III	Grand Ballroom I
8:00 a.m.	**AA** Apparatus for Beyond First Year of Instruction	**AB** Broader Perspectives: Students' Understanding	**AC** Implementing Competency-based Grading in a Variety of Physics Classrooms	**AD** Introductory Physics for Life Science Majors	**AE** **Panel** – Seeking Employment in Academia	**AF** Modern Physics in the High School Classroom	**AG** Teachers in Residence and Master Teachers in Teacher Preparation	**AH** PER: Classroom Strategies and Problem Solving Using Online Tools	**AI** If They Make it, They Will Learn	**AJ** Labs and Activities for Sustainability	**AK** Frontiers in Astronomy and Space Science			
8:30 a.m.														
9:00 a.m.														
9:30 a.m.														
10:00 a.m.														
10:30 a.m.														**Awards:** AAPT Teaching Awards; DSCs
11:00 a.m.														
11:30 a.m.														
12:00 p.m.			**CRK01** Crackerbarrel: Physics and Society		**CRK02** Crackerbarrel: Web Resources for Astronomy									
12:30 p.m.														
1:00 p.m.														
1:30 p.m.														**Special Session:** Honoring the Contributions of Bob Fuller to Physics Education
2:00 p.m.														
2:30 p.m.														
3:00 p.m.														
3:30 p.m.														
4:00 p.m.	**BG** Teaching Physics Around the World		**BI** **Panel** – Teaching Controversial Topics	**BH** Implementations of Modeling Instruction	**BD** **Panel** – Massively Open Online Courses	**BB** Demo and Lab Ideas for the H.S. Physics Classroom		**BE** PER: Teacher Prep. and Professional Development	**BF** Education Research at the Boundary of Physics and Biology		**BA** **Panel –** Curriculum, Assessment, & Student Outcomes in Undergraduate Program	**BC** Engineering in the Physics Classroom	**BJ** Evolving Practices of Teacher Preparation	
4:30 p.m.														
5:00 p.m.														
5:30 p.m.														
6:00 p.m.														**Millikan Medal**
7:10 p.m.			**CRK03** Crackerbarrel: Graduate Students		**CRK04** Crackerbarrel: Writing in the Laboratory			**CRK05** Crackerbarrel: Vidshare						
7:30 p.m.														
8:30 p.m.														

Tuesday, July 16, 2013 – Session Schedule

Rooms are at the Hilton Portland & Executive Tower

	Parlor A/B	Skyline III	Broadway I/II	Salon Ballroom II/III	Broadway III/IV	Galleria II	Salon I	Pavilion West	Skyline IV	Pavilion East	Galleria I	Galleria III	Grand Ballroom I
7:30 a.m.	**CG** Assessment of Informal Science Education	**CC** Teaching Physics Online	**CA** PIRA Session: Managing Instructional Resources	**CE** Student Attitudes, Confidence, Self-Efficacy, and Motivation	**CB** Using Simulations and Models for Pre-High School Teaching	**CF** Research in Undergraduate Mathematics Education		**CI** Gender and Sexual Diversity Issues in Physics	**CD** Teaching Assistants and Learning Assistants	**CH** What Does Success Mean in Graduate School?			
7:45 a.m.													
8:00 a.m.													
8:30 a.m.													
9:00 a.m.													**Plenary:** Alan Nathan
9:30 a.m.													
10:00 a.m.													
10:30 a.m.	**DB** Introductory Courses	**DJ** Physics Preparation of Pre-service Elementary Teachers	**DC** Best Practices in Educational Technology	**DI** Learning Assistants and Supplemental Instructors in TYCs	**DD** Methodologies for Identifying and Investigating Cognitive 'Resources' in Physics	**DE** Teaching Physics to the Liberal Arts Major		**DG** Introductory Course Laboratories and Hands-on Activities for Life Science Majors	**DF** Innovations in Teaching Astronomy	**DA** *The Physics Teacher:* Celebrating 50 Years	**DH** Investigating Classroom Strategies		
11:00 a.m.													
11:30 a.m.													
12:00 p.m.													
12:30 p.m.			**CRK06** Crackerbarrel: Planning Future TYC Meetings		**CRK07** Crackerbarrel: There's an App for That								
1:00 p.m.						**CRK08** Bringing Apparatus to Conferences Nationally							
1:30 p.m.													
2:00 p.m.													**APS Plenary**
2:30 p.m.													
3:00 p.m.													
3:30 p.m.													
4:00 p.m.	**EF** Interactive Lecture Demonstrations		**EC** **Panel** – Fighting Over Lab Goals	**EE** Physics Students' Identity and Community Building	**ED** Introductory Courses II	**EH** High School		**EG** Posters on Apparatus		**EI** PER: Reasoning, Mathematics, and Representations	**EA** Science and Society	**EB** Physics Majors: H.S. to Doctorate	
4:30 p.m.													
4:45 p.m.													
5:00 p.m.													
6:00 p.m.													

Wednesday, July 17, 2013 – Session Schedule

Rooms are at the Hilton Portland & Executive Tower

Poster Session 2 is 8:30-10 a.m. in Grand Ballroom II

	Parlor A/B	Skyline III	Broadway I/II	Salon Ballroom II/III	Broadway III/IV	Galleria II	Salon Ballroom I/II	Pavilion West	Pavilion East	Galleria I	Galleria III	Grand Ballroom I
8:00 a.m.												
8:30 a.m.												
9:00 a.m.												
9:30 a.m.												
10:00 a.m.												**Awards:** Melba Newell Phillips Medal
10:15 a.m.												
10:30 a.m.												
11:00 a.m.						**CRKR11** Crackerbarrel: For Solo PER		**CRKR10** Crackerbarrel: Next Generation Science Education Standards	**CRKR09** Crackerbarrel: The State of the Instructional Lab			
11:30 p.m.												
12:00 p.m.												
12:30 p.m.	**FA** Affective Issues and How They Impact Equity in the Classroom		**FE** **Panel** – A Modern Approach to Teaching Quantum Mechanics		**FD** The AIP Career Pathways Project	**FJ** Teacher Recruitment	**FC** Pre-college PER	**FH** PER: The Birth of a Subdivision of Physics	**FB** PER: Upper-Division Courses	**FG** ALPhA Labs in the Classroom	**FI** Physics & Society	
1:00 p.m.												
1:30 p.m.												
2:00 p.m.												
2:30 p.m.												
2:40 p.m.	**GF** Lessons from Successful Professional Development	**GJ** Post-Deadline Papers II	**GB** Quantum & Condensed Matter Labs Beyond the First Year	**GE** Upper Division and Graduate	**GC** Facilitating Faculty Change Through Research	**GG** Best Practices in Educational Technology II		**GA** PER: Problem Solving	**GD** PER: Student Reasoning and Topical Understanding	**GH** Other	**GI** Post-Deadline Papers	
3:00 p.m.												
3:30 p.m.												
4:00 p.m.												
4:20 p.m.												**PERC** Bridging Session
4:40 p.m.												
4:45 p.m.												
5:00 p.m.												
8:30 p.m.												

Workshops – Saturday, July 13

All workshops are held at Portland State University, except W35 and W40, which are held at Vernier Software & Technology

W01: Learn Physics While Practicing Science: Introduction to ISLE

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on Graduate Education in Physics
Time: 8 a.m.– 5 p.m. Saturday
Member Price: $85 **Non-Member Price:** $110
Location: SRTC 155

Eugenia Etkina, Rutgers University, Graduate School of Education, 10 Seminary Place, New Brunswick, NJ 08901; eugenia.etkina@gse.rutgers.edu

David Brookes

Participants will learn how to modify introductory physics courses to help students acquire a good conceptual foundation, apply this knowledge effectively in problem solving, and develop the science process abilities needed for real life work using Investigative Science Learning Environment (ISLE). We provide tested curriculum materials including: The Physics Active Learning Guide (30 or more activities per textbook chapter for use with any textbook, including a new ISLE-based textbook) in lectures, recitations, and homework; (b) a website with over 200 videotaped experiments and questions for use in lectures, recitations, laboratories, and homework; and (c) a set of labs that can be used to construct, test, and apply concepts to solve problems. During the workshop we will illustrate how to use the materials in college and high school physics courses to have an explicit emphasis on using the processes of science and various cognitive strategies consistent with the NGSS.

*Please bring your own laptop to the workshop. Make sure it has Quicktime installed. If you do not own a computer, you will be paired with somebody who does.

W03: Real LHC Data for the Classroom

Sponsor: Committee on Physics in High Schools
Time: 8 a.m.–5 p.m. Saturday
Member Price: $80 **Non-Member Price:** $105
Location: SB1 409

Kenneth Cecire, University of Notre Dame, Department of Physics, 225 Nieuwland Science Hall, Notre Dame, IN 46556; kenneth.W.Cecire.1@nd.edu

Kris Whelan

Learn how to introduce students to particle physics with real data from the Large Hadron Collider (LHC) at CERN. Assume the role of a student and work through investigations that cover not only cutting-edge research but also the very physics found in all high school curricula: momentum, energy, electricity and magnetism, and more. Bring a laptop if you can — it will help.

W04: AP Physics 1 and 2

Sponsor: Committee on Physics in High Schools
Co-sponsor: Committee on Teacher Preparation
Time: 8 a.m.–5 p.m. Saturday
Member Price: $90 **Non-Member Price:** $115
Location: SRTC 113

Martha Lietz, Niles West High School, 5701 Oakton St., Skokie, IL 60077; marlie@d219.org

Connie Wells

Based on recommendations from an NRC report, the AP science courses are being redesigned to incorporate more inquiry-based learning. The current AP Physics B course will no longer be offered after 2014 and in 2015, College Board will offer two new courses, AP Physics 1: Algebra-based and AP Physics 2: Algebra-based. These courses will contain the majority of the topics in AP Physics B, at the same level of mathematical complexity, but with a focus on guided inquiry investigations and deep conceptual understanding. This workshop will introduce participants to the new curriculum framework and other materials being made available to help prepare teachers to provide instruction in the new courses.

W06: Tablets in the Physics Classroom

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on Educational Technologies
Time: 8 a.m.–12 p.m. Saturday
Member Price: $68 **Non-Member Price:** $93
Location: SRTC 247

Ben Van Dusen, 990 37th St., Boulder, CO 80303-2142; Benjamin.VanDusen@colorado.edu

Susie Nicholson-Dykstra, Mary Beth Cheversia

During the first half of the workshop, attendees will gain hands-on experience learning the iPad basics. The workshop will begin with guidance about how to set up a class set of iPads. After covering the basics, attendees will use well-known iPad apps (including Edmodo, Pages, Keynote, and Vernier Video Analysis) to create their own exemplar products to share with students while integrating iPad technology into their classroom. During the second half of the workshop, attendees will gain hands-on experience learning how to use a variety of different iPad apps while creating professional, fun, and engaging products that they can use as exemplars in their own classroom. Attendees will create screencast tutorials, stop-animation, and illustrated animations, mind maps, and digital lab notebooks. Facilitators will not supply iPads for the workshop.

W07: Simple Experiments for Learning the Strategies that Mirror Scientific Practice

Sponsor: Committee on Physics in High Schools
Co-sponsor: Committee on Teacher Preparation
Time: 8 a.m.–12 p.m. Saturday
Member Price: $63 **Non-Member Price:** $88
Location: SRTC 161

Gorazd Planinsic, University of Ljubljana, Faculty of Mathematics and Physics, Jadranska 19, 1000, Ljubljana, Slovenia; gorazd.planinsic@fmf.uni-lj.si

This is a hands-on workshop designed for teachers interested in using Investigative Science Learning Environment (ISLE) system to engage students in practical work that mirrors scientific practice and thus helps them develop scientific habits of mind. Creation of successful practical ISLE problems relies on finding suitable experiments. The key features of such experiments are that they are simple and easy to build, that they allow students to construct multiple explanations within the accessible curriculum domain, and that they provide opportunities for the students to actively experience how experiment and theory are interwound. Obviously the requirements are tough and therefore it is understandable why such experiments are not easy to find. In the workshop participants will be solving different problems based on simple experiments using ISLE approach. Participants will work in rotating groups. At the end there will be a discussion about the results.

W08: LivePhoto Physics: Video-based Motion Analysis for Homework and Classroom

Sponsor: Committee on Educational Technologies
Time: 8 a.m.–12 p.m. Saturday
Member Price: $65 **Non-Member Price:** $90
Location: SRTC B1-82

Bob Teese, Rochester Institute of Technology, Physics Department, Rochester, NY 14623; rbtsps@rit.edu

Priscilla W. Laws, Aaron Titus, Maxine Willis

This workshop is for physics teachers who wish to explore the use of video-based motion analysis in a wide range of applications including the teaching laboratory, projects, and homework. Participants will learn how to make digital video clips for analysis, as well as how to use video analysis for homework problems and in the classroom. We will discuss educationally effective uses of video analysis being developed in the LivePhoto Physics project, the Workshop Physics project, and in other settings. The software used in this workshop is available for both Mac and Windows computers. Participants in this workshop may find that some prior, hands-on experience with basic video analysis using software such as Logger Pro or Tracker will be helpful but is not required.

W11: Using Invention to Promote Mathematical Thinking

Sponsor: Committee on Research in Physics Education
Time: 8 a.m.–12 p.m. Saturday
Member Price: $60 **Non-Member Price:** $85
Location: SRTC 101

Andrew Boudreaux, 516 High St., Bellingham, WA 98225-9164; andrew.boudreaux@wwu.edu

Suzanne Brahmia, Stephen E. Kanim

When we introduce new quantities in physics, we usually explain mathematically how they are related to other quantities. Too often students misinterpret the reasoning and simply memorize, approaching physics as a match-the-equation activity. Invention instruction, pioneered by Dan Schwartz, presents open-ended situations in which students must create mathematical procedures to characterize physical situations. Invention tasks prime students to make sense of subsequent formal instruction. This workshop will engage participants in invention tasks and discuss classroom applications.

W12: Physics of Energy

Sponsor: Committee on Science Education for the Public
Co-sponsor: Committee on Professional Concerns
Time: 8 a.m.–5 p.m. Saturday
Member Price: $130 **Non-Member Price:** $155
Location: SRTC 149

Abigail Mechtenberg, University of Michigan, Department of Physics, Ann Arbor, MI 48109; amechten@gmail.com

Regina Barrera

AAPT educators embrace this Physics of Energy workshop for experimental (laboratories) and theoretical (simulations) curricula. Whether motivated by energy security or environmental stability, physicists at all levels must play a role in the scientific literacy shaping the past as we have known it and the future of the world as we should know it. The academic level is set for undergraduate engineers and physicists; however, the astute teacher can easily apply this to other students. During the experimental part of the workshop, laboratories will be executed in groups (starting with cookbook to inquiry through a hybrid design-based approach). During the theoretical part of the workshop, Homer Energy microgrid activities will be executed. All participants will leave with a USB of resources. Together the workshop will weave a coherent common thread for our Physics of Energy from mechanical to electrical energy, thermal to electrical, solar to electrical, and chemical to electrical energy.

W14: Arduino Applications in the Lab and Classroom

Sponsor: Committee on Apparatus
Co-sponsor: Committee on Laboratories
Time: 1–5 p.m. Saturday
Member Price: $80 **Non-Member Price:** $105
Location: SB1 201

Eric Ayars, California State University, Chico, Department of Physics, Campus Box 202, Chico, CA 95929-0202; ayars@mailaps.org

This workshop will allow attendees to see a wide variety of applications for Arduino microcontrollers in physics labs and classrooms, ranging from introductory setup and programming to advanced topics such as communications protocols with other sensors and SD-card storage. Attendees are encouraged to bring their own laptops and an Arduino Uno (or equivalent) if desired. No prior Arduino experience required.

W15: Introductory Labs

Sponsor: Committee on Laboratories
Time: 1–5 p.m. Saturday
Member Price: $70 **Non-Member Price:** $95
Location: SB1 424

Mary Ann Klassen, Swarthmore College, Department of Physics & Astronomy, 500 College Ave., Swarthmore, PA 19081; mklasse1@swarthmore.edu

Whether your lab curriculum is ripe for an overhaul or well-established, this workshop will provide new ideas to bring home to your institution. Six presenters from colleges and universities across the United States will demonstrate their approach to a favorite introductory lab exercise. Attendees will have the opportunity to work with each apparatus. Documentation will be provided for each experiment, with lab manuals, sample data, equipment lists, and construction or purchase information. This workshop is appropriate primarily for college and university instructional laboratory developers.

W16: Introduction to Interactive Laboratory Experience (ILE) – A Hands-On and Minds-On Approach to Effective Physics Teaching

Sponsor: Committee on Committee on Physics in High Schools
Time: 1–5 p.m. Saturday
Member Price: $85 Non-Member Price: $110
Location: SRTC 161

Mark Greenman, Boston University, Physics Department, Metcalf Science Center, 590 Commonwealth Ave., Boston, MA 02215; greenman@bu.edu

This eight-step pedagogy intellectually and actively engages students in learning concepts in physics. The Interactive Laboratory Experience (ILE), a derivative of the Interaction Lecture Demonstration (ILD) approach, moves students through a learning cycle from soliciting student preconceptions, to engaging in animated peer debate, to learning from nature, confronting initial conceptions with experimental observations and making connections to the students' world outside the classroom and laboratory. Participants will leave with an annotated eight-step ILE/ILD "how to" along with a rubric to self assess fidelity to the pedagogy. Workshop participants will be fully immersed in experiencing the use of the ILE/ILD techniques. Participants will also use the ILE/ILD self-assessment rubric to evaluate the fidelity of the presenter to the pedagogy.

W18: Physics and Toys I: Force, Motion, Light, and Sound

Sponsor: Committee on Science Education for the Public
Co-sponsor: Committee on Physics in Pre-High School Education
Time: 1–5 p.m. Saturday
Member Price: $65 Non-Member Price: $90
Location: SB1 304

Beverley Taylor, Miami University, Hamilton, 1601 University Blvd., Hamilton, OH 45011; taylorba@muohio.edu

Stephen Luzader

This hands-on workshop is designed for teachers at all levels in search of fun physics demonstrations, lab experiments, and interactive materials through the use of ordinary children's toys. More than 75 toys will be demonstrated, and the physical principles related to these toys will be discussed. This workshop will concentrate on toys that illustrate the concepts of force, equilibrium, linear and rotational motion, optics and light, sound, and waves. You will have the opportunity to participate in both qualitative and quantitative investigations using some of these toys. The workshop leaders have found that toys can be utilized at all grade levels from kindergarten through college by varying the sophistication of the analysis. These same toys can also be used for informal presentations to public groups of all ages, whether children or adults.

W19: Standards-based Grading

Sponsor: Committee on Educational Technologies
Co-Sponsor: Committee on Physics in High Schools
Time: 1–5 p.m. Saturday
Member Price: $60 Non-Member Price: $85
Location: SRTC B1-82

John Burk, 350 Noxontown Road, Middletown, DE 19709; John.Burk98@gmail.com

Josh Gates, Andy Rundquist

How do your grades themselves become actionable feedback for your students? How can they reflect a student's current level of understanding and not past performance, behavior, or participation? How can grades motivate student improvement, instead of being an immutable anchor or a source of adversarial wheedling and game-playing? Standards-based grading (SBG) removes assignments from the grade book and replaces them with content standards. These grades evolve over time, giving you and your students a real-time picture of understanding. In this workshop, you will hear from experienced instructors from high schools and colleges that have successfully implemented SBG in a variety of settings, and can help with defining standards, assessment strategies, tracking and communicating progress, educating students and parents on SBG, and managing the logistics of making your classroom feedback-centered.

W21: Designing Courses with Moodle

Sponsor: Committee on Physics in Undergraduate Education
Co-Sponsor: Committee on Educational Technologies
Time: 1–5 p.m. Saturday
Member Price: $60 Non-Member Price: $85
Location: SRTC B1-41

Bill Junkin, Eckerd College, 4200 54th Ave. S, St. Petersburg, FL 33711; junkinwf@eckerd.edu

Wolfgang Christian, Davidson College, Davidson, NC 28035; wochristian@davidson.edu

In this hands-on workshop participants will create a demo Moodle site that incorporates text, multimedia resources, and computer simulations. This workshop will benefit high school and college teachers who wish to use Moodle for curriculum distribution and course management. We will discuss the pedagogical and technical issues and have participants add to their demo Moodle site resources and activities such as warm-up (JiTT) pre-class questions, in-class polling (Peer Instruction) using mobile devices and/or clickers, Open Source Physics models, and other resources from ComPADRE. Participants will leave with copies of their demo Moodle site, providing resources for use in their fall courses. Participants may bring their own laptops.

Workshops – Sunday, July 14

All workshops are held at Portland State University, except W35 and W40, which are held at Vernier Software & Technology

W24: Teaching Physics for Life Science and Pre-Health Students: Lab Activities and Strategies for Course Design

Sponsor: Committee on Laboratories
Co-Sponsor: Committee on Research in Physics Education
Time: 8 a.m.–5 p.m. Sunday
Member Price: $95 Non-Member Price: $120
Location: SRTC 161

Ralf Widenhorn, Portland State University, Department of Physics, SRTC, 1719 SW 10th Ave., Room 134, Portland, OR 97201; ralfw@pdx.edu

Catherine H. Crouch, Swarthmore College, Department of Physics and Astronomy; ccrouch1@swarthmore.edu

How can we reform introductory college-level physics courses for life science students, so that we both offer the optimum physics topical coverage and present the physics in the context of rich biological and medical examples? This workshop will share the motivation and design principles used to reform IPLS (Introductory Physics for Life Sciences) courses at several different institutions. Attendees will go through both in-class and laboratory activities for life science majors and pre-health students through multiple breakout sessions, and they will leave with the instructional materials for these field-tested activities. The presenters will discuss the process of developing and refining such activities, as well as addressing the benefits and challenges of a reformed physics curriculum for IPLS. Finally, the workshop will discuss ideas and strategies for implementing changes in different institutional settings.

W25: Arduino Microcontrollers and Underwater ROVs

Sponsor: Committee on Physics in Two-Year Colleges
Time: 8 a.m.–5 p.m. Sunday
Member Price: $150 Non-Member Price: $175
Location: SB1 201

Greg Mulder, Linn-Benton Community College, Department of Physical Sciences, 6500 Pacific Blvd., Albany, OR 97321; mulderg@linnbenton.edu

Parker Swanson, Pat Keefe

Arduino Microcontrollers are relatively inexpensive devices that you can program to collect data from a variety of sensor types and control external devices such as motors and actuators. Microcontrollers can be used in a variety of classroom activities and student projects. We will focus our workshop on using an Arduino Microcontroller to construct a mini-underwater vehicle that will seek out to hover at a desired programmed depth. We will also discuss how our students use Arduinos for fun, research, underwater ROVs, and general exploration. An optional pool-test of your mini-underwater vehicle will occur after the workshop at a nearby hotel pool. No previous microcontroller, programming, or electronics experience is required. You need to bring your own Windows, Mac, or Linux computer.

W26: PIRA Lecture Demonstrations I

Sponsor: Committee on Apparatus
Time: 8 a.m.–12 p.m. Sunday
Member Price: $95 **Non-Member Price: $120**
Location: SRTC 101

Dale Stille, University of Iowa, Department of Physics, Rm 58 Van Allen Hall, Iowa City, IA 52242; dale-stille@uiowa.edu

Sam Sampere, Syracuse University, smsamper@syr.edu

We will introduce you to the Physics Resource Instructional Association (PIRA) and the PIRA 200 during this 1/2-day workshop. The PIRA 200 are the 200 most important and necessary demonstrations needed to teach a typical introductory physics course. Each demonstration has a catalog number according to the Demonstration Classification System (DCS); we will introduce you to the system used to classify these and the bibliography that details journal articles and demonstration manuals for construction and use in the classroom. We will show a subset of approximately 50 demonstrations and explain their use, construction, acquisition of materials, and answer any questions in this highly interactive and dynamic environment. Ideas for organizing and building your demonstration collection will be presented. Those teaching high school physics and faculty members teaching introductory physics will find this workshop extremely useful! It is recommended you also take PIRA Lecture Demonstration Workshop II if possible.

W27: Measuring of Learning in the Astronomy Classroom

Sponsor: Committee on Space Science and Astronomy
Time: 1–5 p.m. Sunday
Member Price: $70 **Non-Member Price: $95**
Location: SRTC 166

Janelle Bailey, UNLV, Department of Teaching & Learning, 4505 S. Maryland Pkwy., Box 453005, Las Vegas, NV 89154-3005; janelle.Bailey@unlv.edu

Tom Foster

This workshop will incorporate practice with and discussion of a variety of assessment strategies that can be used in an astronomy course. Among just some of the examples: concept inventories, ranking tasks, formative assessment probes, minute papers, exit cards — and more. We'll look at the purposes of each, implementation aspects (including "to grade or not to grade"), and how to understand the results. Take home samples and a plan for incorporating more measurement of learning into your own course, whether it is large or small.

W28: Research-based Tools for Teaching Quantum Mechanics

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on Physics in Undergraduate Education
Time: 8 a.m.–12 p.m. Sunday
Member Price: $60 **Non-Member Price: $85**
Location: SRTC 108

Chandralakah Singh, University of Pittsburgh, Department of Physics, 3941 Ohara St., Pittsburg, PA 15260; clsingh@pitt.edu

In this workshop we will discuss the common difficulties students have in learning quantum mechanics and how the use of research-based learning tools can reduce these difficulties. These learning tools include Quantum interactive learning tutorials (QuILTs), concept-tests for peer instruction, and reflective problems which are conceptual in nature. QuILTs are based upon research in physics education and employ active-learning strategies and Open Source Physics visualization tools. They attempt to bridge the gap between the abstract quantitative formalism of quantum mechanics and the qualitative understanding necessary to explain and predict diverse physical phenomena. This workshop is targeted to instructors who would like to supplement their existing course material with research-based field tested tools. Some learning tools deal with contemporary topics such as quantum teleportation that can be taught using simple two-level systems. Participants are encouraged to bring their own laptops. This work is supported by the National Science Foundation.

W29: Green Labs and Activities

Sponsor: Committee on Laboratories
Co-sponsor: Committee on Science Education for the Public
Time: 8 a.m.–12 p.m. Sunday
Member Price: $65 **Non-Member Price: $90**
Location: SRTC 247

Joe Kozminski, Lewis University, Department of Physics, One University Pkwy., Romeoville, IL 60446; kozminjo@lewisu.edu

Labs and activities dealing with green and renewable energy, energy and the environment, and sustainability are great for getting students interested in and excited about science. Putting physics in this context can make it more real and relevant for the students. This hands-on workshop will engage participants in several green-themed labs and activities that are at the level of juniors/seniors in high school or intro/gen ed college students. The labs and activities, which will be drawn from various courses and summer programs around the country, can be implemented at relatively low cost.

W30: Getting Started with eBooks

Sponsor: Committee on Physics in High Schools
Co-sponsor: Committee on Educational Technologies
Time: 8 a.m.–12 p.m. Sunday
Member Price: $62 **Non-Member Price: $87**
Location: SRTC B1-82

Danny Caballero, 1301 Over Drive, Vermillion, SD 57069; danny.caballero@Colorado.EDU

This workshop is designed to help beginners get started creating and using eBooks. An eBook is unique because it is by its nature very portable, editable and can be shared easily. An eBook can even "go viral" on the web if the right readership is tapped. Another advantage of this format is that the usual trappings of publishing aren't an issue anymore — including the high publication costs. eBooks can be offered free or inexpensively to make them available to a wide audience. It is possible to use unique fonts, colored headings, photos, embedded video and slideshows, as well as other visual options to add design interest. We will examine a number of eBook authoring formats for the Mac and PC including discussions about formats for the iPad, Kindle, Nook, etc. Web-based resources and a learning guide will be used as you get started creating a functioning eBook.

W31: Activities and Apparatus for Teaching About Climate and Climate Change

Sponsor: Committee on Science Education for the Public
Co-sponsor: Committee on Apparatus
Time: 8 a.m.–12 p.m. Sunday
Member Price: $60 **Non-Member Price: $85**
Location: SRTC 155

Brian Jones, Colorado State University, Physics Department, Fort Collins, CO 80523-1875; bjones@lamar.colostate.edu

Paul Williams, Austin Community College

During the day, the Earth is warmed by sunlight that shines on it. This is something that your students can see, something that they can feel. But, over the course of a day, the surface of the Earth receives more radiant energy from the bottoms of clouds and the lower atmosphere than it does from the Sun. This influence of thermal radiation is critically important for an understanding of the Earth's climate and how it is changing. In this workshop we'll share activities that make this invisible form of energy transfer tangible. We'll also share activities that illuminate other important but complex concepts, such as how climate models work, how feedbacks —both positive and negative—affect the climate. Our goal is to give you a set of tools to give your students a real understanding of the Earth's climate and how scientists predict its development in the future.

W32: Ways to Teach Sound and Music

Sponsor: Committee on Teacher Preparation
Co-sponsor: Committee on Physics in Pre-High School Education
Time: 8 a.m.–12 p.m. Sunday
Member Price: $60 Non-Member Price: $85
Location: SRTC 166

Wendy Adams, University of Northern Colorado, Campus Box 127, Greeley, CO 80309; wendy.adams@colorado.edu

The Acoustical Society of America is proud to offer a "Sound and Music Activity Kit" free to K-12 teachers. The kit includes 10 high-quality tuning forks (frequencies chosen to address a range of learning goals), a sound level meter, four laminated posters of the inner ear and hair cells (healthy and damaged), additional items for hands-on demos, and over 50 research-based, interactive, student-tested lessons, laboratory exercises and assessments. These lessons have been reviewed by the AAPT/PTRAs (Physics Teacher Resource Agents). There are lessons for lower elementary, physical science, and physics. Topics include basic learning goals for teaching the physics of sound with examples and applications relating to medical imaging, animal bioacoustics, physical and psychological acoustics, speech, audiology, and architectural acoustics. In this workshop the introductory lesson will be demonstrated and we will work with several of the hands-on portions of additional lessons.

W33: Major League Physics – Using Baseball to Teach Mechanics

Sponsor: Committee on Physics in Undergraduate Education
Time: 8 a.m.–12 p.m. Sunday
Member Price: $70 Non-Member Price: $95
Location: SB1 304

David Kagan, California State University, Chico, Department of Physics, Chico, CA 95929-0202; dkagan@csuchico.edu

Paul Robinson, Alan Nathan

Baseball provides a wealth of material for introductory mechanics. We'll share a collection of demonstrations, hands-on activities, and online resources to enrich your physics classes. In addition, we'll be treated to a talk by Dr. Alan Nathan, the preeminent American baseball physicist. Among other things, you'll leave with Paul Robinson's renowned "The Physics of Baseball" DVD and, if you're lucky a raffle prize. So that you're really in the "swing," wear your favorite team gear and be prepared to sing "Take Me Out to the Ball Game." Reserve your "sweet spot" now!

W34: Heliophysics

Sponsor: Committee on Space Science and Astronomy
Time: 8 a.m.–12 p.m. Sunday
Member Price: $35 Non-Member Price: $60
Location: SRTC 162

Mary Kadooka, UH Institute for Astronomy, 2680 Woodlawn Drive, Honolulu, HI 96822; kadooka@IfA.Hawaii.Edu

Michael Nassir, Kathryn Whitman

Our Sun has numerous applications for learning physics such as the solar wind and how it affects our magnetosphere to interaction of charged particles in space. It provides a wealth of fascinating resources to stimulate student interest and increase motivation to learn physics. From the twisting magnetic field lines of sunspots resulting in solar flares and coronal mass ejections that can cause blackouts on Earth, you will learn about the Sun's central role in space weather. Complementing this background knowledge will be activities using images from the NASA Solar Dynamic Observatory (SDO) developed by physics teachers and heliophysicists. You will be introduced to JHelioviewer, a database of Sun images, to stimulate your thinking to enable you to create your own lessons. University of Hawaii Institute for Astronomy and Stanford Solar Center science personnel will share their curriculum materials suitable for high school and college students.

W35: Activity-based Physics in the Advanced Physics High School Classroom

Sponsor: Committee on Physics in High Schools
Co-sponsor: Committee on Educational Technologies
Time: 8 a.m.–12 p.m. Sunday
Member Price: $65 Non-Member Price: $90
Location: Vernier Software & Technology

Maxine Willis, Dickinson College, Department of Physics and Astronomy, PO Box 1773, Carlisle, PA 17013; willism@dickinson.edu

Priscilla Laws, Steve Henning, David Sokoloff, Ron Thornton

This hands-on workshop is designed for teachers in advanced physics classes such as AP, International Baccalaureate, and honors physics. Teachers attending should be interested in enabling their students to master physics concepts in mechanics by engaging in inquiry-based active learning. Participants will work with classroom-tested curricular materials drawn from the Activity Based Physics Suite materials. These curricula make creative use of flexible computer tools available from Vernier and PASCO. These materials have been developed in accordance with the outcomes of physics education research. Affordable access to the Suite materials for secondary school use is now available and will be discussed.

W36: Advanced Lab Workshop

Sponsor: Committee on Laboratories
Time: 1–5 p.m. Sunday
Member Price: $85 Non-Member Price: $110
Location: SB1 424

Van Bistrow, University of Chicago, Department of Physics, 5720 S. Ellis Ave., Chicago, IL 60637; vanb@uchicago.edu

This workshop is appropriate for college and university instructional laboratory developers. At each of five stations, presenters will demonstrate an approach to an intermediate or advanced laboratory exercise. Each presenter will show and discuss the apparatus and techniques used. Attendees will cycle through the stations and have an opportunity to use each apparatus. Documentation will be provided for each experiment, with sample data, equipment lists, and construction or purchase information.

W37: Strategies to Help Women Succeed in Physics Related Professions

Sponsor: Committee on International Physics Education
Co-sponsor: Committee on Graduate Education in Physics
Time: 1–5 p.m. Sunday
Member Price: $60 Non-Member Price: $85
Location: SRTC 108

Chandralekha Singh, University of Pittsburgh; clsingh@pitt.edu

Women are severely under-represented in physics-related professions. This workshop will explore strategies to help women faculty members in K-12 education, colleges, and universities understand and overcome barriers to their advancement in careers related to physics. A major focus of the workshop will be on strategies for navigating effectively in different situations in order to succeed despite the gender schema, stereotypes, and subtle biases against women physicists. We will also examine case studies and learn effective strategies by role playing.

W38: LEAP: Learner-Centered Environment for Algebra-based Physics*

Sponsor: Committee on Research in Physics Education
Time: 1–5 p.m. Sunday
Member Price: $60 **Non-Member Price:** $85
Location: SRTC 149

Paula Engelhardt, Tennessee Technological University, Department of Physics, 110 University Drive, Cookeville, TN 38505; Engelhar@tntech.edu

Steve Robinson

The Learner-centered Environment for Algebra-based Physics (LEAP) is a newly developed, two-semester physics curriculum for algebra-based physics appropriate for both university and high school settings. The course pedagogy and activity sequence is guided by research on student learning of physics and builds on the work of the NSF-supported project, Physics for Everyday Thinking (PET). Students work in groups to develop their understanding of various physics phenomena including forces, energy, electricity and magnetism, light, and optics. Students utilize hands-on experiments and computer simulations to provide evidence to support their conceptual understanding. Traditional problem solving is scaffolded by using the S.E.N.S.E. problem solving strategy. During this workshop, participants will be introduced to the LEAP curriculum and S.E.N.S.E. problem solving strategy, will examine and work through a sample of the types of activities students do, and view video from the college LEAP classroom.

*Supported in part by NSF CCLI grant #DUE-0737324.

W40: New RTP and ILD Tools and Curricula: Video Analysis, Clickers, and E&M Labs

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on Educational Technologies
Time: 1–5 p.m. Sunday
Member Price: $75 **Non-Member Price:** $100
Location: Vernier Software & Technology

David Sokoloff, University of Oregon, Department of Physics, Eugene, OR 97403-1274; sokoloff@uoregon.edu

Priscilla Laws, Dickinson College

Ronald Thornton, Tufts University

RealTime Physics (RTP) and Interactive Lecture Demonstrations (ILDs) have been available for over 15 years — so what's new? The just released Third Edition of RTP includes five new labs on basic electricity and magnetism in Module 3 as well as a new approach to projectile motion in Module 1. Some of these new labs make use of video analysis. Also new are clicker-based ILDs. This hands-on workshop is designed for those who want to make effective use of active learning with computer-based tools in their introductory courses. These active learning approaches for lectures, labs, and recitations (tutorials) are based on physics education research (PER). Participants will work with new activities as well as original ones. The following will be distributed: Modules from the Third Edition of RTP, the ILD book, the *Physics with Video Analysis* book and CD, and *Teaching Physics with the Physics Suite* by E.F. Redish. Partially supported by the National Science Foundation.

W41: Interactive Engagement in the Upper Division: Methods and Materials from CU-Boulder

Sponsor: Committee on Educational Technologies
Co-sponsor: Committee on Research in Physics Education
Time: 1–5 p.m. Sunday
Member Price: $70 **Non-Member Price:** $95
Location: SB1 304

Steven Pollock, University of Colorado, Department of Physics, 390 UCB, Boulder, CO 80309; steven.pollock@colorado.edu

Charles Baily, Marcos (Danny) Caballero, Bethany Wilcox

The physics department at the University of Colorado Boulder has been developing active-learning materials and research-based assessments for courses beyond the introductory level: Modern Physics, Math Methods/Classical Mechanics, Quantum Mechanics, Electrostatics & Electrodynamics. We have shown that improved student learning can be achieved in advanced courses by adopting and adapting student-centered pedagogies and instructional techniques proven effective in introductory courses. This workshop will provide participants with an overview of the research base and course transformation process, along with a guided exploration of our online resources. Discussions of how learning goals for advanced courses differ from those for introductory courses will help you to adapt these resources to your classroom. We will provide practical demonstrations of how clicker questions and activities can be incorporated into advanced courses. Please bring a laptop. (You will also receive a flash drive containing a complete collection of our latest materials and assessments. See http://www.colorado.edu/sei/physics)

W42: Skepticism in the Classroom

Sponsor: Committee on Physics in High Schools
Co-sponsor: Committee on Science Education for the Public
Time: 1–5 p.m. Sunday
Member Price: $60 **Non-Member Price:** $85
Location: SRTC 247

Dean Baird, 240 Selby Ranch Road #2, Sacramento, CA 95864; dean@phyz.org

If our students learn that kinetic energy is one half mass times speed squared but then proceed to check psychic media to learn what the future holds, have we done our job as science teachers? I will present a variety of lessons, appropriate for the physics classroom, that focus on the skeptical and critical thinking nature of science. Some lessons involve obvious physics content; some bring in examples from the real world. Participants will leave with ready-to-use lessons and resources designed to bring healthy, scientific skepticism to their classrooms — lessons that slip into content-based instruction without disruption. Topics include fire walking, ghosts and angels, balance bracelets, pareidolia, back masking, media credulity, and more. This is an interactive workshop: participants are encouraged to share their experiences and lesson ideas.

W43: Physics TIPERs and Ranking Tasks

Sponsor: Committee on Physics in Two-Year Colleges
Co-sponsor: Committee on International Physics Education
Time: 1–5 p.m. Sunday
Member Price: $70 **Non-Member Price:** $95
Location: SRTC 155

Curt Hieggelke, Joliet Jr. College, Department of Natural Sciences, 1215 Houbolt Ave., Joliet, IL 60431; curth@comcast.net

David Maloney, Steve Kanim

This workshop will deal with alternative task formats such as Ranking Tasks, Bar Chart Tasks, Changing Representations Tasks, Comparison Tasks, Student Contentions Tasks, Troubleshooting Tasks, Working Backwards Tasks, Linked Multiple Choice Tasks, Qualitative Reasoning Tasks and What, if anything, is Wrong Tasks that are useful in improving student learning and understanding of physics. The exercises that have been developed are based, in part, on efforts in Physics Education Research and thus are called TIPERs (Tasks Inspired by Physics Education Research). These tasks support active learning approaches and can be easily incorporated into instruction. TIPERs focus on making connections between the concepts and helping students to make sense of them. This workshop will feature new TIPERs that have been developed for high school physics and conceptual physics as well as issues in using and grading these tasks. Participants will receive copies of published TIPERs and Ranking Tasks.

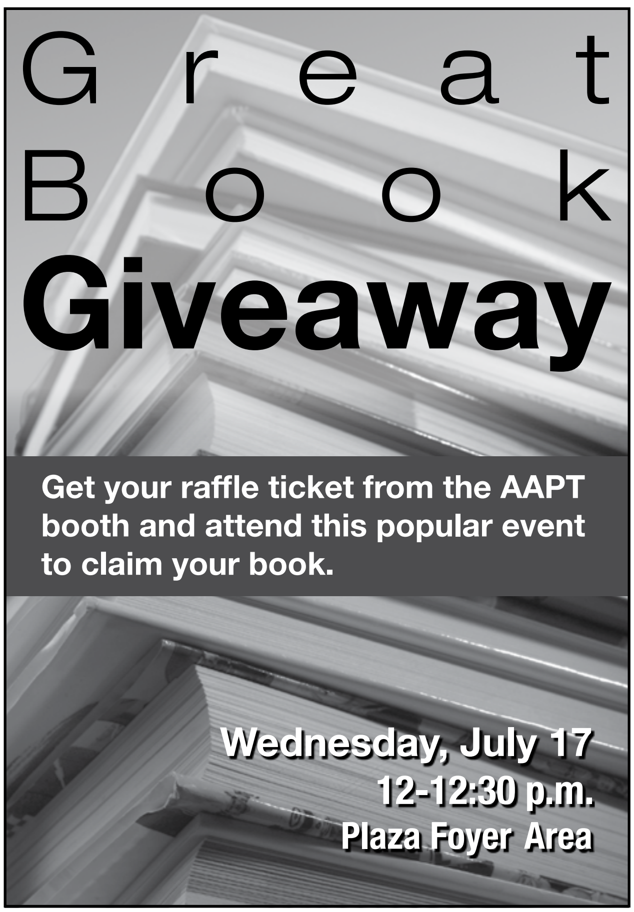
W44: Modeling Applied to Problem Solving with Associated Free Online Course

Sponsor: Committee on Physics in Undergraduate Education
Co-sponsor: Committee on Educational Technologies
Time: 1–5 p.m. Sunday
Member Price: $60 **Non-Member Price:** $85
Location: SRTC 104

AAPT Welcome Reception and Exhibit Hall Opening

Sunday, July 14 • 8-10 p.m.

Exhibit Hall



David Pritchard, Massachusetts Institute of Technology, Cambridge, MA 02139; dpritch@mit.edu

Colin Fredericks, Saif Rayyan, Raluca Teodorescu, Andrew Pawl, Analia Barrantes

Modeling Applied to Problem Solving (MAPS) pedagogy applies ideas from Hestenes' seminal work on modeling: existing physics knowledge is cast into core models whose structure (System, Interactions, Model) parallels the general problem-solving approach students are advised to use. MAPS generates problem-solving skills that transfer to a subsequent E&M course and helps students develop more expert-like attitudes toward science. The workshop goal is to enable participants to introduce some or all elements of this pedagogy into their courses with the help of our free Mechanics Online course (http://relate.mit.edu/physicscourse). This open source mechanics learning environment incorporates MAPS into a standard introductory mechanics course combining multi-level research-based homework sets with e-text. Workshop participants are encouraged to bring their laptops for a hands-on introduction to our course. We seek users/collaborators for our materials, which can be freely modified. We acknowledge support by NSF and MIT.

W45: PIRA Lecture Demonstrations II

Sponsor: **Committee on Apparatus**
Time: **1–5 p.m. Sunday**
Member Price: $95 **Non-Member Price: $120**
Location: SRTC 101

Dale Stille, University of Iowa, Department of Physics and Astronomy, Iowa City, IA 52242; dale-stille@uiowa.edu

Sam Sampere, Syracuse University, smsamper@syr.edu

We will introduce you to the Physics Resource Instructional Association (PIRA) and the PIRA 200 during this 1/2-day workshop. The PIRA 200 are the 200 most important and necessary demonstrations needed to teach a typical introductory physics course. Each demonstration has a catalog number according to the Demonstration Classification System (DCS); we will introduce you to the system used to classify these and the bibliography that details journal articles and demonstration manuals for construction and use in the classroom. We will show a subset of approximately 50 demonstrations (E&M thru Astro) and explain their use, construction, acquisition of materials, and answer any questions in this highly interactive and dynamic environment. Ideas for organizing and building your demonstration collection will be presented. Those teaching high school physics and faculty members teaching introductory physics will find this workshop extremely useful! It is recommended you also take PIRA Lecture Demonstration Workshop I.

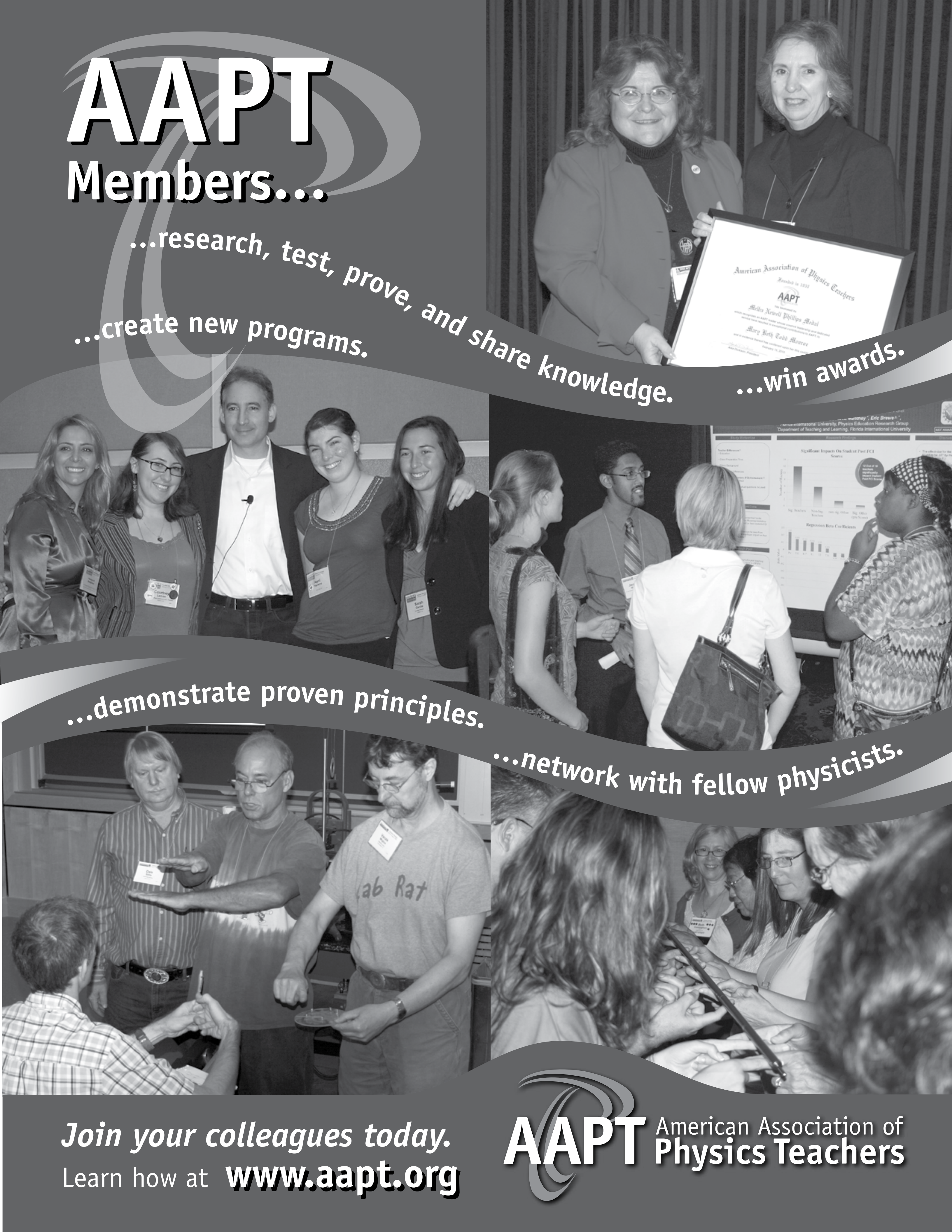
W46: Exoplanets

Sponsor: **Committee on Space Science and Astronomy**
Time: **1–5 p.m. Sunday**
Member Price: $70 **Non-Member Price: $95**
Location: SRTC 162

Mary Kadooka, University of Hawaii Institute for Astronomy, 2680 Woodlawn Drive, Honolulu, HI 96822; kadooka@IfA.Hawaii.Edu

Edna DeVore

The NASA Kepler satellite has found hundreds of stars that may have orbiting planets. Could they be terrestrial like the Earth? Astrobiology, the search for life in the universe, is fascinating to everyone. Since the 1990s when the first exoplanets were discovered, the number of other star systems found keeps increasing with improved technology. Learn how to access and use Kepler archived data. You and your students would then be able to conduct actual research using the transit method of light curves. A wealth of available online resources such as activities and timelines will be shared. This workshop is sponsored by the University of Hawaii NASA Astrobiology Institute team and the SETI Institute, both doing extensive exoplanet research.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Members...
...research, test, prove, and share knowledge.
...create new programs.
...win awards.
...demonstrate proven principles.
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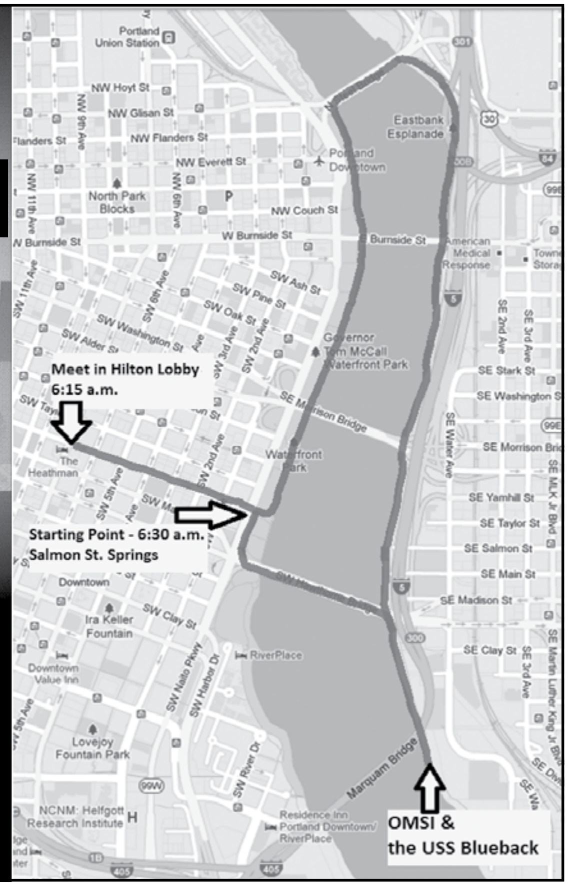
Join your colleagues today.
Learn how at www.aapt.org
AAPT American Association of Physics Teachers

AAPT Fun Run/Walk

Tuesday, July 16 • 6:30-7:30 a.m.

Meet in the Hilton lobby at 6:15 and walk to the Salmon Street Springs water fountain in Tom McCall Waterfront Park, with views of Mt. Hood and Mt. St. Helens. You'll find out why Portland is called Bridgetown, as you run under and over four of Portland's historic bridges. The route includes the Vera Katz Esplanade, one of the longest floating walkways in the world and the USS Blueback, a submarine docked next to OMSI and star of "The Hunt for Red October."

Photo, courtesy: www asfrunning.com



Melba Newell Phillips Fundraiser and Dinner

Join us for an elegant reception in honor of the life and legacy of **Melba Newell Phillips**. Melba Phillips was the first female president of AAPT. Robert Oppenheimer's first student to receive a degree in theoretical physics, she researched radar countermeasures during WWII. Her service to AAPT was long and varied, including a stint as Acting Executive Officer of AAPT from 1975-77, and she was a founder of the PER community within AAPT. The net proceeds from this event will help to endow the Melba Newell Phillips Medal established in her honor to recognize creative leadership and dedicated service to AAPT. A portion of the dinner cost is tax deductible.

Saturday, July 13
6:30–8:30 p.m.
Pavilion Ballroom

$180 per ticket
$1000 for table of 8

Session SPS: SPS Undergraduate and Graduate Outreach Poster Session

Location: Exhibit Hall
Sponsor: Committee on Physics in Undergraduate Education
Date: Sunday, July 14
Time: 8–10 p.m.

Presider: Toni Suancy

SPS01: 8-10 p.m. Similar Density Questions with Very Different Results

Poster – Ashley E. Lindow, Grove City College, 200 Campus Drive, Grove City, PA 16127; lindowae1@gcc.edu*

Elizabeth Carbone, DJ Wagner, Grove City College

While developing a standardized fluids assessment covering buoyancy and pressure, we discovered deficiencies in student understanding of density. In particular, many college students do not recognize that density is a fixed property of a solid substance, such as aluminum or gold. We added questions to our diagnostic exam to probe the extent of student difficulties. In one of our questions, only 50-60% of students recognize that the density of gold is a fixed value. When similar questions from an existing diagnostic[1] are used, however, 85-90% of students correctly identify the density of a piece of wood and of a diamond as fixed values. In this paper we discuss the differences between these questions and how those differences affect student responses.

1. http://physics.fullerton.edu/~mloverud/densitysurvey.pdf. R. Yeend, M. Loverude, and B. Gonzalez, presented at the Physics Education Research Conference 2001, Rochester, New York, 2001, WWW Document, (http://www.compadre.org/Repository/document/ServeFile.cfm?ID=4313&DocID=1045).

*Sponsored by DJ Wagner

SPS02: 8-10 p.m. A Low-Cost Photolithography System for Simple Device Fabrication

Poster – Chris Nuzzi, Coastal Carolina University, Conway, SC 29526; csnuzzi@g.coastal.edu*

Christopher Moore, Coastal Carolina University

We have built and tested a mask-less photolithographic prototyping system using a low-cost consumer digital projector and an inexpensive trinocular stereomicroscope. Photolithography is a key step in the fabrication of modern electronic devices. Specifically, we have used the microscope optics in reverse to project micrometer-sized patterns onto substrates spin-coated in commercially obtained photoresist. Patterns can be designed quickly using presentation software, such as PowerPoint, and developed in under one hour. We present optical and atomic force microscopy images of our university logo at micrometer scale outlined in aluminum on a silicon substrate. We also present the fabrication of metal-semiconductor-metal (MSM) photodetector devices and their characterization.

*Sponsored by Christopher Moore. Funded by NSF DMR 1104600.

SPS03: 8-10 p.m. An Accretion Model for a Falling Raindrop*

Poster – Ngan Le, Montgomery College, Silver Spring, MD 20910; nle45@montgomerycollege.edu

This mechanics problem involves a raindrop gaining mass due to accretion as it falls through a cloud of droplets in a non-uniform gravitational field. This article investigates the motion of very small droplets, those of diameter less than 0.003 inches, which are falling at relatively slow speed, less than 0.188 m/s. With these conditions, the raindrop is experiencing mostly laminar air flow without turbulent air flow when the Reynolds number is less than 1. Using both analytical and numerical methods, we are able to predict the existence of terminal velocity of falling raindrop, and terminal acceleration in the case of accretion. This mathematical model of falling raindrops proposes a relationship to rocket ship problem which is considered a reversed process.

*The research was conducted under the support of a FIPSE grant from the Department of Education, and a STEM-access grant.

Sunday, July 14 Highlights

AAPT Workshops at Portland State University; W35 and W40 are at Vernier Software & Technology

REGISTRATION	7 a.m.–4 p.m.	Plaza Foyer
Publications Committee	7:30–10 a.m.	Studio Suite
Meetings Committee	7:30–10 a.m.	Forum Suite
Focused Discussion: Development of Effective Assessment to Inform Instruction in Undergraduate Physics	8 a.m.–12 p.m.	Broadway I
Programs Committee I	4–5:30 p.m.	Broadway III/IV
SI Units & Metric Ed. Com.	4–5:30 p.m.	Forum Suite
Section Representatives	5–8 p.m.	Broadway I/II
H.S. Share-a-Thon	6–8 p.m.	Broadway III/IV
REGISTRATION	7:30–9 p.m.	Plaza Foyer

Exhibit Hall Opens / Welcome Reception
8–10 p.m. Exhibit Hall

SPS Undergraduate Research and Outreach Poster Session and Reception
8–10 p.m. Exhibit Hall

SPS04: 8-10 p.m. Capacitive Multiplexing on a High-Purity, Germanium, 2-D, Planar Detector

Poster – Lena E. Heffern, California State University, Chico, Physics Department, Campus Box 202, Chico, CA 95929-0202; lheffern89@gmail.com*

Morgan T. Burks, Lawrence Livermore National Laboratories

Gamma-ray imagers based on high-purity germanium (HPGe) utilize multiple segmented strips of germanium to determine the position of gamma emitters. To cut down on the need for electronics, a simple readout method involving capacitive multiplexing was developed. The goals of this new method include maximizing the number of multiplexed channels, maintaining high resolution, and determining the intrinsic capacitance, and ground capacitance. Theoretical results are confirmed by experiment on an EIGHT-strip, 2-D, dual planar, HPGe detector.

*Sponsored by Eric Ayars

SPS05: 8-10 p.m. Energy Efficiency vs. Tire Pressure and Rolling Weight in Bicycles

Poster – Brody Boeger, Portland State University, Department of Physics, Portland, OR 97207; bboeger@pdx.edu*

Erik Bodegom, Portland State University

Cycling is one of the fastest growing modes of transportation in large cities. As a result, bicycles and their function are of increasing interest to an environmentally minded society. When utilized for transportation, maintenance and efficiency become important aspects of cycling, but are often overlooked by everyday riders. Using a standard bicycle, digital force plates, and a power-metering hub it is possible to quantify the individual and combined effects of tire pressure and weight on the bicycle in terms of energy expended by the rider. Similar to studies on fuel efficiency in automobiles, assessing an energy-efficiency value for bicycles provides additional motivation for adopting sustainable transportation.

*Sponsored by Erik Bodegom

SPS06: 8-10 p.m. Integrated Physics Laboratory Assessment

Poster – Amanda Skuriat, Ramapo College of NJ, 505 Ramapo Valley Road, Mahwah, NJ 07430; askuriat@ramapo.edu, dbuna@ramapo.edu

Daniela Buna, Caroline Brisson, Ramapo College of NJ

The Engineering Physics program at Ramapo College of New Jersey has conducted a comprehensive assessment of the department's laboratory curriculum in order to determine how to improve our student learning outcomes. The data collected highlight the significant progress made through the introduction of innovative laboratory equipment and teaching methods. However, evaluative feedback provided by the students on their work was overly optimistic in comparison with feedback of their professors. The findings also showed that there was a minimal increase in interest of pursuing independent research among students. Therefore, it is imperative to further analyze what aspects can be improved upon in the curriculum as well as how to improve students' evaluative skills and propagate increased interest in the field. Several suggested tactics and future plans of action are included with the best interests of our students in mind.

SPS07: 8-10 p.m. Temperature Dependence of the Persistent Photoconductivity for ZnO

Poster – Cody V. Thompson, Coastal Carolina University, Conway, SC 29526; cvthomps007@gmail.com*

Christopher Moore, Coastal Carolina University

We have investigated the temperature dependence of the persistent photocurrent observed for polycrystalline zinc oxide (ZnO) thin film photodetectors. ZnO films were grown on c-plane sapphire substrates with aluminum contacts, forming a metal-semiconductor-metal (MSM) planar structure. The current across the ZnO films was measured before, during, and after exposure to ultraviolet light with a 5-V bias across the contacts. Ambient temperatures ranged from 20°C to 150°C. This process was completed with several different ambient temperatures to observe changes in the persistent photocurrent after removal of illumination. Results were fitted to a temperature-dependent phenomenological model based on thermionic electron transport across a time-varying surface-to-bulk energy barrier.

*Sponsored by Christopher Moore. Funded by NSF DMR 1104600.

SPS08: 8-10 p.m. Modeling Gyroscopic Motion in Terms of Linear Quantities

Poster – Harvey Kaplan, Purdue University, 525 Northwestern Ave., West Lafayette, IN 47907-2036; hkaplan@purdue.edu

Rebecca Lindell, Andrew Hirsch, Purdue University

Gyroscopic motion is often described in terms of torque and angular momentum. This method of describing gyroscopic motion proves to be powerful, but conceals the forces responsible for the motion. Using the VPython programming language, a simplified version of a gyroscope of four identical masses is used to study the forces on each mass. The program allows for effective analysis of gyroscopic motion in terms of forces and linear momentum, and permits the user to increase the number of masses until the limit of a physical gyroscope is reached. This program is intended to serve as a pedagogical tool for understanding gyroscopic motion in terms of forces.

SPS09: 8-10 p.m. Kerr Microscopy of Spin Currents in a Metallic Nanowire

Poster – James T. Delles, CSU, Chico, Physics Department, Campus Box 202, Chico, CA 95929-0202; barrinmw@gmail.com*

Andrew Galkiewicz, Paul Crowell, University of Minnesota

When a beam of polarized light is reflected off a magnetized surface, the angle of polarization of the light changes with regards to the magnitude and direction of the magnetization. This is known as the magneto-optic Kerr effect. A spin valve is a device in which current is passed through a ferromagnet and due to the density of states of the electrons in the ferromagnet, the leaving current is all of the same spin direction. It should be possible to use the Kerr effect to measure this spin current created in a nanowire from ferromagnets with their magnetization being out of the plane.

*Sponsored by Eric Ayars

SPS10: 8-10 p.m. Mpemba Effect in Water

Poster – Yuxin Wang, Southeast University, No. 2 Southeast University Road, Nanjing, Jiangsu 211189, P. R. China; wyxkx55@163.com

Mpemba effect, referring to a phenomenon that hot water freezes faster than cold under certain conditions, has been under discussion for a long period of time. Based on the freezing mechanism, we first figure out that the Mpemba effect is scientific by deducing the Newton's law of cooling, and then discuss the mechanism of Mpemba effect in theory. Experiments about Mpemba effect were done on our own specific and certain conditions. Via the experimental phenomena and data, we make further analysis of the mechanism of Mpemba effect. In addition, we make assumptions of a type of phenomenon about high energy level back to ground state, and imply the applications from both microscopic view and macroscopic view.

SPS11: 8-10 p.m. Introduction and Research on Touch Screen Technology

Poster – Yupeng Wang, No. 2 Southeast University Road, Nanjing, Jiangsu 211189, P. R. China; wyp940712@163.com

Recently, touch-screen technology has been more and more widely used in production and living. With the improvement of people's living standard, there will be a continuing increase in demand for electronic products, so touch-screen technology has good development prospects. Our paper is based on the principles of different types of touch screen and we focus on the projected capacitive touch screen. We design a principal experiment to have a better understanding of the projected capacitive touch screen and do the preliminary research on it. We will introduce the three newest touch screen technologies, "sol," "on-cell," and "in-cell," in the paper. Ideas about how to make the touch screen thinner, more sensitive, and user-friendly are discussed, based on "in-cell" technology. We hope this paper will have a positive effect on the research of optimizing the structure of future touch screens.

SPS12: 8-10 p.m. Forced Vibration of Nonlinear Oscillator System

Poster – Zeyang Shen, Southeast University, No. 2 Southeast University Road, Nanjing, Jiangsu 211189, P. R China; 213120972@seu.edu.cn

Linear harmonic oscillator is a classical model for simple harmonic vibration. When applied by an external force with a stabilized frequency, the closer the frequency of the external force comes to natural frequency of the oscillator, the larger amplitude can be observed. For non-linear harmonic oscillator system, numerical results show something distinguishing. The ball which is set between two springs, moves in a frequency identical to the frequency of the external force applied to the system. By increasing the frequency of the external force from very small, the ball vibrates with an increasing magnitude of amplitude. When the frequency reaches to a certain level, a jump can be clearly seen on the amplitude of the ball. A realistic experiment is being conducted to verify the results.

SPS13: 8-10 p.m. Theoretical Calculation of a New Type Superconductor

Poster – Jingrong Ji, Southeast University, No. 2 Southeast University Road, Nanjing, Jiangsu 211189; jjr6699@126.com

Human beings have been exploring superconductors with critical temperature at room temperature since the discovery of the super-conduction phenomenon about one hundred years ago. Although the superconductors have some profound and lasting significance in many fields, there are still various factors that will limit the superconductors from being widely used in our daily life in each period of the research process. This thesis is based on the pre-existing superconductivity theories and improves the calculation formula about the transition temperature about the superconductors and puts forward a new type of superconductor: metal-copper-based-iron-based superconductor material and calculates the formula and simulates the molecular structure of this kind of superconductor material with these theories so that we can get a special kind of superconductor with the critical temperature at an even higher temperature. We hope this research can broaden our train of thought of discovering this potential material and help us find the superconductors that can be widely used in our daily life.

First Timers' Gathering

going green with Portland 2013 AAPT

Learn more about **AAPT** and the Summer Meeting

High School Physics Teachers Day attendees are encouraged to check in at this event!

Monday, July 15
7–8 a.m.
Skyline III, 23rd floor

Robert G. Fuller

Session to Honor the Contributions of Bob Fuller to Physics Education

Come and hear four invited speakers talk about their unique working and personal relationships with Robert G. Fuller (1935-2012), the leader of the Research in Physics Education Group (RPEG) in the Department of Physics and Astronomy at University of Nebraska, Lincoln, from 1989 to 2005. He became a full-time emeritus professor in the spring of 2005.

He is also recognized for his books, *A Love of Discovery: Science Education – The Second Career of Robert Karplus* and *College Teaching and the Development of Reasoning.*

Monday, July 15
1:30–3 p.m.
Grand Ballroom I

Physics Center Stage

Tuesday, July 16, 2013
Portland Center for Performing Arts
Newmark Theatre
8–9:30 p.m.

Ballet dancers' grace and beauty of movement is awe inspiring. Dancers have learned how to use physics concepts such as force, impulse, inertia, and conservation of angular momentum to perform artful jumps and turns that wow audiences.

Portland State University's **Science Outreach Society** and the **Oregon Ballet Theatre** will define these concepts and demonstrate them through the vocabulary of ballet. The show will include dance performances as well as ideas and demonstrations that you can use in your classroom. The performance will feature results from motion capture analysis of dancers taken at the Oregon Health & Science University.

Presenters:

– Kelsey Adams, Elizabeth Anderson, Elliot Mylott, Justin Dunlap, Lester Lampert, and Ralf Widenhorn, Portland State University's Dept. of Physics and Science Outreach Society

– Kenneth Laws, Dickinson College

– Anne Mueller and dancers from the Oregon Ballet Theatre

Poster Sessions

with Refreshments

Poster Session 1

8:30–10 p.m.
Monday, July 15
Grand Ballroom II
Assorted ice cream bars and punch!

Poster Session 2

8:30–10 a.m.
Wednesday, July 17
Grand Ballroom II
Assorted donuts and coffee !

Session AA: Apparatus for Beyond the First Year of Instruction

Location: Parlor A/B
Sponsor: Committee on Apparatus
Date: Monday, July 15
Time: 8–9:10 a.m.

Presider: Eric Ayars

AA01: 8-8:10 a.m. A Cosmic Microwave Background Radiation Experiment for Undergraduate Labs

Contributed – Carl W. Akerlof, University of Michigan, Randall Laboratory of Physics, Ann Arbor, MI 48109-1040; cakerlof@umich.edu*

Jeff McMahon, Anastasiya Romadan, University of Michigan

The discovery and understanding of the 2.7°K cosmic microwave background has been a fundamental key to the remarkable advances of cosmology over the past 50 years. Ever more sophisticated measurements of these fingerprints from the early universe will play a major role in testing current theories. We have constructed a relatively inexpensive 12 GHz radiometer as an optional experiment for an advanced undergraduate lab to demonstrate this radiation and the basic principles of detection. The radiometer consists of a narrow beam horn coupled to a low-noise amplifier followed by a diode detector all supported on a simple alt-az mount. Detection is inferred from careful comparisons with room temperature and liquid nitrogen baths as well as the variation of signal with zenith angle.

*Sponsored by Ramon Torres-Isea.

AA02: 8:10-8:20 a.m. 34 Experimental Versions of a Device Demonstrating Kinetic Motion of Gas Molecules

Contributed – Jung Bog Kim, Korea National University of Education, Department of Physics Education, Cheongwon, CB 363-791, Korea; jbkim@knue.ac.kr

Hyung Kun Park Korea, National University of Education

We have modified a commercial simulator for 34 experiments in eight categories, which are 6 for pressure and buoyancy, one for Brazil nuts effect, 8 for gas molecules motion-related, 2 for osmosis, 6 for changes in states of matter, 5 for dissolving, 4 for temperature and heat transfer, 2 for sound. The product originally was developed for showing kinetic motion of gas molecules to teach both Boyle and Charles laws. Many small metal balls can be randomly moving in a long cylindrical tube by a vibrator installed on the cylinder bottom. Speed of the vibrator can be increased to show higher pressure at the fixed volume. By changing the position of a stopper inside the tube, volume can be controlled. Visualizations of molecule motion help students, who may have misconceptions because molecular motion is invisible, understand and form a scientific concept.

AA03: 8:20-8:30 a.m. Apparatus to Visualize Radiography Without the Use of Ionizing Radiation

Contributed – Otto K. Zietz, Portland State University, 555 NW Park Ave. #313, Portland, OR 97209; Ottozietz@gmail.com

Kelsey Adams, Elliot Mylott, Ralf Widenhorn, Portland State University

A device was constructed to demonstrate principles of radiography without the use of ionizing radiation. The device projects infrared radiation from light emitting diodes through an enclosure onto an upconverting phosphor screen. The enclosure is surrounded by material that transmits infrared light but absorbs visible light causing the identity and position of any objects inside to be obscured from sight. By rotating the infrared emitting array and the phosphor screen around the enclosure, students can view the contents of the box from multiple angles and thereby discern the shape and orientation of objects contained within. The apparatus can be used when teaching x-ray imaging and the fundamental concepts of computed tomography to pre-health majors.

Monday, July 15 Highlights

High School Physics Teachers Day

REGISTRATION	7 a.m.–5 p.m.	Plaza Foyer
First Timers' Gathering	7–8 a.m.	Skyline III
PTRA Oversight Committee	7–8:30 a.m.	Council Suite
Spouses' Sightseeing	10–11:30 a.m.	
PIRA Resource Room		Exhibit Hall
TYC Resource Room		Grand Ballroom II
H.S. Physics Photo Contest Voting		Plaza Foyer
Apparatus Competition		Exhibit Hall
Kindle Raffle	10:15 a.m.	Exhibit Hall
TEACHING AWARDS, DSCs	**10:30–12**	**Grand Ballroom I**

COMMITTEE MEETINGS, 12–1:30 p.m.

–Physics in Two-Year Colleges	Council Suite
–Apparatus	Galleria I
–History & Philosophy	Studio Suite
–Pre-High School Education	Directors Suite
–Research in Physics Education	Salon II/III
–Membership & Benefits (12:30–1:30)	Forum Suite

Early Career Professionals Speed Networking	12–1:30 p.m.	Skyline IV
High School Luncheon	**12–1:30 p.m.**	Skyline III

COMMERCIAL WORKSHOPS

–Perimeter	9 and 11:30	Galleria III
–WebAssign	9–10 a.m.	Galleria I
–PASCO	12–1 p.m.	Pavilion West
–Pearson	12–1 p.m.	Pavilion East
–American 3B	12–1 p.m.	Parlor A/B

Robert Fuller Memorial Session	1:30–3:30	Grand BallroomI
Gift Card Raffle	3:45 p.m.	Exhibit Hall
MILLIKAN MEDAL	**6:10–7:10 p.m.**	**Grand Ballroom I**

COMMITTEE MEETINGS, 7:10-8:30 p.m.

–PIRA Business Meeting	Galleria I
–Physics in High Schools	Pavilion East
–International Physics Education	Council Suite
–Minorities in Physics	Forum Suite
–Professional Concerns	Directors Suite
–Space Science and Astronomy	Galleria II
–Governance Structure (COGS)	Studio Suite

Poster Session I	8:30–10 p.m.	Grand Ballroom II
SPS Undergrad Awards Reception	8:30–10	Skyline III

AA04: 8:30-8:40 a.m. Low-Cost Radar Sensor Kit for STEM Education

Contributed – Scott MacIntosh, Black Cat Science, Inc., 70 Dwinell St., Boston, MA 02132; scott.macintosh@blackcatscience.com

Erik Bodegom, Erik J. Sanchez, Portland State University

A low-cost radar sensor kit has been developed for teaching a range of STEM-related concepts and laboratory skills. The kit utilizes an inexpensive commercially available off-the-shelf frequency-modulated continuous-wave 24-GHz Gunn-diode based radar transceiver whose output frequency is controlled by a 0-10 V control signal. Because the sensor utilizes a homodyne detection architecture, signal outputs are typically in the low kHz range, which allows for the use of inexpensive A/D devices for signal capture and display. The novelty of the system is that with the same kit one can teach introductory concepts at the high school level, such as basic wave theory, to advanced concepts at the graduate level, such as image reconstruction with diffracting sources. Currently, a system is being field tested as part of an upper-level undergraduate physics lab at Portland State University. Results of the preliminary test will be presented and discussed.

AA05: 8:40-8:50 a.m. Specially Designed Geiger-Mueller Counter for Instrumentation Training

Contributed – Yongkang Le, Fudan University, No. 220 Handan Road, Shanghai 200433; yongkangle@fudan.edu.cn

Shuo Wang, Fudan University

Instrumentation, defined as the art and science of measurement and control of process variables within a production or manufacturing area,[1] is one of the important contents in frontier research. However, training on instrumentation is far from sufficient in teaching laboratories. Geiger-Mueller counter is widely employed for radiation detection. Characterization of a Geiger-Mueller counter is a typical teaching laboratory for students beyond the first year. Due to the long resolution time (in the order of 100 microsecond), the dynamic range of a typical Geiger-Mueller counter is limited to about 3000 counts per second. With the help of a differential circuit, the resolution time could be reduced significantly, thus extends the dynamic range of the Geiger-Mueller counter. Teaching practice based on such a device aiming the basic training on instrumentation will be reported.

1. http://en.wikipedia.org/wiki/Instrumentation.

AA06: 8:50-9 a.m. The Millikan Experiment Without Oil Drops

Contributed – Gerald Feldman, George Washington University, Department of Physics, Washington, DC 20052; feldman@gwu.edu

Students learn about the Millikan Oil Drop experiment in their Modern Physics courses. Some courses have associated labs in which students actually perform the experiment, at the risk of going blind by following tiny illuminated droplets for many minutes. Since the value of this experiment lies in the analysis, a clever way to circumvent the difficulties of using oil drops was developed[1] in which discrete masses are measured (instead of discrete charges). By weighing film canisters with a finite number of marbles hidden inside, the same analysis can be applied to determine the "unit mass" of an individual marble. The experiment is simple to execute, very little equipment is needed, and students are challenged to deduce an analysis method that will yield an accurate result. Since my course at GWU has no formal lab, this was an ideal classroom activity that required little time but provided a large pedagogical payoff. I report on such a trial in the spring 2013 semester, including student results and reactions.

1. Eric Ayars, AAPT Workshop at the Summer 2008 Meeting (Edmonton, AB).

AA07: 9-9:10 a.m. Force-Distance Curve Reconstruction Experiments Using a Multi-Frequency Atomic Force Microscope

Contributed – Yingzi Li, Beihang University, College of Applied Physics, Xueyuan Road No. 37, Haidian District, Beijing, China 100191; yingzilee@163.com

Liwen Zhang, Jianqiang Qian, Hua Li, Beihang University

The signals from atomic force microscope (AFM) contains all the information of an interaction. Analyzing these signals can be very useful for researchers to understand the interaction. In this paper, the force curve, which indicates the interaction status, was obtained from AFM signals. Its corresponding frequency spectrum is produced by using Fourier transform, and higher harmonics are extracted from the spectrum to reconstruct the force curve. This method depends on the study of the motion of cantilever, which can be achieved using a platform built in the laboratory. A special external dual-frequencies driver was used in force curve reconstruction experiments to enhance the produced signals because they were too weak to detect. Consequently, the force curve can be obtained by this method and experimental platform. In the beginning of the paper, the method shown above was introduced and then the result of force curve reconstruction experiment based on it was subsequently discussed. The experiment is expected to be a part of physical experiment courses.

Session AB: Broader Perspectives: Students' Understanding

Location: Nines Hotel – Gallery 1
Sponsor: Committee on International Physics Education
Co-Sponsor: Committee on Research in Physics Education
Date: Monday, July 15
Time: 8–9:40 a.m.

Presider: Genaro Zavala

AB01: 8-8:30 a.m. Claims, Arguments, and Evidence: Examples from Qualitative and Quantitative PER*

Invited – Paula Heron, University of Washington, Department of Physics, Box 351560, Seattle, WA 98195-1560; pheron@uw.edu

The Physics Education Group at the University of Washington investigates student learning in an iterative cycle in which basic research, classroom instruction, and the development of instructional materials are inextricably linked. In talks and presentations we make (at least) two types of claims: we attribute student errors made in response to tasks posed in writing or during interviews to underlying thought patterns, and we attribute improved performance on such tasks to the instructional interventions we design. In this talk I will use examples to discuss the nature of these claims and the evidence required to support them.

*Supported in part by the NSF.

AB02: 8:30-8:40 a.m. Student Difficulties with Implications of the Buoyant Force

Contributed – DJ Wagner, Grove City College, 100 Campus Drive, Grove City, PA 16127; djwagner@gcc.edu

Zachary Bazan, Elizabeth Carbone, Ashley Lindow, Grove City College

One "standard" buoyancy question asks about the effect on the water level of an enclosed container, when objects are removed from a floating boat and sink to the bottom of the container, or when objects from the bottom are placed in a floating boat. We have used several versions of this question during the development of a static fluids assessment, in an attempt to find one that students with a reasonable understanding of buoyancy can answer correctly. This talk will discuss results for different versions of this question and present the results for different populations.

AB03: 8:40-8:50 a.m. Similar Density Questions with Very Different Results

Contributed – Ashley E. Lindow, Grove City College, 200 Campus Drive, Grove City, PA 16127; lindowae1@gcc.edu*

Elizabeth Carbone, DJ Wagner, Grove City College

While developing a standardized fluids assessment covering buoyancy and pressure, we discovered deficiencies in student understanding of density. In particular, many college students do not recognize that density is a fixed property of a solid substance, such as aluminum or gold. We added questions to our diagnostic exam to probe the extent of student difficulties. In one of our questions, only 50-60% of students recognize that the density of gold is a fixed value. When similar questions from an existing diagnostic[1] are used, however, 85-90% of students correctly identify the density of a piece of wood and of a diamond as fixed values. In this paper we discuss the differences between these questions and how those differences affect student responses.

1. http://physics.fullerton.edu/~mloverud/densitysurvey.pdf. R. Yeend, M. Loverude, and B. Gonzalez, presented at the Physics Education Research Conference 2001, Rochester, New York, 2001, WWW Document, (http://www.compadre.org/Repository/document/ServeFile.cfm?ID=4313&DocID=1045).

*Sponsored by DJ Wagner

AB04: 8:50-9 a.m. An Evaluation of the Translated Version of the FMCE

Contributed – Michi Ishimoto, Kochi University of Technology, Tosayamada-cho Kami-shi, Kochi 780-0832, Japan; ishimoto.michi@kochi-tech.ac.jp

This study assesses the Japanese translation of the Force and Motion Conceptual Evaluation (abbreviated to FMCEJ). Because of differences between the Japanese and English languages, as well as between the Japanese and American educational systems, it is important to assess the Japanese translation of the FMCE, a test originally developed in English for American students. The data consist of the pre-test results of 1095 students, most of whom were first-year students at a mid-level engineering school between 2003 and 2012. The basic statistics and the classical test theory indices of the FMCEJ indicate that its reliability and discrimination are adequate in assessing Japanese students' preconcepts about motion. The preconcepts assessed with the FMCEJ are quite similar to those of American students, thereby supporting its validity.

AB05: 9-9:10 a.m. Introductory Physics Students' Abstraction Levels

Contributed – Sergio Flores, University of Juarez, Plutarco E. Calles 1210, Juarez, Chih 32310, Mexico; seflores@uacj.mx

Juan Ernesto Chavez-Prieto, Juan E. Chavez, Maria Dolores Gonzalez, Sergio Miguel Terrazas, University of Juarez

We present results related to students' abstraction levels in learning situations through the concept of variation in the context of one-dimensional motion. This investigation was conducted in the University of Juarez. The main goal was the exploration of the relationship between the different representation systems, and the mathematical and physical contexts. The collected data show that this relationship represents an ultimate tool to improve the development of the mathematical abstraction levels during the students' understanding of physics. We calculated correlation coefficients as indicators of the functionality and transference level of the evaluated topics.

AB06: 9:10-9:20 a.m. Students' Difficulties in Learning the Field Theory in Electromagnetism at First Year of University

Contributed – Jenaro Guisasola, University of the Basque Country, Plaza Europa, 1 San Sebastian, 20018 Spain; jenaro.guisasola@ehu.es

This study examines first-year engineering students' understanding of the field theory in classical electromagnetism. It is assumed that significant knowledge of the field theory is a basic prerequisite when students have to think about electromagnetic phenomena. We made an epistemological analysis of the Maxwell's field theory that shows the principal conceptual knots of the theory. From the analysis we have raised questions to test students' understanding. We found that most students failed to distinguish between field concept and forces, to recognize that field cannot change instantaneously, identifying the source of magnetic field, to confuse the imaginary representation of the field lines with real lines in the space. It is concluded that although the questionnaire and interviews involved a limited range of phenomena, the identified can provide information for curriculum development by identifying the strengths and weaknesses of students' conceptions.

AB07: 9:20-9:30 a.m. Using PER-based Curriculum for Non-STEM Students Under Difficult Conditions

Contributed – Julio C. Benegas, Universidad Nacional de San Luis, Ej. de los Andes, 950 San Luis, SL 5700, Argentina; jbenegas@unsl.edu.ar

Carmen Esteban, Myriam Villegas, Silvina Guidugli, Universidad Nacional de San Luis

The general subject of how to implement effective pedagogy in settings very different to those where they were developed is addressed in this presentation. The case study is the general physics course for pharmacy students at a National University in Argentina whose main subjects are mechanics, E&M, optics, sound and fluids. Course evaluation is problem-solving based. An extra difficulty is the very low initial students' knowledge of basic math and physics, compounded with their very poor scientific reasoning abilities. Results show important learning gains obtained by using PER-based curriculum in lectures, problem solving and lab sessions, while the previous traditionally oriented courses obtained low reduced gains, resembling those previously obtained by STEM students of American colleges and universities. The measuring instruments are a conceptual math and physics diagnostic, built up with selected questions of a multiple-choice, single answer PER-based test and the Lawson test of scientific reasoning.

AB08: 9:30-9:40 a.m. The Trouble with Logarithmic Algebra

Contributed – James Day, University of British Columbia, 6224 Agricultural Road, Vancouver, BC V6T 1Z1, Canada; jday@phas.ubc.ca

Doug Bonn, Natasha Holmes, Ido Roll, University of British Columbia

The ability to handle real data is a key skill for students to develop. Scientists communicate using various representations of data (i.e. tables, graphs, and equations) and must be fluent in translating between them. The ability to analyze data has been given prominence in the descriptions of the goals of physics teaching by policy bodies such as the AAPT: one specific learning goal states that "students should be able to graph data and describe the relationships between quantities both in their own words and in terms of the mathematical relationship between the variables." In-class assessments have shown us that major obstacles for students in translating from a graph or table to a mathematical model stem from deficiencies in basic logarithmic algebra ability. In this talk I will share the concepts that students struggle with most and suggest strategies to target this base skill.

Session AC: Panel – Implementing Competency-based Grading in a Variety of Physics Classroom Settings

Location: Broadway I/II
Sponsor: Committee on Physics in Undergraduate Education
Co-Sponsor: Committee on Physics in High Schools
Date: Monday, July 15
Time: 8–10 a.m.

Presider: Aaron Titus

What is Competency (or Standards)-Based Grading and how can it be implemented? This panel consists of high school and college physics teachers who are experienced with Standards-based Grading (SBG) in a variety of different settings. They will define SBG, will describe the philosophy behind SBG, and will offer practical suggestions for applying SBG in physics classes of all levels.

AC01: 8-10 a.m. The Logistics of Effective Implementation of Standards-based Grading

Panel – Joshua Gates, The Tatnall School, 5 E Brookland Ave., Wilmington, DE 19805; joshuagatesnc@yahoo.com

The pedagogical implications of standards-based grading are attractive to many teachers: increased student accountability for learning, lack of confounding variables in the grade, attention to sustained mastery, incentivizing student improvement, and clear expectations of learning objectives for students and teachers. The logistics of implementation can be a barrier to adoption or an impediment and distraction during use, obscuring the goals of SBG, however. There are many choices to be made, and the costs and benefits of a large variety of SBG implementation options will be presented: student-initiated or teacher-initiated reassessments? What type of grading scale will be used? How many standards should be used? What's necessary to demonstrate proficiency? How should reassessments be generated, tracked, and managed? Some digital tools to assist in these efforts, including Google forms, ActiveGrade, LaTeX, and custom software will be presented as well.

AC02: 8-10 a.m. Student Voice-based Assessments

Panel – Andy Rundquist, Hamline University, 1536 Hewitt Ave., MS B1807, Saint Paul, MN 55104; arundquist@hamline.edu

Having grown to appreciate the oral exams that my department uses, I set about finding ways to craft assessments that allow me to get a feel for my students' understanding of, confidence with, and ability to apply the various concepts we're studying. I've come to rely heavily on student initiated assessments that involve their voice. They make either pencasts or screencasts of their work and submit the videos to me. I will talk about the logistics and benefits involved.

AC03: 8-10 a.m. Switching to SBG – It Can Work for You

Panel – Stephen T. Collins, Lusher Charter School, 5624 Freret St., New Orleans, LA 70115, stephen_collins@lusherschool.org

For many, switching to a grading scheme that focuses on student learning ("standards") rather than tasks ("points") is philosophically attractive but logistically intimidating. The assessment system used in physics classes at Lusher Charter School is presented as a case study, highlighting aspects that enhance student learning, promote student accountability, manage teacher time commitment, and make the system easy for students and parents to understand. Alternative implementation approaches are also considered, with varying levels of technology integration. Learn how to make the change—you and your students will be glad you did.

Session AD: Introductory Physics for Life Science Majors

Location: Salon Ballroom II/III
Date: Monday, July 15
Time: 8–9:30 a.m.

Presider: Gary White

AD01: 8-8:10 a.m. Lab Activities for Pre-health Majors

Contributed – Grace R. Van Ness, Portland State University, Portland, OR 97207; vanness@pdx.edu

Ralf Widenhorn, Portland State University

The majority of students taking algebra-based physics in the college classroom are pre-health and life science majors. Pre-health and life science majors would greatly benefit from effective teaching methods which connect physics to their future careers as health-care providers and life scientists. One way to address this issue is the development of hands-on physics exercises that engage students. With this in mind, we present hands-on exercises as part of our Physics in Biomedicine course at Portland State University. These labs are easily constructed using materials readily available in many colleges or high schools. Hard copies of lab descriptions will be available.

AD02: 8:10-8:20 a.m. Randomness and Structure 1: Introductory-level Conceptual Framework for Biological Materials

Contributed – Edit Yerushalmi, Weizmann Institute of Science, 234 Herzl St., Rehovot, 76100 Israel; Edit.Yerushalmi@weizmann.ac.il

Elon Langbeheim, Shelly Livne, Samuel Safran, Weizmann Institute of Science

Explaining the spontaneous formation of molecules into mesoscopic (nanometric) or even micron-sized structures that are important in biological materials (i.e. membranes, polymers, colloids), requires an understanding of cooperative behavior in interacting multi-particle systems. We present a conceptual framework for treating these phenomena with introductory-level students, which was tested in a pilot interdisciplinary course entitled "Soft and messy matter." We first discuss the competition of configurational entropy (that promotes randomness) and interparticle interactions (that promote order) in terms of a lattice model in the context of binary mixtures. The lattice model, allowing for concrete visualization, is later used to model the phase behavior of fluid mixtures, wetting, and self-assembly of surfactants via free-energy minimization. This approach can be incorporated into restructured introductory physics courses for life sciences, allowing students to understand how the competition between interactions and entropy is resolved to determine how molecules self-organize to form mesoscopic structures.

AD03: 8:20-8:30 a.m. Randomness and Structure 2: Computational Modeling of Interacting Multiparticle Systems

Contributed – Ruth Chabay, NC State University, 515 E. Coronado Road, Santa Fe, NM 87505; rwchabay@ncsu.edu

Nava Schulman, Edit Yerushalmi, Weizmann Institute of Science

The concepts of entropy and equilibrium are central to the understanding of the spontaneous formation of structure in soft matter systems such as membranes. We are developing a suite of computational modeling tools with a strong visual component to support the development of these concepts by students in an introductory-level course on soft matter. In the context of the lattice gas model, which is commonly used in the analytical treatment of such systems, students can explore the consequences of random motion, observe the dynamics of the approach to equilibrium, monitor bulk properties of the system, and observe that interparticle interactions are required for the spontaneous formation of mesoscale structures. These tools can be extended to allow students to do significant computational modeling projects by the end of the course. They provide, as well, a stimulus for discussion about the nature of scientific models.

AD04: 8:30-8:40 a.m. Randomness and Structure 3: Explicating Nature's Choices with Computational Tools

Contributed – Nava Schulmann, Weizmann Institute of Science, 234 Herzl St., Rehovot, 76100 Israel; Nava.Schulmann@weizmann.ac.il

Ruth Chabay, North Carolina State University

Edit Yerushalmi, Weizmann Institute of Science

Understanding the balance between randomness and structure in multi-particle systems via statistical thermodynamics methods requires construction of a concrete mental model for the process of weighing between configurations. We present two computational tools intended to support introductory-level students in constructing such a representation. One tool allows students to explore the plausibility of the ergodic principle and the meaning of entropy by displaying systems evolving in time versus their corresponding sets of microstates; another tool provides insights into the crucial role of the Boltzmann factor in determining the behavior of multi particle systems by explicitly tracking the mechanism of the Metropolis algorithm. We integrate these tools in an introductory-level course on soft and biological materials, where the understanding of the spontaneous formation of structures such as polymers, colloidal dispersions and membranes, is grounded in statistical thermodynamics descriptions of matter.

AD05: 8:40-8:50 a.m. Research on a Laboratory Curriculum for NEXUS/Physics

Contributed – Kimberly A. Moore, University of Maryland, College Park, (PERG) 6525 Roosevelt St., Falls Church, VA 22043; MoorePhysics@gmail.com

John Giannini, Wolfgang Losert, University of Marlyand, College Park (Biophysics)

Ben Geller, Vashti Sawtelle, University of Marlyand, College Park (PERG)

In 2012-2013, the UMD PERG and Biophysics Program implemented a new laboratory curriculum for its introductory physics for biologists course in a pair of small test classes. These labs address physical issues at biological scales using microscopy, image, and video analysis, electrophoresis, and spectroscopy in an open, non-protocol-driven environment. We have collected a wealth of data (surveys, video analysis, etc.) that enables us to get a sense of the students' responses to this new approach, with a focus on: 1) the ways in which students see these labs as engaging the biology/chemistry concepts; and, 2) the student reaction and adaptation to the combination of "open-ended" labs with complex, technical equipment. In this talk, we will give a brief overview of what we have learned. (This work is part of the UMD PERG NEXUS/Physics and is supported by funding from HHMI and the NSF.)

AD06: 8:50-9 a.m. Teaching Introductory Physics of Modern Medicine to Non-Science Majors

Contributed – Fang Liu, The Richard Stockton College of New Jersey, 101 Vera King Farris Drive, Galloway, NJ 08205-9441; fang.liu@stockton.edu

Medical Technology is a general studies course developed for non-science majors in the general natural sciences and mathematics (GNM) portion of the General Education curriculum at the Richard Stockton College of New Jersey. In this course the students are introduced to the topics of optics and endoscopes, lasers in medicine, ultrasound in medicine, x-ray & CT, gamma camera, radiation therapy and radiation safety, etc. In this paper I will present a brief overview of the curriculum development with an emphasis on the teaching and learning strategies employed in the course. Student perceptions regarding the course will also be presented.

AD07: 9-9:10 a.m. Negative Energy: Why Interdisciplinary Physics Requires Blended Ontologies

Contributed – Benjamin W. Dreyfus, University of Maryland, Department of Physics, 082 Regents Drive, College Park, MD 20742; dreyfus@umd.edu

Benjamin D. Geller, Vashti Sawtelle, Chandra Turpen, Edward F. Redish, University of Maryland, College Park

Much recent work in physics education research has focused on ontological metaphors for energy (metaphors for what type of thing energy "is"), particularly the substance ontology and its pedagogical affordances. The concept of negative energy problematizes the substance ontology for energy (because there cannot be a negative amount of a substance), but in many instructional settings, the specific difficulties around negative energy are outweighed by the general advantages of the substance ontology. However, we claim that our interdisciplinary setting (an undergraduate physics class that builds deep connections to biology and chemistry) leads to a different set of considerations and conclusions. In a course designed to draw interdisciplinary connections, the centrality of chemical bond energy in biology necessitates foregrounding negative energy from the beginning. We argue that the emphasis on negative energy requires a blend of substance and location ontologies. The location ontology enables energies both "above" and "below" zero.

AD08: 9:10-9:20 a.m. Modeling Fluid Statics to Help Students Understand Fluid Dynamics*

Contributed – James Vesenka, University of New England, 11 Hills Beach Road, Biddeford, ME 04005; jvesenka@une.edu

Katherine Misaiko, Elizabeth Whitmore, University of New England

The UNE PERG is investigating life science student preconceptions about fluid dynamics, specifically understanding the Bernoulli Principle (BP). We have identified important scaffolding content and laboratory interventions that improve student success at understanding BP. The key scaffold element appears to be a sound understanding of kinetic theory including the ability to model fluids as multiple interacting particles. A new modeling centered laboratory on ideal gasses with conceptually rich diagrammatic tools has been deployed. A tactile life science lab activity is currently being evaluated in order to help students address the paradox of high blood pressure and pressure drop within a restriction, e.g. a blocked blood vessel. Complicating effective instructional efforts are numerous incorrect applications of the BP found in many physics texts. The range of practical problems that BP is applicable to is narrow and frequently BP is employed when other dynamic processes are more important.

*Supported by NSF grant DUE 1044154

AD09: 9:20-9:30 a.m. Like Dissolves Like: Unpacking Student Reasoning about Thermodynamic Heuristics*

Contributed – Benjamin D. Geller, University of Maryland, Department of Physics, College Park, MD 20742; geller@umd.edu

Benjamin W. Dreyfus, Vashti Sawtelle, Chandra Turpen, Edward F. Redish, University of Maryland, College Park

In our Physics for Biologists course at the University of Maryland, we are attempting to build interdisciplinary bridges that help students understand thermodynamics better. One aspect of this endeavor involves having students grapple with the physical processes underlying heuristics that they bring to our course from their biology and chemistry classes. In particular, we have implemented a series of activities and problems intended to unpack the hydrophobicity of oil, a key step in understanding the formation of cell membranes. Student reasoning about this process illustrates the challenges we encounter in trying to bridge physics and biochemistry curricula. Understanding the spontaneous separation of oil and water requires careful consideration of the sometimes competing effects of energy and entropy. Reconciling disciplinary distinctions in how these ideas are described is an important step in helping our students develop more coherent thermodynamics concepts.

*Supported by the NSF-TUES DUE 11-22818, and the HHMI NEXUS grant.

Session AE: Panel – Seeking Employment in Academia

Location: Broadway III/IV
Sponsor: Committee on Graduate Education in Physics
Co-Sponsor: Committee on Professional Concerns
Date: Monday, July 15
Time: 8–10 a.m.

Presider: Frances Mateycik

Applying for a career in academia can be an art form. You have to catch the eye of the employer based on a few pages of written words. You must be able to interpret the ad, gather pertinent information quickly, and tailor your materials to the position. There are many questions such as how long, personal, specific, etc. your materials should be. How should you tailor materials when applying to a field-specific position versus a general announcement? What do small private schools look for that large public universities are not interested in? This session features a panel of experts that will provide their opinions on how to adjust your materials to positions at their type of school.

Panelists:
Keith Clay – Green River Community College
Dyan Jones – Mercyhurst College
Tatiana Krivosheev – Clayton State University
Dean Zollman – Kansas State University

Session AF: Modern Physics in the High School Classroom

Location: Galleria II
Sponsor: Committee on Physics in High Schools
Date: Monday, July 15
Time: 8–9:40 a.m.

Presider: Kenneth Cecire

AF01: 8-8:30 a.m. Exploring Elementary Particles with Masterclasses and e-Labs

Invited – Shane Wood, Irondale High School, 3439 Garfield Ave., Apt 104, Minneapolis, MN 55408; shane.wood@moundsviewschools.org

What is the Higgs boson? What is antimatter? What is the Large Hadron Collider? These questions are in popular culture to the point where even many non-physics students are asking them. How can we take advantage of this historic opportunity to engage more students in the exciting field of physics? The international particle physics masterclass is designed for high school students to analyze LHC experimental data to better understand the world of quarks and leptons. Learn how teachers and students have the opportunity to work directly with particle physics data and to collaborate with physicists and other students doing similar work across the country and around the world. They need not stop there: with a classroom cosmic ray detector and an accompanying e-Lab, students can take their own data and share data and analyses worldwide.

AF02: 8:30-9 a.m. Activities from QuarkNet's Data Portfolio

Invited – Kris Whelan University of Washington, Box 351560, Seattle, WA 98195-1560; kkwhelan@uw.edu

You may not have the expensive instrumentation for modern physics experiments in your classroom, but your students can analyze date from these experiments. QuarkNet is developing a portfolio containing instructional resources and data from the Large Hadron Collider, LHC, experiments and cosmic ray studies. Students build on what they are learning in their physics classes, especially conservation of momentum and energy, to develop new conceptual constructs. The portfolio contains fundamental (paper and pencil) data analyses and more challenging, online ones as well. We will explore these fundamental activities. Funded by the National Science Foundation and U.S. Department of Energy, QuarkNet is a long-term, national teacher development program that brings high school teachers and their students into the particle physics research community.

AF03: 9-9:10 a.m. Hands-on Simulations for Modern Physics with Video Supplements

Contributed – Beverly T. Cannon, Highland Park High School, 4220 Emerson Ave., Dallas, TX 75214; cannonb@hpisd.org

Modern Physics can be a puzzlement in a "hands-on" environment. There are some activities that fall into the simulation genre that can be done and that work without computers. Calculators and computers can be used to analyze the data obtained. This presentation will have at least five that you can use in a high school class.

AF04: 9:10-9:20 a.m. Reaching Modern Physics in an Inquiry-based Physics-First Curriculum

Contributed – Richard G. Piccioni, The Bay School of San Francisco, 35 Keyes Ave., San Francisco, CA 94129; rpiccioni@gmail.com

To prepare students for chemistry, physics-first curricula should introduce some key aspects of modern physics. Maximizing student opportunities to construct durable understandings of concepts such as the photon model of light requires carefully structured group work, creative use of technology, and courageous deferral of some material traditionally "covered" in introductory physics courses. The 9th-grade inquiry-based physics-first curriculum at our school now takes the form of a series of investigations conducted by students in small groups.[1] Early in the course, students encounter a comprehensive conservation of energy equation along the lines recommended by Jewett[2] and learn to apply that equation under more than one system definition. By the end of the course, application of energy conservation principles to simple electric circuits enables students to estimate the average photon energy of an LED in electron-volts, paving the way to a deeper appreciation of atomic energy levels in chemistry.

1. R.G. Piccioni, N. Fiszman, "Physics First at the Bay School," submitted to *The Physics Front* (February, 2013).
2. J. W. Jewett, "Energy and the confused student IV: A Global Approach to Energy," *Phys. Teach.* **46**, 210-217 (April 2008).

AF05: 9:20-9:30 a.m. Students' Videoconference to Compare their LHC Particle Event Analyses

Contributed – Dave Trapp, SequimScience.com & QuarkNet,192 Quail's Roost Road, Sequim, WA 98382; dtrapp@mac.com

The U.S. Masterclass, part of the International Masterclass program, engages students to analyze recent high-energy collision data from the LHC including possible Higgs events. Students share, compare, and discuss their analyses via videoconference with physicists and other groups of students around the U.S. and often other countries in the Americas, Europe, and around the Pacific rim. By encouraging students to emulate the processes physicists use, it helps them understand what is science and what it has and can accomplish. This talk will discuss the details of these video conferences, their features and their success.

AF06: 9:30-9:40 a.m. Using the CMS e-Lab with High School Students

Contributed – Michael Fetsko, Mills Godwin High School, 2101 Pump Road, Henrico, VA 23238; mrfetsko@henrico.k12.va.us

This talk will highlight my experiences using the CMS e-Lab with my high school students and with high school students in Beijing, China. The CMS e-Lab is an online tool that provides authentic data from the CMS detector at CERN in Geneva, Switzerland. The CMS e-Lab provides students with an opportunity to analyze data to calibrate the detector and participate in discovery science (as particle physicists do). Students have the opportunity to use the tools and the histograms to "discover" particles and, if they are really determined, discover physics that goes beyond simple calibration. The e-Lab is easily adaptable to a short-term project or as a long- term inquiry project. Even if you do not teach particle physics, the e-Lab could be an excellent addition to your curriculum.

Session AG: Teachers in Residence and Master Teachers in Teacher Preparation

Location: Salon Ballroom I
Sponsor: Committee on Teacher Preparation
Date: Monday, July 15
Time: 8–9:20 a.m.

Presider: Jon Anderson

AG01: 8-8:10 a.m. Development and Implementation of a Physics Teaching Course

Contributed – Kevin M. Dwyer, CSU Long Beach and Cypress High School, 10342 Whirlaway St., Cypress, CA 90630; chsdwyer@yahoo.com

For three years CSU Long Beach has offered a course for preservice and in-service teachers through the PhysTEC program, team-taught with the TIR and a university science educator. The purpose of the course is to develop better physics teachers, but has also created a community of physics teachers. Each year the course has a different physics area of emphasis. The class activities include discussions on how to teach physics content, doing and evaluating high school physics labs and demonstrations, and evaluating textbooks and other teaching tools including simulations and data collection devices. Discussion will include how the course has evolved over time, how students are recruited, and how the course has impacted the students and the university physics department.

AG02: 8:10-8:20 a.m. Visiting Master Teacher at the University of Arkansas

Contributed – Marc Reif, 607 N Walnut Ave., Fayetteville, AR 72701; marc.pricereif@gmail.com

I have served as Visiting Master Teacher at the University of Arkansas for the past two years. In this time, I have mentored several young teachers. Some of them started the process of becoming a teacher by observing my classroom, and two served as interns in my classroom. Most of my mentees have gone on to initial teaching positions in small rural schools. I will discuss the challenges these young teachers face in what are usually very demanding positions with multiple responsibilities. The focus will be on my successes in providing practical and emotional support.

AG03: 8:20-8:30 a.m. A Master Teacher's Contribution to Teacher Preparation in Jamaica

Contributed – Michael Ponnambalam, University of the West Indies, Physics Department, Kingston, 7 Jamaica; michael.ponnambalam@gmail.com

In 2006, the author was chosen to be a Mentor for New Academic Staff in the Physics Department, University of the West Indies, Mona Campus, Jamaica, and in 2009 a Master Teacher of the entire University of the West Indies in all its four campuses across the English-speaking Caribbean. In this presentation, the author's contribution to the future teachers in Jamaica will be discussed.

AG04: 8:30-8:40 a.m. First-Year PhysTEC Program at the University of Alabama*

Contributed – Penni H. Wallace, University of Alabama, 6045 Loblolly Lane, Tuscaloosa, AL 35405; pahwallace@comcast.net

The University of Alabama first-year PhysTEC program features 12 Learning Assistants who assist in Studio Physics classes and take a one-hour pedagogy course taught by physics faculty. Some of the LAs obtain additional early teaching experiences by assisting in local high school physics classes. The Teacher-In-Residence partners with Alabama Science in Motion (ASIM) to train preservice teachers in high school physics labs using PASCO equipment. Upon graduation, these students will be certified to participate in ASIM as new practicing teachers. In addition to the PhysTEC program, Alabama is a partner in a new NSF-MSP award "Alliance for Physics Excellence" to provide in-service and preservice training to high school physics teachers. A component of the award provides 10 $16K scholarships to UA PhysTEC students seeking certification at either the undergraduate or graduate levels. In this talk, I will articulate how these efforts have combined to help us recruit new physics teachers.

*Website: www.phystec.ua.edu

AG05: 8:40-8:50 a.m. The TIR's Role in Teacher Preparation

Contributed – David S. Jones, Florida International University,11200 SW 8 St., CP 204, Miami, Fl 33199; djones@fiu.edu

A veteran high school physics teacher has a unique set of professional skills that they will bring to their role as a TIR at their PhysTec institution. This talk will explore how these particular skills help to build the teacher preparation community at their institution. The TIR can also have a role in the teacher preparation program with preservice teachers after they enter the teaching profession. The TIR can have a significant role in helping the transition from preservice teacher to in-service teacher. Research has shown that support from a community of peers can have a strong influence on a teacher's career path and the TIR role can have an influence on this post graduation community.

AG06: 8:50-9 a.m. Highlights & Limitations as a PhysTEC VMT

Contributed – B. Lippitt, Seattle Pacific University/Institute for Systems Biology, 7349 Seward Pk. Ave. S., Seattle, WA 98118; b.lippitt@systemsbiology.org

An *n* of one shares understandings as a VMT for two years at Seattle Pacific University.

AG07: 9-9:10 a.m. The Eclectic, Dynamic PhysTec Program at Towson University

Contributed – Lisa S. Rainey, Towson University, 8000 York Road, Towson, MD 21252; erainey@towson.edu

There are many dimensions to the PhysTec Teacher in Residence (TIR) position. The range of goals and activities, over the course of the year, was eclectic. The five areas highlighted include: outreach to the high school physics community to recruit for secondary education; mentoring faculty members and Learning Assistants (LAs) to ensure active learning approaches are valued and implemented; community college articulation; support for physics student interns/student teachers; organizing activities/training for LAs which included inquiry based learning, and questioning and problem-solving techniques.

AG08: 9:10-9:20 a.m. Fostering Incremental Shifts in Physics Department Culture as TiR

Contributed – Kelli L. Gamez Warble, Arizona State University, 12950 W. Estero, Litchfield Park, AZ 85340; kelliw@asu.edu

A critical objective of the Physics Teacher Education Coalition is to transform physics departments and spread best-practice ideas throughout the physics teaching community. The goal to "transform physics departments" is non-trivial at Arizona State University, one of the largest institutions in the United States. This talk will discuss strategies implemented by the TiR and the ASU PhysTEC team working towards a gradual shift in physics department culture to value teaching. Activities discussed will include departmental colloquia such as SCALE UP and Berkeley COMPASS, the implementation of a Learning Assistant program, and the influence of strong local teaching organizations such as the American Modeling Teacher's Association.

Session AH: PER: Classroom Strategies and Problem Solving Using Online Tools

Location: Pavilion West
Sponsor: AAPT
Date: Monday, July 15
Time: 8–9:50 a.m.

Presider: Homeyra Sadaghiani

AH01: 8-8:10 a.m. Implicit Scaffolding for Student Learning with Computer Simulations

Contributed – Noah S. Podolefsky, University of Colorado, Campus Box 390, Boulder, CO 80309; noah.podolefsky@colorado.edu

Emily B. Moore, Katherine K. Perkins, University of Colorado

We introduce implicit scaffolding, a research-based theoretical framework we use to design PhET interactive simulations (sims) for inquiry learning. Scaffolding is usually explicit, consisting of prompts, questions, and other forms of guidance. Implicit scaffolding leverages affordance and constraints carefully chosen and built into PhET sims in order to guide without students feeling guided. By making scaffolding implicit, we aim to specifically address affective goals such as student agency, ownership, and productive, self-directed exploration. When scaffolding is implicit, student epistemological framing of their exploration with a sim can be more aligned with the self-directed, personally rewarding exploration done by scientists than when scaffolding is explicit. Additionally, implicitly scaffolded sims provide opportunities for instructors to design and facilitate classroom activities that are 1) more student-centered, and 2) more focused on conceptual learning. Implications for learning tools beyond PhET sims will be discussed.

AH02: 8:10-8:20 a.m. Flipping a College Physics Class Using Video Lectures and PER Tutorials

Contributed – Roberto Ramos, Indiana Wesleyan University, 4201 South Washington St., Marion, IN 46953; roberto.ramos@indwes.edu

Jaki Richter, Indiana Wesleyan University

An introductory college physics class was taught using a "flipped format" in a liberal arts college setting. Outside class, students viewed over 75 online video lectures on introductory mechanics prepared by this author using an inexpensive high-definition webcam and Relay Camtasia software. Videos ranging from five to 20 minutes long were made available via Blackboard, which enabled tracking of viewing. Inside the class, the students mostly worked through PER-based, activity-based tutorials and occasionally solved problems. A professor with one or two undergraduate TAs served more as facilitators in student-centered, peer-learning-based activities. I will report on the learning gains, which were significant, as measured by standard pre- and post-learning physics diagnostic tests. I will also report on student response and feedback as measured by surveys and online video interviews. Interesting aspects of the viewing behavior of students, as measured by Blackboard tracking statistics will be reported as well.

AH03: 8:20-8:30 a.m. The Role of an Online Collaborative Textbook Annotation Tool in a Flipped Introductory Physics Class

Contributed – Kelly A. Miller, Harvard University, Cambridge, MA 02138; kmiller@seas.harvard.edu

Sacha Zyto, David Karger, Massachusetts Institute of Technology

Eric Mazur, Harvard University

In the age of digital learning and flipped classrooms, there is an open question as to how online participation facilitates learning. We investigate the role of NB, an online collaborative textbook annotation tool, in a flipped introductory physics class. NB serves as both the primary content delivery mechanism and provides a discussion forum for students. We analyze the relationship between students' level of online engagement and traditional learning metrics to understand the effectiveness of NB in the context of flipped classrooms.

AH04: 8:30-8:40 a.m. Engaging Non-Majors through Student-Generated Assessment Content

Contributed – Simon P. Bates, University of British Columbia, 1961 East Mall, Vancouver, BC V6T 1Z1, Canada; simon.bates@ubc.ca*

Emily Altiere, Firas Moosvi, University of British Columbia

We describe the first investigation of student-generated assessment content using the PeerWise online system in an introductory physics course composed exclusively of non-majors. Implemented across three concurrent sections of the course (N=700), we have utilized the same scaffolding and instructional design implementation to that which had previously yielded a very high standard of question quality. This is, therefore, a replication study in a very different course context: the final, and for many, only physics course these students will take. We report details of the students' engagement with the online system, together with an investigation of the quality of the questions that students author, by categorizing them into the levels in the cognitive domain of Bloom's taxonomy. Through sampling of questions authored at distinct points in the course, we are able to track changes in the quality of submissions as the course progresses.

*Sponsored by Ross Galloway

AH05: 8:40-8:50 a.m. A New Framework for Computer Coaching of Problem Solving*

Contributed – Evan Frodermann, University of Minnesota, 116 Church St. S.E., Minneapolis, MN 55455; frodermann@physics.umn.edu

Ken Heller, Leon Hsu, Kristin Crouse, University of Minnesota

The physics education research (PER) group at the University of Minnesota has been developing online computer programs intended to aid students in developing problem-solving skills by coaching them in the use of an expert-like problem-solving framework. An early version was tested in a large calculus-based introductory physics class and judged to be helpful by students. The PER group is now working on a second generation of coaches which is more flexible for both students and instructors. The new coaches will allow students to make the decisions critical to problem solving in a non-linear path, more closely resembling the actual way they solve problems. It will also allow instructors without any programming experience to modify both the structure and content of existing coaches and to create new ones. In this talk we will demonstrate the new interface and discuss the rationale behind its design.

*This work is supported by NSF DUE-1226197.

AH06: 8:50-9 a.m. Online Computer Coaches for Introductory Physics Problem Solving – Usage Patterns and Students' Performance*

Contributed – Qing Xu, University of Minnesota-Twin Cities, 116 Church St. SE, Minneapolis, MN 55455; qxu@physics.umn.edu

Kenneth Heller, Leon Hsu, Evan Frodermann, University of Minnesota-Twin Cities

Bijaya Aryal, University of Minnesota-Rochester

The Physics Education Research Group at the University of Minnesota has been developing Internet computer coaches to help students become more expert-like problem solvers. During the fall 2011 and spring 2013 semesters, the coaches were introduced into large sections (200+ students) of the calculus-based introductory mechanics course at the University of Minnesota. In this talk, we will discuss the different usage patterns of the coaches and their correlations with student problem-solving performance and attitudes toward problem solving in physics.

*This work was supported by NSF DUE-0715615 and DUE-1226197.

AH07: 9-9:10 a.m. Improving Exam Performance for Diligent but Failing Students

Contributed – Zhongzhou Chen, University of Illinois at Urbana-Champaign, 1110 West Green St., Urbana, IL 61801; zchen22@illinois.edu

Gary Gladding, Jose Mestre Mats Selen, Tim Stelzer, University of Illinois at Urbana-Champaign

For instructors, it is distressing to see students who spend a considerable amount of time and effort learning physics still end up performing poorly on exams. At university of Illinois, we observe in our introductory physics courses that a substantial fraction of students who receive failing grades actually completed over 80% of all course-related activities. In order to improve the exam performance for those students, we initiated a three-year project aiming at better understanding the causes of their poor exam performance, and developing a computer-based online tool to better guide those students through the process of preparing for an exam. One year into the project, we have identified a number of possible causes leading to the poor exam performance of those hard-working students, including inaccurate self-estimation, lack of basic knowledge/skills, and insufficient ability to learn from worked out solutions. In this talk, we will also demonstrate how we designed our exam-preparation tool to help students address these issues.

AH08: 9:10-9:20 a.m. Practice Exam

Contributed – Witat Fakcharoenphol, University of Illinois at Urbana-Champaign, 1110 W. Green St., Urbana, IL 61821; fakchar1@illinois.edu

It has been shown that practicing on exam-liked problems and getting worked out solutions through an online system can improve students' performance on similar problems both on similar practice problems, as well as on the actual exam. However, the improvements were restricted to problems closely related to the practice problems. In an effort to increase the effectiveness, we performed a clinical study that included two additional treatments, providing targeted homework activities, and one-on-one tutoring. Results of this study and its implications for helping students prepare for the exam will be presented.

AH09: 9:20-9:30 a.m. Capitalizing on Digital Natives' Technological Skills

Contributed – Angela M. Cannava, University of Colorado, Boulder, 249 UCB, Boulder, CO 80309; cannava@gmail.com

The PER community has developed materials that build on students' conceptual and epistemological resources. However, little attention has been given to students' technological resources, which are becoming increasingly important. As "digital natives" make up the majority of our student population, a simple change of replacing paper and pencil lab notebooks with digital notebooks may have a dramatic impact on the extent to which students feel valued and respected. Additionally, digital notebooks are more aligned with the way digital natives have learned to do their work. Initial results suggest that digital lab notebooks lead to increased student achievement, engagement, and quality of work. Survey results revealed that students preferred digital notebooks because they allow for "easier data sharing" and increased "versatility." These results will be discussed along with implications for instruction and further research.

AH10: 9:30-9:40 a.m. Addressing Conceptual Problems in 1D Kinematics Using Interactive Online Laboratories

Contributed – Katie Ansell, University of Illinois at Urbana-Champaign, 1110 West Green St., Urbana, IL 61801; crimmin1@illinois.edu

Mats Selen, Timothy Stelzer, University of Illinois at Urbana-Champaign

Over the past 20 years, microcomputer based laboratories (MBLs) have become a common part of introductory physics courses, either in a formal laboratory setting or as part of the flipped classroom model. While student learning gains have been shown in the classroom context, little work has been done to explore the role and effectiveness of MBL technology for physics instruction outside of the classroom. In this talk we present research in which students used a brief, software-guided lesson with an Interactive Online Laboratory (IOLab) system developed at UIUC to review one-dimensional kinematics. The lesson and hands-on activities were designed to address student graphing skills and common conceptual difficulties that persisted after students received classroom instruction on the topic. This group was compared to an equivalent group that read a textbook excerpt addressing the same issues. Results of this study and implications for future work will be presented.

AH11: 9:40-9:50 a.m. Evaluations of Video Lab Reports in an Introductory Physics MOOC

Contributed – Shih-Yin Lin, Georgia Institute of Technology, School of Physics, 837 State St., Atlanta, GA 30332; hellosilpn@gmail.com

John M. Aiken, Brian D. Thoms, Georgia State University

Ed Greco, Scott Douglas, Michael F. Schatz, Georgia Institute of Technology

Marcos D. Caballero, University of Colorado-Boulder

John B. Burk, St. Andrew's School, Middleton, DE

Assessing student performance becomes challenging when course enrollment becomes very large (~10^5 students). As part of an introductory physics Massive Open Online Course (MOOC) offered via Coursera in summer 2013, students submit video reports on force and motion labs. Peer evaluation of reports provides the primary method for evaluating student laboratory work. This paper describes the methods developed and used to guide students in evaluating each others' video lab report.

Session AI: If They Make it, They Will Learn

Location: Skyline IV
Sponsor: Committee on Physics in Pre-High School Education
Date: Monday, July 15
Time: 8–9 a.m.

Presider: Nina Daye

AI01: 8-9 a.m. Series and Parallel Electric Circuits with XMAS Tree Lights

Contributed – Lynn Aldrich, Misericordia University, 301 Lake St., Dallas, PA 18612; laldrich@misericordia.edu

Make an electrical circuit setup using XMAS tree lights, wire, and brass fasteners on a cardboard backing to use with batteries to show how brightness changes from connecting one light in a circuit to connecting two lights in series or in parallel with each other. Material will be provided to make one setup to take home with you (or more setups depending on the number of attendees).

AI02: 8-9 a.m. Can You Hear Me Now?

Contributed – Nina M. Daye, Orange High School, 500 Orange High Road, Hillsborough, NC 27278; nina.daye@orange.k12.nc.us

Participants will receive materials to make a variety of low-cost musical instruments. The physics behind these instruments will be explained. The focus will be on the the connections with the Next Generation of Science Standards and the use of these instruments in the pre-high school classroom. Connections with literacy and trade books will be noted as well.

AI03: 8-9 a.m. Lever It Up

Contributed – Kathleen Falconer, Buffalo State College, 1300 Elmwood Ave., Buffalo, NY 14217; falconka@buffalostate.edu

Last year at the 2012 OATP Conference, I went to a session with Marilyn Orszulik entitled Creativity and Hands-On Learning in Elementary Science, Design and Technology Programs. It was a wonderful session and using very simple hand tools I made a lever. Then my students made levers. We all had a wonderful time and I was surprised how empowering making a simple machine, like the lever, was for my students. So we are going to make levers. Also we will look at how this activity ties into the NGSS framework. Come join us and have a good time.

AI04: 8-9 a.m. Paper Straw Pan Pipes and Oboes and their Standing Waves

Contributed – Daniel MacIsaac, Buffalo State College, 1300 Elmwood Ave., Buffalo, NY 14222; MACISADL@buffalostate.edu

Make beautiful music in your class with these simple to make instruments. We will make both straw pan pipes and paper straw oboes. We will look at the physics of sound illustrated by these cheap and easy instruments. This activity has been done with Grade 3 students to in-service teachers.

Session AJ: Labs and Activities for Sustainability

Location: Nines Hotel – Gallery 2
Sponsor: Committee on Laboratories
Co-Sponsor: Committee on Science Education for the Public
Date: Monday, July 15
Time: 8–10 a.m.

Presider: Steve Lindaas

AJ01: 8-8:30 a.m. Renewable Energy and Sustainability at Gustavus Adolphus College

Invited – Charles F. Niederriter, Gustavus Adolphus College, 800 West College Ave., Saint Peter, MN 56082; chuck@gustavus.edu

James Dontje, Jeffrey Jeremiason, Colleen Jacks, Gustavus Adolphus College

We live in an era when student interest in energy, sustainability, and the environment is increasing, as it becomes clear that our current production and consumption of energy negatively impacts the environment and raises a number of potentially significant challenges for the future. Gustavus has taken advantage of this trend by integrating renewable energy and sustainability experiences into introductory science classes in order to increase interest and enthusiasm for science. We have found that this is an excellent way to educate students about this important area while teaching quantitative skills. We will report on our NSF-CCLI funded program, including new laboratory experiences in ground source geothermal heating, photovoltaics, solar thermal, fuel cells, wind turbines, and energy content of fuels. We will also report on efforts funded by other foundations and the college, such as campus-wide energy conservation projects, Gustavus' rooftop solar thermal and photovoltaic arrays, and our composter/greenhouse combination.

AJ02: 8:30-9 a.m. Inquiry-based Investigations Using Wind Generators and Solar Panels

Invited – Jeremy Benson, Northern Illinois University, STEM Outreach, 307 Lowden Hall, DeKalb, IL 60115; JJBenson@niu.edu

Environmental sustainability and green energy are popular topics in and out of today's classroom. In this session, we'll take a look at some hands-on activities and tools available to actively engage students in the study of alternative energy sources. Investigations into building wind generators and experiments with solar power can easily be tailored to suit elementary, middle or high school students depending on the concepts included. We'll also discuss ways to relate these activities back to other scientific topics being discussed, such as work and power as well as basic electricity and circuits.

AJ03: 9-9:30 a.m. Using Mathematical Modeling to Understand the Complexities Between Energy and Society

Invited – Pat Keefe, Clatsop Community College, 1651 Lexington Ave., Astoria, OR 97103; pkeefe@clatsopcc.edu

Greg Mulder, Linn-Benton Community College

The issues related to energy in our society can be complex. Understanding basic relationships between energy production, population, and lifestyles can stimulate greater discussion and deeper exploration into energy and our society. We will discuss two spreadsheet modeling exercises that can be used in a variety of classes, seminars, and workshop formats in order to motivate students toward a better understanding of energy and its impact upon our global society.

AJ04: 9:30-9:40 a.m. An Interdisciplinary, Project-based Class in Sustainable Energy

Contributed – David P. Feldman, College of the Atlantic, 105 Eden St., Bar Harbor, ME 04609; dfeldman@coa.edu

Anna E. Demeo, College of the Atlantic

We have developed and taught an interdisciplinary, project-based course on the physics and mathematics of sustainable energy. The course's only prerequisite is high school algebra. Students do a significant solutions-based, hands-on group project. This engages learners, teaches practical skills, and helps lessen feelings of despair that some students experience when learning about energy and climate change. We emphasize back-of-the-envelope calculations and estimations, so that students gain a feel for energy units. We include a unit on basic financial mathematics, including the time value of money, discounting, and the payback time of an investment. This knowledge is essential for seeking funding for a renewable energy project. We believe that the mix of topics and activities in our class teaches important STEM content and well serves students who want to advocate for sustainable energy use. We are writing a textbook based on our course.

AJ05: 9:40-9:50 a.m. A Quantitative Comparison of Four Different Lighting Types

Contributed – Stephen A. Minnick, Kent State University, Tuscarawas, 330 University Drive NE, New Philadelphia, OH 44663; sminnick@kent.edu

Most students have little idea of the differences between the four basic types, incandescent, CFL, LED, and halogen, of household light bulbs being marketed. In order to drive home these differences and demonstrate the tradeoffs between lighting quality, efficiency, and costs, a new laboratory experiment has been developed suitable for high school and undergraduate students in basic science courses. For each lighting type, various quantities such as input power, light output, and efficiency are measured and then compared. Light quality from each bulb is determined by using inexpensive spectroscopes.

AJ06: 9:50-10 a.m. Sustainability and Energy Consumption: Course Module for High School Students

Contributed – Anindya Roy, UC Santa Barbara, Materials Department, Santa Barbara, CA 93106-5050; anindyaroy@engr.ucsb.edu

Ms. Melissa Woods from Santa Barbara High School and I worked together to develop part of a course named "Green Engineering," which she is teaching in 2012-13 to advanced high school students. Some of the main goals of the first quarter were to help students understand the basic terminologies regarding energy, power etc., and about solar photovoltaics in greater detail. In the process, they learned how to handle a different system of units, performed in-class research to find solar generation potential in California, filled out an online spreadsheet in real time to find approximate energy consumption and compared it with their classmates, and made raspberry solar cells. This exercise brought physics ideas in active, fun, and tangible forms to the students. And we learned this to be an effective way to teach them about more involved sociological concepts; e.g., the variation of individual energy consumption with socioeconomic status.

Session AK: Frontiers in Astronomy and Space Science

Location: Pavilion East
Sponsor: Committee on Space Science and Astronomy
Date: Monday, July 15
Time: 8–10 a.m.

Presider: Jeannette Lawler

AK01: 8-8:30 a.m. Engaging Undergrads in Meaningful Scientific Research with Small Telescopes

Invited – Denise C. Stephens, Brigham Young University, Department of Physics and Astronomy, Provo, UT 84602; denise_stephens@byu.edu

Eric Hintz, Brigham Young University

For the past several years we have been using a small 16-in telescope and a 0.9-m telescope to give our undergraduate physics and astronomy majors an opportunity to do meaningful scientific research that can lead to publication. These students have been able to operate both of the telescopes and collect their own data, and then have developed techniques to quickly reduce the data in order to analyze and study what they have found. With these telescopes we have followed up possible transiting planets, eclipsing binaries, and variable stars. I will discuss in more detail how we find our targets, work with the students to teach them data reduction, the analysis tools we use, and how easily this type of research can be implemented at any high school, college, or university with a small telescope and CCD camera.

Gary D. White

New *TPT* Editor Appointed

AAPT has announced the appointment of Gary Dane White as the new editor for *The Physics Teacher* (*TPT*). White, currently on leave from the American Institute of Physics as a program director at the National Science Foundation, will start as the new *TPT* editor on August 1, 2013.

White received his BS in physics from Northeast Louisiana University in 1982, and his PhD in nuclear theory at Texas A & M University in 1986. After a short stint at Oak Ridge National Laboratory, he returned to his home state, developing research interests in ion beam physics and pedagogy. In addition to teaching physics and astronomy for over a decade at Northwestern State University of Louisiana (NSU), being awarded Outstanding Teacher by the NSU Alumni Association in 1996, he taught the mathematics sequence for engineers at TAMU and, most recently, physics for non-science majors at The George Washington University. White served as the Director of the Society of Physics Students (SPS) and Sigma Pi Sigma at AIP from 2001-2012.

AK02: 8:30-9 a.m. Searching for Earth's Twin: NASA's Kepler Mission*

Invited – Edna DeVore, SETI Institute,189 Bernardo Ave., Suite 100, Mountain View, CA 94043; edevore@seti.org

Is Earth unique in the universe? Are Earth-size planets rare? Learn about NASA's Kepler Mission, which seeks to answer these questions by searching for exoplanets orbiting in the habitable zone of Sun-size stars. Launched in 2009, the Kepler spacecraft is a specialized telescope that acts like a very precise light meter, a photometer, that precisely measures changes in stars' brightnesses as planets transit. To date, Kepler has identified more than 2700 candidate planets, with many small, Earth-size planets included. Kepler will continue to observe through 2016, and is closing in on Earth's twin.

*Talk will be presented by Gary Nakagiri, SETI/Kepler EPO Specialist

AK03: 9-9:30 a.m. The Effect of Host Star Spectral Energy Distribution and Ice-Albedo Feedback on the Climate of Extrasolar Planets*

Invited – Aomawa L. Shields, University of Washington, Box 351580, Seattle, WA 98195-1580; aomawa@astro.washington.edu

Victoria S. Meadows, Cecilia M. Bitz, Tyler D. Robinson, University of Washington

Raymond T. Pierrehumbert, University of Chicago

Manoj M. Joshi, University of East Anglia

When exploring the effect of ice-albedo feedback on planetary climate, most often what is considered is the interaction between ice and our own host star, the Sun. However, ice albedo has a spectral dependence, so the ice-albedo feedback mechanism on a planet is sensitive to the wavelength of light coming from its host star. We have explored this effect using a hierarchy of models. We find that terrestrial planets orbiting stars with higher near-UV radiation exhibit a stronger ice-albedo feedback. At a fixed level of CO_2, M-dwarf planets remain free of global ice cover with larger decreases in stellar flux than planets orbiting hotter, brighter stars. At the outer edge of the habitable zone, where CO_2 is expected to increase, the spectral dependence of surface ice and snow albedo is less important, and does not extend the traditional outer edge of the habitable zone given by the maximum CO_2 greenhouse.

*This material is based upon work supported by a National Science Foundation Graduate Research Fellowship under Grant No. DGE-0718124. This work was performed as part of the NASA Astrobiology Institute's Virtual Planetary Laboratory Lead Team, supported by the National Aeronautics and Space Administration through the NASA Astrobiology Institute under Cooperative Agreement solicitation NNH05ZDA001C.

AK04: 9:30-10 a.m. Zooniverse: Cutting-Edge Research Your Students Can Participate In

Invited – Laura Whyte, Adler Planetarium, 1300 Lake Shore Drive, Chicago, IL 60616; laura@zooniverse

The Zooniverse (zooniverse.org) is a collection of research projects that rely on public participation to succeed. Since it began in 2007 with galaxyzoo.org an army of 800,000 citizen scientists have classified galaxies, analyzed light curves to detect exo-planet transits, marked features on the Moon and Mars, and looked for star clusters in Andromeda. Please join Dr. Laura Whyte, an astronomer and educator from the Adler Planetarium, to hear about the cutting-edge research that is being done by the science teams in collaboration with the participants, and to learn about new resources that are being developed to support the use of these projects in the classroom, to give your students the opportunity to become citizen scientists and make a contribution to research.

Ceremonial Session: Welcome; 2013 AAPT Teaching Awards; 2013 Homer L. Dodge Citations for Distinguished Service

Location: Grand Ballroom I
Date: Monday, July 15
Time: 10:30 a.m.–12 p.m.

Presider: Gay Stewart *Presenter: Jill Marshall*

Michael Jackson

David Halliday and Robert Resnick Award for Excellence in Undergraduate Physics Teaching, 2013 – Michael Jackson

Michael Jackson, Department of Physics, Central Washington University, Ellensburg, WA 98926-7422; jacksonm@cwu.edu

Teaching Physics and Its Role in the Survival (and growth) of a Physics Program

The past six years has been a challenging but successful period for the faculty, staff, and students in the physics program at Central Washington University (CWU). Despite budgetary cuts and reductions in faculty, the CWU physics program has about quadrupled the number of majors and has achieved double digit graduation classes in physics. This can be attributed to the implementation or continuation of a number of recommendations outlined in the SPIN-UP report including advising and mentoring, dual-degree programs, and providing all majors with an undergraduate research experience. Instilling a collective ownership of the physics curriculum and a genuine commitment to all aspects of excellent teaching has been key to creating a vibrant undergraduate physics community at CWU. This presentation will outline some of the challenges the physics department has faced during this period and provide an overview of what has changed and how these changes have been implemented.

Thomas F. Haff

Paul W. Zitzewitz Award for Excellence in Pre-College Physics Teaching, 2013 – Thomas F. Haff

Thomas F. Haff, Issaquah High School, Issaquah, WA 98027; hafft@issaquah.wednet.edu

Creating an Environment that Lets Learning Occur

Too many students are reluctant to take physics. Physics teachers are all too familiar with the reasons and arguments. When I have asked colleagues what they teach, the typical answer is “physics” or “mathematics.” At Issaquah High School, I teach students physics… not physics to students. The environment is such that the student is first and foremost. When this environment is created significant physics learning occurs.

Homer L. Dodge Citations for Distinguished Service to AAPT

Daniel H. Phelps
University of British Columbia,
St. Georges School,
and Columbia College

Bob Powell
Professor and Chair of Physics and Director of the Observatory,
University of West Georgia

CKRL01: Crackerbarrel: Physics and Society

Location: Broadway I/II
Sponsor: Committee on Science Education for the Public
Date: Monday, July 15
Time: 12–1:30 p.m.

Presider: Steve Lindaas

Join your colleagues for an informal discussion about physics-related societal issues such as energy use, global warming, nuclear power and weapons, resource extraction, and pseudoscience. Contribute your ideas about teaching these issues and communicating such information to the general public.

CKRL02: Crackerbarrel: Web Resources for Astronomy

Location: Broadway III/IV
Sponsor: Committee on Space Science and Astronomy
Co-Sponsor: Committee on Educational Technologies
Date: Monday, July, 15
Time: 12–1:30 p.m.

Presider: Kevin Lee

The growth of the Internet has placed an abundance of wonderful teaching resources at our fingertips. Simulations, data repositories, wikis, open-courseware, web-based assessment engines, and many other types of resources are transforming how we teach. This crackerbarrel will provide an opportunity for astronomy educators to see a number of these new technologies and participate in discussions of how the technologies can be incorporated into their teaching.

Session to Honor the Contributions of Bob Fuller to Physics Education

Location: Grand Ballroom I
Sponsor: AAPT
Date: Monday, July 15
Time: 1:30–3:30 p.m.

Presider: Dean Zollman

PL0401: 1:30-2 p.m. Instructional Media Development

Invited – Charles Lang, Omaha Westside High School, Box 113, Uehling, NE 68063; bclang2@aol.com

Bob Fuller and Chuck Lang worked together on four week-long workshops, nine media products, and multiple physics education presentations. The development of many of the media products involved Chuck doing the rough drafts and Bob doing much "fine tuning." Even though both spoke Nebraska English, sometimes the translations between Bob and Chuck became distorted. These situations frequently resulted in further communications, translations, and sometimes at much better product, but always an interesting story. Only some of these anecdotes will be presented

PL0402: 2-2:30 p.m. Versatile ICT-Learning Environment to Enable Context-rich and Authentic Physics Education

Invited – Ton Ellermeijer, Foundation CMA, Kruislaan 404, Amsterdam, SM 1098, The Netherlands; ton@cma-science.nl

Ewa Kedzierska, Foundation CMA

Decline in interest for physics at high school stimulated curriculum innovation in the last decade. How could we make physics more relevant, challenging and more attractive? In several European countries we decided to go for context-rich curricula and authentic practices. ICT-learning environments integrating powerful tools for measurements with sensors, advanced video-analysis and numerical modeling facilitate realistic and authentic research projects by students. Examples of these projects will be shown. These ideas are not new. With their pioneering work in the 1980s, Fuller and Zollman showed us the educational potential of the use of video in bringing reality and meaningful context in the physics classroom. Still many teachers around the world have not been able to apply these possibilities, also due to lack of training. In the framework of the ESTABLISH project (EC-funded) we now develop training and support for teachers as much as possible suitable for online use.

PL0403: 2:30-3 p.m. Games that Teach Physics Concepts to Pre-K Through Third Grade Children

Invited – Scott M. Stevens, Carnegie Mellon University, Entertainment Technology Center, Pittsburgh, PA 15219; sms@cs.cmu.edu

Michael G. Christel, Carnegie Mellon University

RumbleBlocks and Beanstalk were developed by the Entertainment Technology Center at Carnegie Mellon University to teach scientific reasoning and the principles of tower stability and center of mass (RB) and beam balancing and torque (B) to children ages 4-8. These Unity games were designed with feedback from early childhood educators and learning researchers and were influenced by pioneering educational games developed by Robert Fuller and colleagues in the 1980s. The ETC is known for an iterative, organic approach to the development of games designed to teach. Our creative methodology is rooted in the belief that unless the game is fun when compared to all games (not just "educational games"), the odds of the student being engaged by the game itself greatly diminishes and, along with the associated lack of engagement, the opportunities for deeper learning so too will diminish. This talk will describe the games, our development process, and early results from studies of the educational effectiveness of the games. This work is funded by the DARPA ENGAGE program.

PL0404: 3-3:30 p.m. Scientific Reasoning and Conceptual Change: A Legacy of Bob Fuller

Invited – Rebecca Lindell, Purdue University, Department of Physics, West Lafayette, IN 47907; rlindell@purdue.edu

Bob Fuller was one of the Physics Education community's pioneers in applying the Karplus Learning Cycle to curriculum design. Building on my work as a PhD student under Bob's direction, I have modified the Karplus Learning Cycle so that it promotes conceptual change as well as develops scientific reasoning. Using the modified Karplus Learning Cycle, I have developed curricula for multiple courses in physics and astronomy. In this talk, I will present the modified Karplus Learning Cycle, in addition to examples from the different curricula.

Session BA: Panel – Curriculum, Assessment, and Student Outcomes in the Undergraduate Program

Location: Pavilion East
Sponsor: Committee on Physics in Undergraduate Education
Date: Monday, July 15
Time: 4–6 p.m.

Presider: Andy Gavrin

The AAPT has established a task force to consider the future of the undergraduate physics curriculum. The task forced is charged with "developing specific, multiple recommendations for coherent and relevant undergraduate curricula (including course work, undergraduate research, mentoring, etc.) for different types of physics majors in collaboration with the APS and AIP, and with developing recommendations for the implementation and assessment of such curricula." Panelists will address topics and lead a discussion.

Speakers:
– *Robert C. Hilborn, American Association of Physics Teachers*
– *Ernie Behringer, Eastern Michigan University*

Session BB: Demo and Lab Ideas for the H.S. Physics Classroom

Location: Galleria II
Sponsor: Committee on Apparatus
Co-Sponsor: Committee on Physics in High Schools
Date: Monday, July 15
Time: 4–6 p.m.

Presider: Ray Polomski

BB01: 4-4:30 p.m. Fun and Insightful Demonstrations for High School Teachers

Invited – Ralf Widenhorn, Portland State University/Science Outreach Society, SRTC, 1719 SW 10th Ave., Room 134, Portland, OR 97201; ralfw@pdx.edu

Justin Dunlap, Elliot Mylott, Lester Lampert, Elizabeth Anderson, Portland State University/Science Outreach Society

We will present a number of demonstrations for the high school physics classroom covering a range of topics. The presentation is done by Portland State University's Science Outreach Society and physics high school teachers and demonstrators from Oregon, led by Ralf Widenhorn. The presentation includes time for discussion and questions and contributions throughout the half hour.

BB02: 4:30-5 p.m. More Demonstration Ideas for the H.S. Physics Classroom

Invited – David E. Sturm, University of Maine, Department of Physics & Astronomy, 5709 Bennett, Orono, ME 04469-5709; sturmde@maine.edu

Adam Beehler, University of Utah

Sam Sampere, Syracuse University

David Maiullo, Rutgers University

We continue the presentation of demonstrations for the high school physics classroom. This presentation includes PIRA and national physics demonstrators, led by D. Sturm (PIRA representative to AAPT). Includes time for discussion and questions, and contributions from participants throughout the half hour. (Part 2 of 2).

BB03: 5-5:30 p.m. Exploring Electricity and Circuits from a Battery's Perspective*

Invited – John P. Lewis, Glenbrook South High School, 4000 West Lake Ave., Glenview, IL 60025; jlewis@glenbrook225.org

Tiberiu Dragouiu-Luca, Hillsborough High School, Hillsborough, NJ

Exploring electricity from the perspective of the battery provides a rich, data-driven, laboratory-centered experience for students which propels them to understand practical applications of electrical energy including battery life, energy storage, and the difference between power and work. Connecting batteries in series and parallel while measuring the potential difference and current provided in each case leads students to experimental revelations that far exceed more traditional approaches to the studies of electric circuits. Students put batteries to the test to determine answers to real-world questions like, "Which battery provides the greatest value for my dollar?" "Why doesn't a flashlight give me a hint when it is about to fail?" or "How does the cost of energy provided by a commercial battery compare to that provided by our electrical power companies?" This session will share the benefits and challenges of undertaking this type of study and will provide ample time for participants to reflect, question and discuss.

*This research was developed and supported by the "Introductory Physics Laboratory Writing Conference" A joint project of Lee College, Estrella Mountain Community College and the National Science Foundation.

BB04: 5:30-6 p.m. A Common "Cents" Lab

Invited – Duane L. Deardorff, University of North Carolina at Chapel Hill, CB 3255, Chapel Hill, NC 27599-3255; duane.deardorff@unc.edu

This simple laboratory activity provides a basic introduction to measurements and their uncertainties while challenging students to use critical thinking and reasoning skills. By taking measurements of mass, diameter, and the thickness of pennies, students calculate the average density of these coins and often find that their results do not agree with other students or the theoretical value based on the metal composition. The reasons for these discrepancies provide valuable lessons for students. An overview of this activity along with typical results will be presented.

Session BC: Engineering in the Physics Classroom

Location: Galleria I
Sponsor: Committee on Physics in High Schools
Date: Monday, July 15
Time: 4–5:40 p.m.

Presider: Susan Johnston

BC01: 4-4:30 p.m. Strategies for Bringing Back the "T&E" in STEM

Invited – Duane B. Crum, San Diego State University, 5500 Campanile Drive, San Diego, CA 92182-1328; dcrum@engineering.sdsu.edu

When modern physics was first introduced to high schools in the 1950s, it provided much better alignment with college physics but introduced a number of unintended consequences. Most importantly, the "T&E" in STEM was largely removed from high school course offerings. Today, as the STEM phenomenon grows exponentially, schools struggle to reincorporate "T&E". Our economy is driven by technology and fields of engineering that didn't even exist 20 years ago. Introducing our students to this information is critical but, with budget cutbacks and reductions in class periods, adding this material is difficult at best. Adding such material to a physics class is nearly impossible without changes to the standards. Successful strategies for dealing with this problem in high schools and middle schools will be discussed. Project Lead the Way will be described as one example of a successful program that is helping to solve these problems.

BC02: 4:30-5 p.m. Teaching Green Engineering and Physics with Project Lead the Way

Invited – Michael J. Waltz, Livermore High School, 600 Maple St., Livermore, CA 94550; mwaltz@lvjusd.k12.ca.us

Project Lead the Way (PLTW) is primarily known as a source of Pre-Engineering curriculum which helps students in grades 7-12 prepare for college through hands-on, project-based learning. Many of the engineering topics in this curriculum overlap with the high school physics curriculum. Additionally, the PLTW curriculum contains many projects that already have "Green" components or that can be modified to teach renewable energy, energy efficiency, and recycling. The Green Engineering Academy at Livermore High School has combined PLTW, Physics, and Green Engineering topics in an innovative new course.

BC03: 5-5:10 p.m. Research Experience for Teachers: Creating an Automated Waste Sorting Device

Contributed – James B. Hancock II, Central Michigan University, DOW Science, 215 Mt. Pleasant, MI 48859; james.brian.hancock@gmail.com

Tolga Kaya, Central Michigan University

Based on the automated waste sorting competition from the American Society of Mechanical Engineers (ASME), the participants in this Research Experience for Teachers (RET) designed and fabricated a device used to sort recyclable materials. The purpose of the RET was to expose current and future teachers to engineering processes and how they relate to content standards covered in the NGSS. Working closely with an undergraduate engineering student and a CMU faculty member, the preservice and in-service teachers developed a plan to create a robot with the capability of autonomously sorting glass, plastic, aluminum, and tin recyclables. Lego Mindstorms NXT 2.0 were used as the computer and sensing devices for the project. Extensive fabrication and revision were required to create the final waste sorter. The principles of engineering research to be incorporated in a 7-12 grade classroom include research, development, fabrication, and prototyping elements.

BC04: 5:10-5:20 p.m. Designing a Model Rocket to Deliver Air Quality Sensors

Contributed – Kathleen Melious, T Wingate Andrews High School, 1900 Cana Road, Mocksville, NC 27028; meliouk@gcsnc.com

James P. Healy, UNCG

Shan Faizi, Kyle Payton, Thomas Lyons, Blake Compton, T Wingate Andrews High School

In 2013 the EPA estimates that it will spend close to $1 billion on projects related to improving the air quality of the United States. [1] While the air quality across a community is easily monitored at ground level, crucial data about the health of an area's atmosphere can be obtained by monitoring conditions at low altitudes (100-800 meters) across a community.[2] The goal of our project is to construct a delivery system for air quality sensors from commonly available amateur rocketry supplies. The delivery system must be reliable in delivering the payload to a constant and reproducible altitude as well as allowing for safe and reliable recovery of the system after each flight.

1. FY 2013 - EPA Budget in Brief, www.epa.gov
2. Campaign to diagnose air quality concludes in California, http://climate.nasa.gov/news/870 Blake Compton T Wingate ANdrews High School

BC05: 5:20-5:30 p.m. Ice Investigations for Physics Students – A Post AP-Exam Opportunity

Contributed – Mark T. Buchli, Liberty High School, 16655 SE 136th St., Renton, WA 98059; buchlim@issaquah.wednet.edu*

How can a year of physics instruction be topped? Take those bright students into a complex research setting and see what they can do. Ice Investigations for Physics Students challenges AP physics students in two areas: a) the physics of sea ice (experiments in thermodynamics & light transmission) and b) working with Arctic Sea Ice data in predicting and analyzing spatial and temporal trends in sea ice extent. Experiments will be described, resources will be presented, and design possibilities will be discussed in an engaging format. This project is supported by a National Science Foundation grant through the Polar Science Center at the Applied Physics Lab - University of Washington.

*Sponsored by Tom Haff

BC06: 5:30-5:40 p.m. Promote the "E" in STEM: Renewable Energy Connect Engineering Research*

Contributed – Lisa L. Grable, NC State University, 749 Powell Drive, Raleigh, NC 27606; grable@ncsu.edu

Power-related activities from The Science House, NC State University (in partnership with the NSF FREEDM Systems Center) will be presented. Learn techniques for middle and high school hands on wind, solar, capacitors, and more! Renewable energy activities will be presented as eight crosscutting concept stations. The activities are appropriate for middle or high school and include endothermic reaction; batteries, bulbs, and capacitors; solar panel; wind turbine; fruit battery and more. The activities connect to the electrical engineering research being done by the FREEDM Systems Center (Future Renewable Electric Energy Delivery and Management). The activities are based in inquiry (scientific and engineering practices) and include data collection and analysis. They are intended to introduce students to the renewable energy work of power engineers. (www.science-house.org/freedm)

*Project is supported in part by NSF Award #EEC-0812121.

Session BD: Panel – Massively Open Online Courses

Location: Broadway III/IV
Sponsor: Committee on Educational Technologies
Date: Monday, July 15
Time: 4–6 p.m.

Presider: Danny Caballero

Massively Open Online Courses (MOOCs) are a new part of the 21st century educational landscape. MOOCs provide free access to instruction in many areas (including physics) and have been heralded as a major positive change in higher education. However, many MOOCs employ ineffective and impersonal instructional methods (e.g., lecture) and have been written off as just another educational fad. As we begin to make sense of these new environments, we must discuss how to incorporate educational best practices into MOOC instruction and investigate the outcomes of such instruction. In this panel discussion, Dave Pritchard and Michael Schatz will discuss the design of two different introductory physics MOOCs and present preliminary data on how students participate and succeed in these new online learning environments. Each speaker will present for 30 minutes and a one-hour open discussion will follow. This session will be broadcast online as part of AAPT's alternative access initiative.

BD01: 4-6 p.m. MIT Open Online Physics Courses Are Research Goldmines[1]

Panel – David E. Pritchard, MIT, Room 26-241, 77 Mass. Ave., Cambridge, MA 02140; dpritch@mit.edu

Daniel Seaton, Yoav Bergner, Colin Fredericks, Gerd Kortemeyer, MIT

MOOCs offer research opportunities based on data mining from their time-stamped log of everything students do in a complete learning environment. We report on student distribution of time on various tasks, fraction of each resource used, and particularly on e-text usage. e-text usage depends dramatically on course structure, but is similar for OOCs, distance courses at MSU, and blended courses at MSU and MIT. Data will be drawn from ~14 MSU physics courses on LONCAPA.org, ~8 MIT courses on edX, and the 2 RELATE administrations of Mechanics ReView (http://relate.mit.edu/physicscourse/), an open enrollment course that uses the MAPS Pedagogy[2] to develop both more expert-like organization of core mechanics knowledge and more systematic problem solving skills. ReView includes hundreds of assessment questions, many based on results from physics education research, most of them available on LON-CAPA. The previous and current summer versions of ReView are aimed at practicing teachers and offer CEUs.

1. We acknowledge support from NSF and MIT, and important help on the course from Andrew Pawl, Saif Rayyan, and Raluca Teodorescu.
2. AIP Conf. Proc. 1179, pp. 51-54 (2009).

BD02: 4-6 p.m. An Introductory Physics MOOC with a Lab

Panel – Michael F. Schatz, Georgia Institute of Technology, School of Physics, Atlanta, GA 30332; mike.schatz@physics.gatech.edu

Numerous Massive Open Online Courses (MOOCs) have been devised for advanced/upper level coursework; by contrast, relatively few MOOCs have, to date, focused on introductory courses. We describe a Gates Foundation supported effort to develop a college-level introductory physics course that will offer bona fide laboratory experiences that are arguably superior to experiences in laboratories for typical large lecture introductory physics courses. The course will be offered on Coursera in summer 2013.

Session BE: PER: Teacher Preparation and Professional Development

Location: Pavilion West
Sponsor: AAPT
Date: Monday, July 15
Time: 4–5:20 p.m.

Presider: Hunter Close

BE01: 4-4:10 p.m. Comparison of In-Service and Preservice Teachers

Contributed – Karen J. Matsler, UT Arlington, 502 Yates/SH 224, Arlington, TX 76001; kmatsler@uta.edu

The UTeach program is answering the urgent call for more qualified math and science instructors across the nation, including physics teachers. The program is a collaborative effort between university science and education departments designed to produce teachers who are confident and competent in STEM subject matter. A recent study revealed that between 2003-2008, 39% of all science teachers in Texas taught more than one subject and approximately half of those were certified in composite science but ended up teaching physics upon graduation. Hence the need in the physics community to engage in helping future teachers develop in both content knowledge and knowledge of how students learn. We will report on a study by UTeach programs at the University of Texas Austin and Arlington to compare content understanding and confidence of UTeach preservice physics majors and non-majors to in-service teachers who participated in the national PTRA program between 2003 and 2008.

BE02: 4:10-4:20 p.m. Analysis of Preservice Teachers' Reflections on Teaching

Contributed – Marianne Vanier, Rutgers University, 10 Seminary Place, New Brunswick, NJ 08901-1183; marianne.vanier@rutgers.edu

Marina Malysheva, Eugenia Etkina, Rutgers University

Preservice physics teachers at Rutgers University teach laboratories and recitations in a reformed introductory physics course as part of their teacher preparation program. They reflect on their weekly teaching experiences on a Google group page. We developed a coding scheme to analyze their reflections and analyzed patterns in the reflections (total of 300 journal entries). We focused on the dependence of the content and depth of reflection on the class material and the time of teaching (before or after student teaching). In this talk we will present the patterns that emerged.

BE03: 4:20-4:30 p.m. Does Higher Education Increase Student Scientific Reasoning Skills?

Contributed – Rachel E. Scherr, Seattle Pacific University, 3307 Third Ave. W, Seattle, WA 98119; rescherr@gmail.com

Amy D. Robertson, Lane Seeley, Stamatis Vokos, Seattle Pacific University

"Content knowledge for teaching" is the specialized content knowledge that teachers use in practice—the content knowledge that serves them for tasks of teaching such as making sense of students' ideas, anticipating conceptual challenges students will face, selecting instructional tasks, and assessing student work. We examine a middle school physical science teacher's interactions with a group of students for evidence of content knowledge for teaching energy (CKT-E). Our aim is not only to better understand a single teacher's practices but also to develop criteria for observational assessment of CKT-E.

BE04: 4:30-4:40 p.m. Learner Understanding of Energy Degradation*

Contributed – Abigail R. Daane, Seattle Pacific University, 3307 3rd Ave. W, Seattle, WA 98119; abigail.daane@gmail.com

Stamatis Vokos, Rachel E. Scherr, Seattle Pacific University

Learners' everyday ideas about energy often involve energy being "used up" or "wasted." In physics, the concept of energy degradation can connect those ideas to the principle of energy conservation. Learners' spontaneous discussions about aspects of energy degradation have motivated us to introduce new learning goals into our K-12 teacher professional development courses. One of our goals is for teachers to recognize that since energy degradation is associated with the movement of some quantity towards equilibrium, the identification of energy as degraded or free depends on the choice of the objects involved. Teacher discussions of a particular energy scenario (about a wind-powered heating system) led to productive conversations about the nature of energy degradation and its possible dependence on the choice of what to include in the scenario.

*This material is based upon work supported by the National Science Foundation under Grant No. 0822342.

BE05: 4:40-4:50 p.m. Interactive Laboratory Experience – Closing the Knowledge Gap

Contributed – Mark D. Greenman, Boston University, Boston, MA 02215; greenman@bu.edu

During the summers of 2008 through 2012 five cohorts totaling 114 secondary school teachers responsible for teaching physics concepts enrolled in a Massachusetts Department of Elementary and Secondary Education funded summer institute hosted at area universities to enhance the teachers' physics content knowledge and to improve their use of research-based best practices in teaching physics. The content knowledge gap between male and female science teachers was reduced from a gap of 25% to 6%, and the gap between physics majors teaching physics and other science majors teaching physics was reduced from a gap of 31% to 8%. The average paired fractional gain (measured using the FMCE) for these participants was .68 with teachers in every comparison group showing strong gains (.57 to .74). Just as encouraging, these gains showed little decay over time.

BE06: 4:50-5 p.m. From "Cookbook" to Inquiry-based Laboratory: Assessing Physics Teachers' Professional Development

Contributed – Zehorit Kapach, Weizmann Institute of Science, Department of Science Teaching, 234 Herzl St., Rehovot, Israel 76100; Kapach@weizmann.ac.il

Bat-Sheva Eylon, Bagno Esther, Weizmann Institute of Science

This study was carried out in a Continuing Professional Development (CPD) program for high school physics teachers aiming to integrate Inquiry-based Laboratory activities into their practice. How can one assess teachers' development in such a program? Discourse analysis of interviews with teachers and audiotaped CPD meetings indicate that during the program the criteria used by teachers to describe their views and experiences changed. For example, in discussing views about the essence of inquiry teaching: initial narrow literal interpretations ("inquiry is carrying out an experiment"), then reflective descriptions about the role of inquiry in meaningful learning and finally considering inquiry beyond the laboratory (transfer). Similar changes were observed for various inquiry skills such as communication: initial literal interpretation ("communication is preparing a ppt"); then reflective negotiation of meaning with peers; and finally transfer to additional applications. We suggest that this kind of analysis is a powerful tool for assessing teachers' professional development

BE07: 5-5:10 p.m. Navigating Disequilibrium between Pedagogy and Epistemology: Exploring Preservice Teacher Tensions

Contributed – Richard P. Hechter, University of Manitoba, Faculty of Education, CTL, Room 234, Education Building, Winnipeg, MB R3T 2N2, Canada; richard.hechter@ad.umanitoba.ca

The purpose of this paper is to explore the tensions of preservice teachers in terms of their pedagogical orientations towards integrating different modes of representation, namely; visual, graphical, symbolic, and numerical, to enhance student learning against their self-reported epistemological framework. Data were collected from preservice physics teachers (n=8) through semi-structured problem-solving and critical-thinking interviews before and after their teaching practicum experience. Data were analyzed through qualitative research methods to identify emerging themes and positions. Results indicate that although preservice teachers were aware of their individual tendencies towards integrating multiple modes of representation into their pedagogy, participants reported low-efficacious behaviour towards helping students who deviated from their own epistemological framework and perspective. As this disequilibrium tends to manifest frequently for novice and beginning secondary-level physics teachers, especially where students' mathematical and conceptual fluency vary, the implications of this research includes physics teacher preparation and professional development strategies.

BE08: 5:10-5:20 p.m. Why They Cannot Solve the Problem Although They Know How Already

Contributed – Ji Won Lee, Korea National University of Education, 411-e Science building, San 7, Darakri, Gangnaemyon Chong Won, Chung-Buk 363-791, S. Korea; ljiwony@naver.com

Jung Bog Kim, Korea National University of Education

We investigated through an atypical problem the features of science teachers' problem solving processes and why they could not solve the problem even though they already had the key knowledge needed. We found that they could solve another typical problem using the key knowledge. We analyzed the problem solving process of 18 science teachers in explaining the contradictory situation. Science teachers had not been able to solve the problem because they could not recall the answer although the key knowledge exists in their knowledge structure. And they rejected the scientific model even though they heard the correct explanation. Also, they made ad hoc hypotheses upon ignoring their existing knowledge structure. But because sometimes ad hoc hypothesis has been the key for problem solving in science history, so we propose that it is related with creativity.

Session BF: Education Research at the Boundary of Physics and Biology

Location: Skyline IV
Sponsor: Committee on Research in Physics Education
Date: Monday, July 15
Time: 4–6 p.m.

Presider: Mel Sabella

BF01: 4-4:30 p.m. Designing an Interdisciplinary Physics Course to Support Scientific Reasoning Skills

Invited – Vashti Sawtelle, University of Maryland, 082 Regents Drive, College Park, MD 20742; vashti.sawtelle@gmail.com

Chandra Turpen, University of Maryland, College Park

Julia Gouvea, University of California, Davis

Our course in Introductory Physics for Life Science (IPLS) majors at the University of Maryland works to bridge the disciplines of biology and physics with a primary focus on developing students' scientific reasoning skills. These include developing students' abilities (1) to know when and how to use different concepts, (2) to make and justify modeling decisions, and (3) to make implicit assumptions visible. Our interdisciplinary course provides students an opportunity to examine how these decisions may differ depending on canonical disciplinary aims and interests. Our focus on developing reasoning skills requires shifting course topics to focus on core ideas that span the disciplines as well as foregrounding typically tacit disciplinary assumptions. In this talk we present concrete examples from our IPLS course to give a sense of what it looks like to implement a vision focused on these reasoning skills in an interdisciplinary classroom.

BF02: 4:30-5 p.m. Introductory Physics in Biological Context

Invited – Catherine H. Crouch, Swarthmore College, 500 College Ave., Swarthmore, PA 19081; ccrouch1@swarthmore.edu

Physics is an increasingly important foundation for today's life sciences and medicine (hereafter "the life sciences"). However, the physics content and ways of thinking identified by life scientists as most important for these fields are often not taught, or underemphasized, in traditional algebra-based college physics courses. Furthermore, such courses rarely give students practice using physics to understand the life sciences in a substantial way. Consequently, students are unlikely to recognize the value of physics to their chosen fields, or to develop facility in applying it to biological systems. In this talk I will present common themes among reformed introductory physics for the life sciences (IPLS) courses that are organized around significant life science applications of physics, describe the guiding pedagogical principles and the process of developing and implementing such courses, present initial assessment data, and identify directions for further development and research.

BF03: 5-5:30 p.m. Preparing to Teach IPLS: Motivations, Challenges, and Resources

Invited – Juan R. Burciaga, Mount Holyoke College, Department of Physics, 50 College St., South Hadley, MA 01075; jburciag@mtholyoke.edu

The physics community is experiencing a growing pressure to reform the Introductory Physics Courses for the Life Sciences (IPLS). Part of this pressure for reform is external (e.g., the changing nature of biological research or the revision to the MCAT) and part is internal (e.g., faculty dissatisfaction with the traditional course). And as faculty turn their attention to reform efforts, we encounter many challenges and barriers, some expected but many unexpected, and far too many intransigent. What is the source of this demand for reform? How can an individual faculty respond to this demand? What are the barriers to both local and community-wide reform? What resources exist, or are being developed, to aid individual faculty and the physics community as a whole to respond to the groundswell of change? The paper will summarize, and expand on, the discussions that members of the physics community have been pursuing over the last four years.

BF04: 5:30-6 p.m. Exploring "Thinking Like a Biologist" in the Context of Physics

Invited – Kimberly D. Tanner, San Francisco State University, 1600 Holloway Ave., San Francisco, CA 94132; kdtanner@sfsu.edu

University biology education aims to produce students with biological expertise, which includes not only accrual of biological knowledge, but also organization of that knowledge into a biological framework. The recent publication of "Vision and Change in Undergraduate Biology Education" includes such a framework that can be used to prioritize what biology students are learning and to help them organize this information. This framework asserts only five fundamental biological principles: 1) structure-function relationships, 2) pathways and transformations of energy and matter, 3) interconnected systems, 4) information flow, and 5) evolution. So, how might these principles inform the development of physics courses for life science students? To what extent might these fundamental organizing principles of biological expertise align with physics principles? To what extent might they be in conflict? And how could we begin to measure how students navigate, integrate, or segregate these organizing principles across the disciplines of physics and biology?

Session BG: Teaching Physics Around the World

Location: Parlor A/B
Sponsor: Committee on International Physics Education
Date: Monday, July 15
Time: 4–5:30 p.m.

Presider: Colin Fredericks

BG01: 4-4:30 p.m. Challenging the Status Quo: Experiences in Producing Lasting Curricular Change

Invited – Ian G. Bearden, University of Copenhagen, Niels Bohr Institute, Blegdamsvej 17, Copenhagen, NA 3460, Denmark; bearden@nbi.dk

We are currently redesigning the experimental component of our curriculum. This project has grown from a desire to ensure that all students master what we consider the basic experimental skills and competences required of physicists. In addition to traditional components of an experimental physics curriculum such as data analysis, error propagation, experimental procedures, etc., we aim to explicitly focus on other skills that are of vital importance to all physicists, regardless of whether they follow an academic or industrial career. Among these are oral and written communication, project planning and management, critical thinking, and team work—all skills that are often assumed to be obtained by students despite the lack of explicit focus on them in traditional curricula. This talk will give an overview of the initial stages of this process, with a focus on the difficulties encountered in effecting change in a conservative academic environment, and will discuss possible future strategies for successfully navigating dangerous academic waters.

BG02: 4:30-5 p.m. Physics Teaching in Spain

Invited – David Méndez Coca, Centro Universitario Villanueva, Costa Brava, 4, Madrid, 28034 Spain; dmendez@villanueva.edu

At the beginning of the century, the percentage of early abandon of the studies in Spain was 30% whereas in the EU it was 17%. Only 56% of 15-year-old students study in the year according to their age. In science, the number of students who choose the physics degree has decreased from 2000/01 to 2009/10 in 43%. The physics scholar studies start at the age of seven although the first subject of physics can be studied at the age of 17, the last year before the university studies. The research in physics education is not very wide, there is no journal of physics education, there is only one Spanish congress about physics in general each two years. In this congress there are communications about physics education. In Spain, physics education is always included in science education.

BG03: 5-5:10 p.m. Bringing Developing World Meaning to Our Physics Classrooms and Laboratories

Contributed – Stephen J. Mecca, Providence College, Department of Engineering-Physics-Systems, 1 Cunningham Square, Providence, RI 02918; smecca@providence.edu

Physics teaching-learning and research that have relevance and meaning in the developing world offers benefits to learners in our classrooms in the U.S. and to students and others living in rural communities in the developing world. This paper will describe the authors' experiences in three programs designed to impact participants in the U.S. and Ghana. A conceptual physics course for non-science majors has been offered at Providence College with a goal to produce a workbook of demonstrations, activities, and experiments to help junior high school girls in a village in Ghana master selected concepts in physics. The four-year experience of a Community Based Student Internship (CBSI) focusing on real problems in developing communities is also discussed. The CBSI partners university students from the U.S. with students from Ghana to address pressing problems in health, education, and the environment. Finally, the author's and his student's research in the S-lab in the Department of Engineering-Physics-Systems at Providence College and its global implications will be presented.

BG04: 5:10-5:20 p.m. Secondary School Physics in Shanghai, China, and Orange County, California, U.S.

Contributed – Kevin C. Yang, Mission Viejo High School, 25702 Minoa Drive, Mission Viejo, CA 92691; candokevin@hotmail.com

Using surveys and information from government/school websites, this study compares secondary school physics education in Orange County (OC), California to that of Shanghai (S), China. 18(S)/19(OC) schools were included in this study. There is a lower students / teacher ratio (S: 100±13 vs. OC: 1494±713.6, p<0.0001) in Shanghai's middle (8-9th)/high school (10-11th) where students receive 2/4 years of mandatory physics (240/500 instructional hours). Only 18.9% of OC students complete one year of physics (180 hours) by the end of 11th grade. None of the 2618 accredited four-year U.S. universities require the physics SAT II for freshman admission. 49608 U.S. students took the SAT II physics exam compared to more than 2 million taking the SAT I or the 4.57 million Chinese students taking a required physics examination for college admission. To improve secondary school physics education, physics exams should be heavily incorporated into the U.S. college admission process.

BG05: 5:20-5:30 p.m. Practical Study of Extracurricular Learning and Development Patterns of Physics Students*

Contributed – Fuli Zhao, Sun Yat-sen University, School of Physics and Engineering, 510275, China 135, Xingangxi Road, Haizhu District Guangzhou, GD 510275, P.R. China; stszfl@mail.sysu.edu.cn

Donghua Yang, Min Chen, Biao Wang, Sun Yat-sen University

With the progressing development of economic globalization and increasingly fierce international competition, we need groups of high-quality innovative talents to enhance the overall scientific and technological innovation capacity and competitiveness while also improving the visibility of students on the international stage. Accordingly, the cultivated talents should develop a more open vision, more novel awareness, and a more proactive learning attitude. They will be more sensitive to new things, have stronger practical capacities, and have the courage to break through routines to conduct their work more innovatively. Therefore we have established a talent cultivation philosophy of "Profound Foundation, Wide Range, Internationalization, Value Innovation" in the physics education and have explored the extracurricular learning and development pattern of physics students in order to promote a well-rounded development.

*This work was supported by National Science Fund for Talent Training in Basic Science of China.

Session BH: Implementations of Modeling Instruction for Different Audiences

Location: Salon Ballroom II/III
Sponsor: Committee on Physics in High Schools
Co-Sponsor: Committee on Research in Physics Education
Date: Monday, July 15
Time: 4–5:30 p.m.

Presider: Renee Michelle Goertzen

BH01: 4-4:30 p.m. Modeling Instruction in University Physics

Invited – Eric Brewe, Florida International University, 11200 SW 8th St., Miami, FL 33199; ebrewe@fiu.edu

We describe the ongoing process of adapting Modeling Instruction from the high school Modeling Instruction curriculum and workshop project to university physics. This project has highlighted the strengths of the high school project and has taken advantage of the opportunities to develop new materials and approaches to content and especially pedagogy. We describe the advantages and challenges of adapting the highly successful Modeling Instruction to university physics. In this talk we draw on the lessons learned from Modeling Instruction in high school and then we showcase our take on curriculum and dissemination efforts.

BH02: 4:30-5 p.m. Modeling in Middle School: NGSS and the STEM Connection

Invited – Colleen Megowan-Romanowicz, American Modeling Teachers Association, 2164 E Ellis Drive, Tempe, AZ; amtaexec@realstem.com

For 20 years Modeling Instruction has helped high school physics students to ask questions, develop and use models, plan and carry out investigations, analyze and interpret data, use mathematics and technology to do computational thinking, engage in arguments from evidence, evaluate and communicate information...in short, to do science as scientists do. With the advent of the NGSS these practices are expected to frame the way science is done by ALL children at ALL grade levels. I will describe a new program of Modeling Instruction-based content courses for middle school science and mathematics teachers developed and piloted over the past four years. These courses are designed to help teachers re-model their teaching practice to incorporate the science and engineering practices mentioned above, improve their disciplinary content knowledge, and ground their teaching in engaging STEM applications.

BH03: 5-5:10 p.m. Localized Physics Reform in a Cogenerative Modeling Learning Environment

Contributed – Natan Samuels, Florida International University, 11200 SW 8th St., Miami, FL 33199; nsamu002@fiu.edu

Renee Michelle Goertzen, Eric Brewe, Laird Kramer, Florida International University

We describe research into CMPLE—the Cogenerative Mediation Process for Learning Environments. CMPLE is a formative process that physics instructors have used to facilitate cogenerative dialogues, support local reform, and guide their changes in practice. Based on their collective learning preferences, students and instructors negotiate, develop, and implement changes to their classroom behaviors and structure. We have traced a high school Physics Modeling instructor's semester-long implementation of CMPLE through data sources such as classroom videos and artifacts, as well as interviews. The instructor's changes in practice developed from her expanding understanding of her students' preferences and classroom experiences. She also described a greater understanding of the modeling process. Our Activity Theory-based analysis has identified the instructor's general change process as 1) questioning about areas of concern, 2) analyzing the current state of affairs, 3) constructing a new model of behavior, 4) implementing the new model, and 5) evaluating changes.

BH04: 5:10-5:20 p.m. Interactive and Constant Force Models Discourse for High School Freshmen and Seniors

Contributed – Igor V. Proleiko, McKinley Classical Leadership Academy, 2156 Russell, St. Louis, MO 63104; igor.proleiko@slps.org

Modeling Instruction could be used with both high school freshmen and seniors. The process for model deployment is the same, however the structure and scaffolding differs somewhat between the level of the class. The example of questioning for different classes is to be presented and discussed.

BH05: 5:20-5:30 p.m. Whole Class "Board" Meetings in Modeling-based Introductory University Physics

Contributed – Brant Hinrichs, Drury University, 729 N. Drury Lane, Springfield, MO 65802; bhinrichs@drury.edu

This talk describes whole-class whiteboard meetings and gives examples of how they are used in a calculus-based introductory physics course taught using modeling instruction. Students in one section of the course are divided into six groups of four to five students each. Each group creates a solution to the same problem on a small whiteboard. The groups then form a large circle in the center of the classroom with their whiteboards on the ground, resting against their knees, facing out to the rest of the group. The instructor is outside the circle and interjects only rarely, if at all. The goal of the discussion is to come to a consensus on the "best" answer to the given problem. Examples are given of some of the amazing conversations students can have in such a format. Students are learning the epistemology of science by actively engaging in it every class.

Session BI: Panel – Teaching Controversial Topics

Location: Broadway I/II
Sponsor: Committee on Science Education for the Public
Co-Sponsor: Committee on Space Science and Astronomy
Date: Monday, July 15
Time: 4–6 p.m.

Presider: Stacy Palen

Grand societal challenges such as climate change, peak energy, and hydraulic fracturing require thoughtful, creative, and considerate discussions. Join our panel to discuss methods to approach controversial subjects in the classroom.

BI01: 4-6 p.m. When Science Says No

Panel – Tom Murphy, UCSD, 9500 Gilman Drive, MC 0424, La Jolla, CA 92093-0424; tmurphy@physics.ucsd.edu

Our society relishes futuristic projections of Utopian life, often set in space. Students are especially prone to such outlooks, informed in no small part by virtual/escapist experiences provided by a wide array of media. The grittier truth is that the present century brings grand-scale challenges unprecedented in the human experience as unchecked growth interests collide with a finite Earth. This will likely show up in many domains at once, including energy availability, water, food, population, and climate stability. Inevitably, the public will sense a shift in the aggregate message of science from what "is" possible toward what "isn't." In the classroom, we can prepare students to understand fundamental aspects of the challenges we face via estimation/order-of-magnitude quantitative analysis, aided by stark--and sometimes amusing--extrapolations, analogies, surveys, and thought-provoking millennial-scale perspectives.

BI02: 4-6 p.m. Teaching Controversial Topics in Physics Courses

Panel – Art Hobson, University of Arkansas, Department of Physics, Fayetteville, AR 72701; ahobson@uark.edu

The conceptual physics course I developed in 1975 at the University of Arkansas is now taught to nearly 1000 introductory non-science students per year. It is based on my textbook, "Physics: Concepts & Connections" (Pearson/Addison-Wesley, 5th edition 2010), a general introductory conceptual physics textbook emphasizing physics-related social topics and modern physics. Students say they especially enjoy the social topics. The scientific process, according to which we learn via evidence and reason, is the frequently-recurring theme. Other social topics, in order of appearance, are pseudoscience, transportation and energy, electric power plants, exponential growth, ozone depletion, global warming, radioactive dating, the geological ages, biological effects of radiation, technological risk, nuclear weapons, nuclear terrorism, the energy future, nuclear power, fossil fuels, renewable energy, and energy efficiency. Many of these bear on controversial religious and political issues. I will discuss how I deal with such controversies.

BI03: 4-6 p.m. Advocating for Controversial Science Topics in Congress

Panel – Aline D. McNaull, American Institute of Physics, One Physics Ellipse, College Park, MD 20740; amcnaull@aip.org

Policymakers and their staff rely on the science community to provide resources and advice on a wide range of science topics. Some scientific subjects, such as climate change and evolution, have become the source of significant political debate. In this talk I will address how science advocates approach Members of Congress regarding research funding and support for topics that have been deemed politically "questionable." When describing a scientific process, it is important to consider certain phrases that have been deemed "wrong" to non-science audiences and reflect on how scientific terms are perceived if they are not well understood. Of equal importance is the ability to see both sides of any issue, whether or not one side is uncontroversial to the scientific community. The ability to perceive and address misconceptions while at the same time leveraging economic and social interests provides a context for understanding research and development.

BI04: 4-6 p.m. Teaching Climate Change Science in a Skeptical World

Panel – Minda R. Berbeco, National Center for Science Education, 420 40th St., Oakland, CA 94609; berbeco@ncse.com*

Though the scientific consensus around human causes of climate change are clear, the public remains skeptical, making it challenging for educators to teach well-established, peer-reviewed science to their students. Furthermore, the implications for climate change can be emotionally disturbing for students to learn, potentially leading to a sense of disillusionment. How do teachers address the science of climate change without scaring students? How do they address challenges from students, parents, administrators and even other educators that are based in political ideology? The National Center for Science Education is using its 30 years of experience countering science denial in evolution education to support, educate, and counter denial in climate change education. As climate change science is increasingly integrated in public education in coming years, teachers will need to take advantage of the strong scientific network that has been established to support teachers, debunk myths, and provide quality educational materials.

*Sponsored by Steve Lindaas

Session BJ: Evolving Practices of Teacher Preparation to Meet the Next Generation Science Standards

Location: Galleria III
Sponsor: Committee on Physics in Pre-High School Education
Co-Sponsor: Committee on Teacher Preparation
Date: Monday, July 15
Time: 4–5:30 p.m.

Presider: Jon Gaffney

BJ01: 4-4:30 p.m. Scientific Practices in NGSS and Physics Courses for K-12 Teachers

Invited – Paul Hutchison, Grinnell College, Department of Education, Steiner Hall, Grinnell, IA 50112; hutchiso@grinnell.edu

Tiffany Sikorski, George Washington University

With the arrival of the Next Generation Science Standards (NGSS) it is important to consider how physics content courses for K-12 teachers can support NGSS-envisioned science instruction. The NGSS is the first significant science education reform document to place the learning of scientific practices on equal footing with the development of conceptual understanding. While teachers are skilled in assessing students' conceptual understanding, we expect many current and future science teachers "even those with undergraduate degrees in science" are ill-prepared to assess the quality of student engagement in scientific practices. That is an ability teachers will need if implementation of NGSS is to be successful. Physics content courses provide an ideal venue for developing that ability, but only if we shift our assessment in them away from conceptual correctness and toward the authentic use of scientific practices. We provide examples from courses we and others have taught.

BJ02: 4:30-5 p.m. Preparing Teachers for the Next Generation Science Standards

Invited – Jennifer L. Docktor, University of Wisconsin-La Crosse, Department of Physics, 1725 State St., La Crosse, WI 54601; jdocktor@uwlax.edu

Gubbi Sudhakaran, University of Wisconsin-La Crosse

The release of the Next Generation Science Standards (NGSS) in spring of 2013 not only dramatically impacts K-12 science education, but also requires institutions of higher education to reform the preparation of preservice science teachers. I will describe the efforts we have made at the University of Wisconsin-La Crosse to integrate the NGSS into the physics for elementary school teachers course and the secondary science methods course. I will also describe a project funded by a U.S. Department of Education Math Science Partnerships program grant to provide professional development for in-service elementary and middle school teachers during summer institutes and weekend workshops which has been explicitly designed to integrate the draft NGSS into physical science activities and pedagogy instruction.

BJ03: 5-5:10 p.m. Physics in the Earth and Space Science Strand of the Next Generation Science Standards

Contributed – Ramon E. Lopez, University of Texas at Arlington, Department of Physics, Arlington, TX 76034; relopez@uta.edu

The Next Generations Science Standards (NGSS) will guide K-12 science instruction in many states. Earth and space science comprises a significant amount of the NGSS content, and much of that content will likely be distributed among typical courses as opposed to the creation of new Earth and Space Science courses in high school. This has enormous implications for high school physics classes since much, if not most, of the space science content is based in physics. This presentation will provide an overview to the NGSS and illustrate the kinds of space science content that high school physics teachers may be asked to include in their classes.

BJ04: 5:10-5:20 p.m. Preservice Teachers' Understanding of the Nature of Science vs. Engineering

Contributed – Jill Marshall, University of Texas at Austin, 1 University Station, D5705, Austin, TX 78712-0382; marshall@austin.utexas.edu

Physics teachers at the introductory level are aware that the majority of their students will not ultimately become professional physicists. Future engineers comprise a large fraction of our students at the introductory university level, and likely at the high school level as well. The Framework document for the Next Generation Science Standards explicitly includes engineering practices, and engineering is increasingly being offered as a high school course, but many of our preservice teachers are not well prepared to represent engineering as a career or as a practice to their students, and to articulate differences between engineering and science. I will present results of a study of UTeach preservice teachers' understanding of engineering as a discipline and how incorporating a design challenge into their preservice training affected that understanding. Student understanding is probed pre and post-instruction with previously developed instruments assessing knowledge of engineering design, supplemented by interviews.

BJ05: 5:20-5:30 p.m. Educational Data Mining: An Approach in Physics Education Research

Contributed – Daniel Sanchez-Guzman, Instituto Politecnico Nacional, Legaria, No. 694, Mexico City, NA 11500, Mexico; dsanchezgzm@gmail.com

Educational Data Mining (EDM) is becoming a powerful tool to analyze the behavior of students and the practice of teachers; their implementation has been done in most cases with students that work with Mathematics, Learning Languages, and Social Topics. Present work shows the preliminary implementations of an EDM System with Physics Education Research. This implementation tries to support the research made with post-graduate students in the Physics Education Research field in Mexico; the goal is to have a website that lets the teacher upload and analyze data generated of the experiments and to offer a set of web tools to have a better granularity in the research.

Robert A. Millikan Medal 2013 – Harvey Gould

Location: Grand Ballroom I
Date: Monday, July 15
Time: 6:10-7:10 p.m.

Presider: Jill Marshall

Harvey Gould

New Challenges for Old Physics Departments

Harvey Gould, Clark University, Research Professor of Physics, Worcester, MA

The use of computation has expanded the type of problems of interest to physicists and can allow us to reach more students. At the same time the concepts and techniques of physics are becoming increasingly important in the other sciences and engineering as well as in many areas of social science. I argue that the biggest challenge facing physics departments is not increasing the number of physics majors, however desirable that would be, but is teaching physics to other science majors as well as to non-science majors. I will discuss examples of how physicists have influenced other fields, as well as how concepts from other fields are being used by physicists. These developments are of much interest to physics majors and other students and imply that we need to change what and how we teach.

CKRL03: Crackerbarrel: Graduate Students

Location: Broadway I/II
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Graduate Education in Physics
Date: Monday, July 15
Time: 7:10–8:30 p.m.

Presider: Ben Van Dusen

This session is the primary opportunity for members of the PER graduate students community to meet and discuss common issues.

CKRL04: Crackerbarrel: Writing in the Laboratory

Location: Broadway III/IV
Sponsor: Committee on Laboratories
Date: Monday, July 15
Time: 7:10–8:30 p.m.

Presider: Mark Masters, Elizabeth George

In this crackerbarrel we (as in all attendees) will discuss the value and importance of writing in the laboratory and the use of writing as an assessment tool.

CKRL05: Crackerbarrel: Vidshare: Motivating and Elucidating Short Videos You Can Use!

Location: Pavilion West
Sponsor: Committee on Educational Technologies
Date: Monday, July 15
Time: 7:10–8:30 p.m.

Presider: Bruce Mason

At this crackerbarrel, 15-20 contributors will be given 3-5 minutes to show a short (2-3 minute) video segment and then explain and answer questions about how it could be used in class. A list of all submitted videos and descriptions will be compiled and made available online after the session. Those wishing to contribute a video to the session should contact Bruce Mason, *bmason@ou.edu*. Participants will also be able to sign up at the session, if time is available. Videos should be online and easily accessible over the web.

PST1: Poster Session

Location: Grand Ballroom II
Date: Monday, July 15
Time: 8:30–10 p.m.

Odd number poster authors should be present 8:30-9:15 p.m. Even number poster authors should be present 9:15-10 p.m. (Posters should be set up by 9 a.m. Monday and then taken down by 10 p.m. Monday)

A – Astronomy

PST1A01: 8:30-9:15 p.m. Astrobiology: Presenting Evolution, Intelligent Design and the Nature of Science

Poster – Carl T. Rutledge, East Central University, 1100 East 14th St., Ada, OK 74820; crutledge@mac.com

Presenting the ideas of evolution, intelligent design, and the nature of science in a clear but inoffensive manner to an audience with a wide range of backgrounds and beliefs can be a challenge. Whether or not students believe the theory of evolution is correct, they will not be educated unless they understand the basic ideas. Following a general lecture on life in the universe, students are shown two videos, one from the Cosmos series by Carl Sagan and one called Unlocking the Mystery of Life, both of which accurately present the theory of evolution but with different emphases. Then they have a class period devoted to student discussion of the origin and evolution of life, the difference between science and non-science, how to critically analyze the facts and questions that have arisen, and the options they have about what to believe. Student reaction to this type of presentation has been very positive.

PST1A02: 9:15-10 p.m. Earthworks Rising: Games, Badges, and Informal Learning

Poster – Michelle A. Aubrecht, Ohio State University, Columbus, OH 43210; gjaii@columbus.rr.com*

Christine Ballengee-Morris, Jonathan Diehl, Larissa Borcz, Ohio State University

Though video games have been around for over 40 years, employing them as viable learning environments is relatively new. We utilized a consulting collaborative approach, created a Native American Advisory Board, made a prototype, 2D mini-game that focuses on a lunar observatory, and obtained additional funding to create an affinity space (Gee, 2012). The Newark Earthworks in Ohio spans several kilometers and the Octagon precisely tracks the northernmost moonrise, which occurs only every 18.6 years. The 2D mini games will be part of a larger game that demonstrates the moon's monthly cycle as it is observed at the Newark Earthworks, a world heritage nominated site. We will explain our learning objectives, design process, and how games teach. We think that in exploring this structure and the culture of ancient Native Americans, learners will be inspired to learn more about astronomy and begin observing the moon themselves. Project support from the National Endowment for the Humanities, grant HD-51348-11.

*Sponsored by Gordon Aubrecht

PST1A03: 8:30-9:15 p.m. The Eratosthenes Project

Poster – Steven E. Bailey, The Gunnery, 99 Green Hill Road, Washington, CT 06793; baileys@gunnery.org

Simon Langlois, Cégep Marie-Victorin

This poster session describes an International Project that replicated The Eratosthenes Method of determining the circumference of the Earth. Background: Eratosthenes (~240BC) was the first person credited with determining the circumference of the Earth using simple geometry. He utilized the difference in the Sun's angle at noon on the summer solstice between similar longitudinal cities of Syene and Alexandria (Egypt), and using proportions calculated the circumference. Implementation: Physics students from longitudinally similar cities of Washington, CT, and Montreal, Canada, replicated The Eratosthenes Method on the Autumnal Equinox to determine the circumference of the Earth. Students utilized computers (e.g. Skype, IMs, and email), scientific calculators, metersticks, accurate time measurements, and French-English translators. Results: Quantitative results compared favorably with the established circumferential value with best results within 2% of 40,008 km. Benefits: Students validated an astronomical method utilized 2300 years ago and collaborated bilingually with peers from another country.

B – Labs/Apparatus

PST1B01: 8:30-9:15 p.m. High-Speed Movies for Introductory Physics Labs

Poster – Michael R. Gallis, Penn State Schuylkill, 200 University Drive, Schuylkill Haven, PA 17972; mrg3@psu.edu

Some modern digital cameras have the ability to take digital video at up to 1000 frames per second (FPS). While not true "high speed video", using higher than the default 30 FPS provides higher temporal resolution and reduced motion blur. We present an exercise where students study vertical motion with air resistance of several objects including a basketball and a beach ball. Students determine the drag coefficient by determining the terminal velocity of the objects' vertical motions. Some additional applications of high-speed movies to amusement park physics will also be discussed.

PST1B02: 9:15-10 p.m. Managing Increasing Enrollment in Upper Level Laboratories

Poster – Karen A. Williams, East Central University, 1100 E. 14th St., Physics Department, PMB D-5, Ada, OK 74820; kwillims@ecok.edu

Our physics department enrollment has increased, however the money for our lab equipment has not. This poster will illustrate the ways I have adapted to cope with this challenge.

PST1B03: 8:30-9:15 p.m. Non-linear Capacitance-Voltage Relation of a Diode

Poster – Yongkang Le, Fudan University, No. 220 Handan Road, Shanghai, 200433; yongkangle@fudan.edu.cn

Zhe Sun, Fudan University

Unlike the non-linear current-voltage characteristic of a diode, its non-linear capacitance-voltage relation is not so familiar to the students. With the help a simple LC circuit, we can measure the capacitance variation of a diode in dependence of the applied bias voltage. Physics underlying this phenomenon and possible further development of the teaching lab will be discussed.

PST1B05: 8:30-9:15 p.m. Scaffolding Technical Writing with Rubrics, Bad Examples and Partial Reports

Poster – Scott W. Bonham, Western Kentucky University, 1906 College Heights Blvd., #11077, Bowling Green, KY; 42101-1077; scott.bonham@wku.edu

Douglass L. Harper, Western Kentucky University

Technical writing is a major learning outcome for our calculus-based physics laboratories. For that purpose we have combined several strategies to help students understand and meet expectations. First, a standardized grading rubric is used to communicate high expectations for every component of the reports. Second, students are provided with both good and poor example reports; they seem to learn more from the latter. Third, the first week of the semester students are assigned to grade the sample reports using the rubric and explain their reasoning. Fourth, each week class discussion focuses on one report section, and then that is added to what students are responsible for; their first report contains only the data and results section, the second report has the procedure as well as data and results section, the third report adds the conclusion section, and so on. There is evidence that this combination has led to better report writing.

PST1B06: 9:15-10 p.m. Scaling the Campus

Poster – Andrew D. Cahoon, Colby-Sawyer College 541 Main St., New London, NH 03257; acahoon@colby-sawyer.edu

At the start of introductory physics, students often struggle to grasp the wide range of scales encountered in the natural world and to use basic skills such as dimensional analysis, scientific notation, and estimation. In this lab activity, students are asked to work in teams to build a scale model of the campus. A list of campus buildings is prepared, teams draft two or three buildings each, and then they set out to make measurements necessary to build a scale model of each building according to an agreed-upon scale. This serves as an excellent way to start the Physics 101 course, introducing important skills for the remainder of the course, getting students engaged in active learning and working as a team, and tackling a problem that is generally interesting and applicable to a broad range of disciplines. The activity guidelines and motivation are presented along with the students' results and reactions.

PST1B07: 8:30-9:15 p.m. Using the Programmable System on a Chip (PSoC) in the Physics Laboratory

Poster – Mark F. Masters, IPFW, 2101 Coliseum Blvd., E. Fort Wayne, IN 46805; masters@ipfw.edu

Jacob Millspaw, IPFW

Microcontrollers are very interesting devices that enable one to build dedicated instrumentation to help complete some experimental task. There are many different types of microcontrollers: Atmel (on which the Arduino is based), Cypress, Freescale, Microchip, Parallax Propeller, and Texas Instruments to name a few. However, even though there is a great diversity of microcontroller, at AAPT there seems to be a monoculture of microcontroller based upon the Arduino. We present a very different type of device, the Programmable System on a Chip. This type of device has distinct advantages for physics instrumentation, some of which we will present.

PST1B09: 8:30-9:15 p.m. A National Assessment of Undergraduate Physics Labs: First Results

Poster – Benjamin Zwickl, University of Colorado, Department of Physics, Boulder, CO 80309; benjamin.zwickl@colorado.edu

Takako Hirokawa, Noah Finkelstein, H. J. Lewandowski, University of Colorado-Boulder

The Colorado Learning Attitudes about Science Survey for Experimental Physics (E-CLASS) is a short multiple-choice survey that assesses students' attitudes about conducting physics experiments in an instructional setting and in professional research. The survey is given at the beginning and at the end of a course, whereupon students are also asked about what helped to earn a good grade in the course. A variety of aspects of experimentation are explored, including students' sense-making, affect, self-confidence, and the value of collaboration. Over 4000 E-CLASS responses have been gathered from over 30 courses at 17 colleges and universities. We will present a broad overview of our findings, including which student views are the least expert-like, which views shift most over the course of a semester, and which have largest differences between introductory and upper-division courses.

PST1B10: 9:15-10 p.m. Building a Ramp: Four-Semester Laboratory Curriculum

Poster – Anna Karelina, Occidental College, 1600 Campus Road, Los Angeles, CA 90041; anna.karelina@gmail.com

Daniel Snowden-Ifft, Occidental College

We developed a four-semester sequence of introductory laboratories for physics and engineering majors at Occidental College. The main objective was to create a consistent long-term ramp that helped students build up experimental skills and abilities over two years. Our pedagogical approach was based on the methods of the Investigative Science Learning Environment (ISLE) that has proven to be a powerful tool for developing scientific abilities, such as ability to design an experiment, test a hypothesis, analyze and evaluate results.* In this presentation we show that we were able to successfully adapt the ISLE method to the existing lab courses.

*Etkina, E. & van Heuvelen, A. (2007). Investigative Science Learning Environment - A science process approach to learning physics. In E. F. Redish and P. J. Clooney (Eds), Research-based reform of university physics. American Association of Physics Teachers.

C – Physics Education Research

PST1C01: 8:30-9:15 p.m. Assessing Gender Differences in Students' Understanding of Magnetism

Poster – Chandralekha Singh, University of Pittsburgh, 3941 Ohara St., Pittsburgh, PA 15260; clsingh@pitt.edu

Jing Li, University of Pittsburgh

We investigate gender differences in students' difficulties with concepts related to magnetism using a multiple-choice test whose reliability and validity have been substantiated earlier. We also conducted individual interviews with a subset of students to get a better understanding of the rationale behind their responses. We discuss gender differences in students' performance and possible reasons for these differences. Supported by NSF.

PST1C02: 9:15-10 p.m. Secondary Students' Point and Set Paradigms in Handling of Experimental Measurement

Poster – Eunmi Lee, Korea National University of Education, Department of Physics Education, 431 Cheongwon, Chung-Buk 363-791 Korea; l-emi@hanmail.net*

Nam-Hwa Kang, Korea National University of Education

The idea of secondary school students about measurement has been investigated in the context of experimental work in physics. Subjects were 197 middle school students and 200 high school students. A written instrument PMQ1 was used to probe the students' ideas about data collection, data processing, and data comparison. The responses were classified in terms of point and set paradigms. A point paradigm is characterized by the notion that each measurement results in a single, "point-like" value that could in principle be the true value. Set paradigm is characterized by the notion that each measurement is only an approximation to the true value and the deviation from the true value is random. Set paradigm had a high frequency in data processing and point paradigm had a high frequency in data collection and data comparison. A trend in frequencies according to grade was shown in data comparison but not in other areas.

*Sponsored by Nam-Hwa Kang

PST1C03: 8:30-9:15 p.m. Making Sense of Friction as an Interaction Using System Schema

Poster – Brant Hinrichs, Drury University, 729 N Drury Lane, Springfield, MO 65802; bhinrichs@drury.edu

After learning Newton's second law, students in a university modeling-based introductory physics class are asked to imagine a box sliding across a floor and slowing to a stop. Although they've had extensive experience with friction in the context of energy, this is their first exposure to friction within the context of forces. They are asked to make different representations for this scenario, including a system schema, and force diagram. During their small-group work, students quickly run into a difficulty: there are only two interactions with the box (contact, gravitational), so there should only be two forces, yet the box is slowing, which means it must have unbalanced forces in the direction of acceleration. In this poster, I present evidence from the student-led whole class discussion showing how the class uses the System Schema to help reason about this problem in a productive manner and come to a useful consensus.

PST1C04: 9:15-10 p.m. Development of Tutorial for Teaching Electric Potential in High School

Poster – Joon Hee Hong, Korea National University of Education, Department of Physics Education, Cheongwon, CB 363-791, Korea; bradjjun@naver.com

Jung Bog Kim, Korea National University of Education

The purpose of this study was to develop a tutorial for teaching electric potential. For this study, we investigated the 7th national curriculum and the previous studies about the misconceptions about electric potential difference. Tutorial for total eight class hours consisted of three sub-units. On the basis of the two preliminary tests, the final version was developed. We applied the developed tutorial to 10th grade women students. Students said that the experiment and reasoning were very helpful in learning and that the reasoning was not difficult and particularly the one using the pictures was very helpful. Also they said that they could resolve the curiosity produced in the pretest through the tutorial activity and could understand what was wrong in their prior thought.

PST1C05: 8:30-9:15 p.m. Evaluations of Video Lab Reports in an Introductory Physics MOOC

Poster – Shih-Yin Lin, Georgia Institute of Technology, School of Physics, 837 State St., Atlanta, GA 30332; hellosilpn@gmail.com

John M. Aiken, Ed Greco, Scott Douglas, Michael F. Schatz, Georgia Institute of Technology

Marco D. Caballero, University of Colorado-Boulder

Brian D. Thoms, Georgia State University

John B. Burk, St. Andrew's School, Middletown, DE

Assessing student performance becomes challenging when course enrollment becomes very large (~10^5 students). As part of an introductory physics Massive Open Online Course (MOOC) offered via Coursera in summer 2013, students submit video reports on force and motion labs. Peer evaluation of reports provides the primary method for evaluating student laboratory work. This poster describes the methods developed and used to guide students in evaluating each others' video lab report.

PST1C06: 9:15-10 p.m. Investigating Interactive Whiteboard Use with Design-based Research Approach

Poster – Bor Gregorcic, University of Ljubljana, Faculty for Mathematics and Physics, Jadranska 19, Ljubljana, 1000 Slovenia; bor.gregorcic@fmf.uni-lj.si

Eugenia Etkina, Rutgers University

Gorazd Planinsic, University of Ljubljana

Interactive Whiteboards have become widely used in the last decade. Most studies of the IWB use are fairly general and there is still a great need for studies addressing effective IWB use for teaching specific subjects, including physics. The framework for our study is based on the Design Based Research approach. It is a cyclical process of designing, implementing, evaluating and redesigning of a learning unit. As the cycle is repeated, the result is an improved unit and emergence of principles for IWB use and curriculum material design. Combining the IWB with dynamic interaction software (Algodoo, for example) is of special interest to us, as the interactive surface of the board is one of major advantages of IWB technology over a standard computer-projector setup. It makes possible a personal and creative, graphical and even kinesthetic input from the students.

PST1C07: 8:30-9:15 p.m. Placement of Students' Group and Individual Problem-Solving Activities

Poster – Bijaya Aryal, University of Minnesota-Rochester, 300 University Square, 111 S Broadway, Rochester, MN 55904; baryal@umn.edu

The body of research aimed at explaining the effect of peer group interaction has indicated that social constructivism involved in group interaction has positive impact on students' group performances. However, it has not provided adequate evidence on students' individual learning after small group interactions. This study used three types of group and individual problem-solving sequences. As a part of group learning, students were engaged in small groups of three to four to complete problem-solving activities. Students later completed isomorphic problems as individual assignments. Students' scores on multiple tasks from various semesters were used as data in this study to investigate the influence of group interactions on individual learning. Data analysis revealed the impact of placement of group and individual problem-solving activities on students' subsequent individual performance. Results of this study provide insights into the design of effective learning sequences involving peer group interaction in physics classroom.

PST1C08: 9:15-10 p.m. Student Collaborative Networks and Academic Performance in Physics

Poster – David R. Schmidt, Colorado School of Mines, 2015 Infinity Circle, #191, Golden, CO 80401; dschmidt@mines.edu

Ariel M. Bridgeman, Patrick B. Kohl, Colorado School of Mines

Undergraduate physics students commonly collaborate with one another on homework assignments, especially in more challenging courses. However, it is not well known if the types of collaboration students engage in affect their performances. We empirically investigate collaborative networks and associated performances through a required collaboration reporting system in two sophomore- level and three junior-level courses during the 2012-2013 academic year. We employ social network analysis to quantify the structure and time evolution of these networks, which involve approximately 140 students. Analysis includes analytical and numerical assignments in addition to exam scores. We discuss results from this analysis.

PST1C09: 8:30-9:15 p.m. Student Understanding of Newton's Second Law with Computational Modeling

Poster – John M. Aiken, Georgia State University, 3736 Gloucester Drive, Tucker, GA 30084; johnm.aiken@gmail.com

Shih-Yin Lin, Scott S. Douglas, Michael F. Schatz, Georgia Institute of Technology

Marcos D. Caballero, University of Colorado-Boulder

John B. Burk, St. Andrews' School

Brian D. Thoms, Georgia State University

When learning with any representation of a physical model (e.g., graphs, diagrams, computation), students must learn to connect the model to the individual representation. This paper follows previous work where computational modeling (using VPython) was integrated into a high school Modeling Instruction physics course. To characterize student understanding of Newton's second law, five representative students were recruited in a think-aloud session with a follow-up interview. During the think-aloud session, students wrote a program modeling the motion of a baseball. Students' understanding of the physics concepts behind the computational model will be reported. In particular, we will focus on students' ability to relate Newton's second law to the velocity update in a computational model of force and motion.

PST1C10: 9:15-10 p.m. Student Understanding of Traditional and Standards-based Grading Methods

Poster – Joshua Gates, The Tatnall School, 5 E Brookland Ave., Wilmington, DE 19805; joshuagatesnc@yahoo.com

Student qualitative and quantitative understanding of traditional grading systems (points-based and category-based) and a standards-based system were examined. Students were asked to articulate their current grading system, to determine how a new grade (given an existing set of grades) would change their overall grade, and to calculate an overall grade (given a set of existing grades). Student comprehension of the grading systems is compared and contrasted, and may be a good response to those questioning student understanding of a 'new' SBG system—did they really understand the traditional method in the first place?

PST1C11: 8:30-9:15 p.m. Successful Implementation of Active Methodologies in a University in Chile

Poster – Hugo Alarcon, Universidad Tecnica Federico Santa Maria, Av. Espana 1680, Valparaiso, Valparaiso 2340000, Chile; hugo.alarcon@usm.cl

Valeria del Campo, Pedro Del Canto, Ricardo Henriquez, Rodrigo Vergara, Universidad Tecnica Federico Santa Maria

With the implementation of SCALE-UP rooms at Universidad Tecnica Federico Santa Maria the introductory mechanics course has been redesigned in order to incorporate active methodologies based on Physics Education Research. The exposure time of the instructor has been drastically reduced to allow time for students to work in different types of activities. They have worked with tutorials of the University of Washington, modeling based activities and Context Rich Problems. All of these activities were performed by the students in collaborative groups. The SCALE-UP environment, in particular the inclusion of whiteboards, leads naturally to collaboration. There was a significant conceptual learning, as measured by the FCI and a pass rate well above traditional control groups.

PST1C12: 9:15-10 p.m. Teaching to Learn: Using iPads to Transform Physics Students' Roles

Poster – Susan M. Nicholson-Dykstra, Streamline to Mastery Program, University of Colorado-Boulder, 249 UCB, Boulder, CO 80309-0249; susie.dykstra@gmail.com*

Ben Van Dusen, Valerie Otero, University of Colorado-Boulder

With the explosion of tablet technology and e-Resources available to students who are digital natives, it is vital that teachers develop strategies for purposefully incorporating these resources into the learning experience. In this study, iPads were utilized as tools for students to teach, create, synthesize and apply ideas in a physics classroom. This research investigated the impact of a 1:1 iPad environment on student achievement, engagement, agency, and attitude toward science in an urban science classroom. Students who utilized iPads to create teaching tools, such as screencasts, animations and other digital models, report an increased sense of pride in their product and confidence in their understanding of the content material. Ongoing investigations are being conducted to determine whether student achievement is consistent with student perception of content mastery. Project was partially funded by NSF grant #DUE 934921 and Northglenn High School, Adams 12 Five Star Schools.

*Sponsored by Valerie Otero

PST1C13: 8:30-9:15 p.m. Tactile Kinesthetic Methods in the Pedagogy of Physics

Poster – Christine M. Carmichael, Woodbury University, 7500 Glenoaks Blvd., Burbank, CA 91510; christine.carmichael@woodbury.edu

There are many ways to enhance the way students learn beyond the conventional classroom techniques. New research sheds light on some of these methods. It is well known in pedagogy that different students have different learning styles, and give priority to different sensory modalities. Recent research results indicate that there is a role for tactile-kinesthetic methods in the teaching of abstract concepts in physics. For example, "a person's ability to solve a problem can be influenced by how he or she moves." Reasons are considered for augmenting the visual and auditory techniques normally used in the university-level physics classroom.

PST1C14: 9:15-10 p.m. Development of an Estimation Skills Diagnostic

Poster – Andrew J. Macdonald, University of British Columbia, Department of Physics and Astronomy, 6224 Agricultural Road, Vancouver, BC V6T 1Z4, Canada; ajmacd@phas.ubc.ca*

Sarah A. Burke, Cynthia E. Heiner, University of British Columbia

The ability to accurately estimate physical quantities is an invaluable skill for scientists and engineers. The development of estimation skills has become an explicit learning goal in the first-year physics course for engineering students at UBC. In order to establish a baseline and look for possible gains in skill level, we have developed a 10-question multiple-choice assessment designed to probe student ability and confidence in estimating physical quantities such as mass, size, and time. Student interviews were used to establish question validity and open-ended written versions were used to seed multiple-choice responses. The diagnostic was administered as a pretest and post-test and given to a set of experts to establish its discriminatory power. The results showed a statistically significant difference between students and experts, but no overall student gains. This poster will give an analysis of the results and share some observations based on student interviews.

*Sponsored by Cynthia Heiner

PST1C15: 8:30-9:15 p.m. Does Higher Education Increase Student Scientific Reasoning Skills?

Poster – Lin Ding, The Ohio State University, Department of Teaching and Learning, 1945 N. High St. Columbus, OH 43210; ding.65@osu.edu

A goal of science and engineering education at the tertiary level is to promote students' scientific reasoning skills. Patterns of such skills are conceptualized as mental plans, strategies, or tools used for making inferences and drawing conclusions that are beyond direct observations. Several key sub-patterns are subsumed within this broad definition of scientific reasoning skills; they are: hypothetical-deductive reasoning, proportional reasoning, correlation reasoning, probabilistic reasoning, and control-of-variables. These sub-skills are frequently investigated among students at various grade levels through the Lawson Classroom Test of Scientific Reasoning (CTSR). Prior studies have consistently shown that results of CTSR are a good predictor of gains in student conceptual learning of domain knowledge. However, little is known regarding what may influence the development of student scientific reasoning skills. We investigate the effect of two factors, student major and grade level, on the progression of university students' reasoning skills measured by the CTSR.

PST1C16: 9:15-10 p.m. Exploring Attributes of College Courses that Develop Scientific Reasoning Abilities*

Poster– Kathleen M. Koenig, University of Cincinnati, 3758 Hubble Road, Cincinnati, OH 45247; kathy.koenig@uc.edu

Lei Bao, The Ohio State University

Carol Fabby, Zach Huard, University of Cincinnati

Scientific reasoning is a naturally developing ability impacted by many factors. Our prior work has demonstrated that although this development follows a general trend, students enter our college courses with wide variations in scientific reasoning abilities, and the typical course does not significantly impact these important skills. Rather, it is through explicit and targeted instruction in scientific reasoning that students have been observed to make significant shifts. We are in the early exploration stages of assessing these abilities in different environments to get a sense of what factors impact scientific reasoning development in the college classroom. Gains in student development of these abilities for diverse classroom settings across multiple campuses will be shared, in addition to details of the differences in these classroom settings that might be influential factors here.

*Partially supported by the National Institutes of Health 1RC1RR028402-01

PST1C17: 8:30-9:15 p.m. Resource-based Analysis of Variable Expertise

Poster – Darrick C. Jones, Rutgers, The State University of New Jersey, Department of Physics and Astronomy, 136 Frelinghuysen Road, Piscataway, NJ 08854-8019; dcjones@physics.rutgers.edu

AJ Richards, Eugenia Etkina, Rutgers University

Using a fine-grained, resource-based model of cognition, we analyze video recordings of individuals with varying physics expertise and different backgrounds solving novel physics problems on the subject of solar cells. These problems incorporate advanced topics such as semiconductor physics and complex circuitry. Through this analysis, we determine what cognitive resources individuals use to reason within the domain. We compare the resources used by individuals from different backgrounds and examine how this affected their reasoning processes. This poster presents the results of the analysis and their importance to the design of instructional tasks.

PST1C18: 9:15-10 p.m. Student Reasoning Using Combinations of Resources

Poster – AJ Richards, Rutgers University, 136 Frelinghuysen Road, Piscataway, NJ 08854; richard6@physics.rutgers.edu

Darrick C. Jones, Eugenia Etkina, Rutgers University

We use the framework of resources to investigate how students construct understanding of a complex modern physics topic. Specifically, we are investigating how students combine multiple resources as they reason about a solar cell. We recorded preservice physics teachers learning about solar cells, analyzed their interactions, and studied how they activated and combined resources. Our analysis shows us that certain combinations of resources can dramatically improve students' understanding and insight. This poster will reveal these combinations and discuss possible implications for instruction.

PST1C19: 8:30-9:15 p.m. Using the Interrogation Method to Help Students Read Physics Textbooks

Poster – Robert C. Zisk, Rutgers University, 10 Seminary Pl., New Brunswick, NJ 08901; robert.zisk@gse.rutgers.edu

Elana M. Resnick, Eugenia Etkina, Rutgers University

The interrogation method is a strategy that has been developed to help students read and interpret science texts. In this method, students are prompted to read a section of the text, and then answer why a sentence from the text is true based on the reading. We have explored the use of this method in an introductory physics course for non-physics science majors. Students were required to respond to two to four interrogation sentences each week on their homework based on the sections there were reading each week. Each exam then included three sentences for the students to interrogate without the text. This poster will outline the evolution of student responses throughout the semester, as well as the relation between homework responses, responses on similar exam questions and overall course performance.

PST1C20: 9:15-10 p.m. An Abbreviated Force and Motion Conceptual Evaluation (Japanese translated version)

Poster – Michi Ishimoto, Kochi University of Technology, Tosayamada-cho Kami-shi, Kochi 780-0832, Japan; ishimoto.michi@kochi-tech.ac.jp

An abbreviated version of the Force and Motion Conceptual Evaluation (FMCE) is created as a prototype to assess Japanese students' understanding of the concepts of motion. This abbreviated version includes 17 of the 47 questions that comprise the FMCE. These questions are selected based on the results of the preconcept survey using the Japanese translated version of the FMCE. The correlation coefficient of the abbreviated version of the test and the single-number scores of the FMCE is 0.92. The purpose of the abbreviated version is to shorten the testing time required so that Japanese instructors can administer the test more easily. The abbreviated version is useful in measuring gains, but its pre-test scores are too low to differentiate students.

PST1C21: 8:30-9:15 p.m. Development of a Standardized Fluids Assessment

Poster – D. J. Wagner, Grove City College, 100 Campus Drive, Grove City, PA 16127; djwagner@gcc.edu

Ashley Lindow, Grove City College

We are developing an FCI-style assessment covering hydrostatic topics commonly included in introductory physics courses. Beta versions have been sent to other institutions, and we are continuing to refine the assessment. This poster will present the assessment, along with analysis of the questions and plans for the future. We're particularly interested in receiving suggestions from other educators and in recruiting more beta-testers. Stop by and chat!

PST1C22: 9:15-10 p.m. Exploring Student Reactions to a Modified Force Concept Inventory

Poster – Wendy K. Adams, University of Nothern Colorado, Department of Physics, Greeley, CO 80639; wendy.adams@unco.edu

Matthew Semak, Richard Dietz, Courtney Willis, University of Northern Colorado

In our earlier work we conducted think-aloud interviews with students as they grappled with questions on the Force Concept Inventory (FCI). Doing so showed us that the difficulties they have with some questions have nothing to do with their understanding of physics. These difficulties involve diagrams, notations, and vocabulary that make perfect sense to physics teachers but can easily confuse beginning students. We modified several of the FCI questions to improve clarity and administered it to two sections of introductory physics students. When compared to years of archival data generated with the canonical FCI, student performance on the modified questions showed a statistically significant difference. To investigate this change we have conducted a new series of think-aloud interviews. Here we present an overview of the insight afforded by the students' perspective.

PST1C23: 8:30-9:15 p.m. Newton's Second Law or Real Forces?

Poster – Jennifer Blue, Miami University, 620 E Spring St., Oxford, OH 45056; bluejm@miamioh.edu

This presentation is a continuation of the presentation "Examining Students' Reservations about Forces" from the Winter 2013 meeting. Students were asked to draw all the forces on both an accelerating car and on a passenger riding in that car. Then they were asked to identify why the car accelerated. As it turns out, these are hard questions. Students cannot always think of the correct forces. In those cases, if they are motivated to make Newton's second law work, they might invent forces, or label things as forces that are not actually forces (i.e. "motion," "momentum," "inertia"). In other cases, the labeled forces are all interactions between two objects, but students cannot then use Newton's second law do explain why things accelerate. This presentation will examine the conditions under which students make these choices.

PST1C24: 9:15-10 p.m. Schlieren Imaging of Standing Sound Waves in a Tube

Poster – Liang Zeng, The University of Texas-Pan American, Department of Physics and Geology, Edinburg, TX 78539; zengl@utpa.edu

Isaac Choutapali, Linda Martinez, The University of Texas-Pan American

Students enrolled in introductory physics classes at a Hispanic Serving Institution in South Texas have difficulty reasoning how air molecules move in a pipe when sound standing waves are formed. The study was conducted to visualize the sound standing waves through Schlieren imaging technique. The technique utilizes a point light source to illuminate a long acrylic tube. A speaker connected to a sine-wave generator sends periodic sound waves down to the tube. Two concave mirrors are employed to converge the refracted light to a CCD Camera through a space filter. The videos and images of sound standing waves obtained in the experiment can help students understand better how sound standing waves form and the underlying physics of the phenomena.

PST1C25: 8:30-9:15 p.m. Scientific Reasoning and Understanding of Graphs and Kinematics in Swedish Algebra-based Courses

Poster – Markku Jaaskelainen, Dalarna University, Falun, SE 79188, Sweden; mjk@du.se

Andreas Lagerkvist, Dalarna University

We present data from algebra-based physics at Dalarna University during the 2012-2013 academic year. LCTSR was administered as pre-test, and TUG-K was used as assessment half-way the course, after the relevant sections on graphs and kinematics were covered. Both tests were translated into Swedish to reduce misunderstandings in the testing situation. We find a statistically significant correlation between the LCTSR score and the post-instruction TUG-K scores The main limiting factor seems to be scientific reasoning, regardless of the mode of instruction (online or on-campus with Peer-Interaction). It is believed that the short time of instruction is insufficient to have fostered enough of a conceptual change to produce a marked difference between the student populations. The data suggests that there is a threshold in scientific reasoning around LCTSR score of 10-12, below which conceptual understanding for graphs and kinematics will not develop during the course.

PST1C27: 8:30-9:15 p.m. The Pre-concepts of Japanese Students Assessed with the FMCE

Poster – Michi Ishimoto, Kochi University of Technology, Tosayamada-cho Kami-shi, Kochi 780-0832, Japan; ishimoto.michi@kochi--tech.ac.jp

This study identifies the pre-concepts of Japanese students assessed with the translated version of the FMCE. The data consist of the pretest results of 1095 students, most of whom were first-year students at a mid-level engineering school between 2003 and 2012. We found a small percentage of the students grasped Newtonian concepts. The percentage of Japanese students who used two concept models together to answer some questions seems to be higher than that of American students. The students with low scores more likely switched from one model of a common sense concept to another to answer the questions.

PST1C28: 9:15-10 p.m. University Students' Understanding on Macro-Micro Relationships of Electric Potential

Poster – Jenaro Guisasola, University of the Basque Country, Plaza Europa 1, San Sebastian, 20018, Spain; jenaro.guisasola@ehu.es

Ane Leniz, Kristina Zuza, University of the Basque Country

Relations between electrostatics and electrodynamics are still a source of teaching-learning problems in the first years of university. In the area of electricity, research shows that students do not relate concepts studied in electrostatics with the phenomena that occur in electrical circuits (Eylon and Ganiel 1990, Park et al. 2001, Thacker et al. 1999). In this poster we will present several questions that have been used to investigate the representations of students about the concept of potential difference. The results presented will show evidence that in current transitional situations students generally do not perform the analysis of the phenomenon considering the concept of potential difference. Students show deficiencies in the explanatory model of charge movement. The results will also show that students do not use descriptive-macro level (potential difference) and interpretative-micro level (surface distribution of charges) to explain the electrical current in a simple circuit current.

PST1C29: 8:30-9:15 p.m. Context and Representation: Insights from Transfer Research on Teaching Physics

Poster – Dean A. Zollman, Kansas State University, 116 Cardwell Hall, Physics Department, Manhattan, KS 66506; dzollman@phys.ksu.edu

N. Sanjay Rebello. Kansas State University

Transfer of learning is frequently considered as the ability to use knowledge in a context different from the one in which it was learned. Transfer to and within physics learning are equally important. Much research has shown us that students rely heavily on their experiences that occurred before they studied physics when interpreting or applying the principles while they are studying physics. Thus, they transfer to physics experiences from other formal learning and from everyday life. Using the work Bransford & Schwartz (1999) as a foundation we have developed a framework for understanding transfer while students are learning physics. Analyzing one's teaching in terms of a transfer framework can help us understand better students' difficulties (and successes) when attempting to learn physics.

PST1C30: 9:15-10 p.m. Learner Understanding of Energy Degradation*

Poster – Abigail R. Daane, Seattle Pacific University, 3307 3rd Ave., W Seattle, WA 98119; abigail.daane@gmail.com

Stamatis Vokos, Rachel E. Scherr, Seattle Pacific University

Learners' everyday ideas about energy often involve energy being"used up" or "wasted." In physics, the concept of energy degradation can connect those ideas to the principle of energy conservation. Learners' spontaneous discussions about aspects of energy degradation have motivated us to introduce new learning goals into our K-12 teacher professional development courses. One of our goals is for teachers to recognize that since energy degradation is associated with the movement of some quantity towards equilibrium, the identification of energy as degraded or free depends on the choice of the objects involved. Teacher discussions of a particular energy scenario (about a wind-powered heating system) led to productive conversations about the nature of energy degradation and its possible dependence on the choice of what to include in the scenario.

*This material is based upon work supported by the National Science Foundation under Grant No. 0822342.

PST1C31: 8:30-9:15 p.m. Physics Professional Development: Closing the Knowledge Gap

Poster – Mark D. Greenman, Boston University, Boston, MA 02215; greenman@bu.edu

During the summers of 2008 through 2012 five cohorts totaling 114 secondary school teachers responsible for teaching physics concepts enrolled in a Massachusetts Department of Elementary and Secondary Education funded summer institute hosted at area universities to enhance the teachers' physics content knowledge and to improve their use of research-based best practices in teaching physics. The content knowledge gap between male and female science teachers was reduced from a gap of 25% to 6%, and the gap between physics majors teaching physics and other science majors teaching physics was reduced from a gap of 31% to 8%. The average paired fractional gain for these participants was .68 with teachers in every comparison group showing strong gains (.57 to .74). Just as encouraging, these gains showed little decay over time.The Force and Motion Conceptual Evaluation (FMCE) tool was utilized to look at change in teacher content knowledge.

PST1C32: 9:15-10 p.m. Constructing Wind Turbines: Physics, Engineering, or Both?

Poster – Joshua A. Ellis, University of Minnesota, STEM Education Center, 1954 Buford Ave., St. Paul, MN 55108; ellis228@umn.edu

Emily A. Dare, STEM Education Center, University of Minnesota

National reform documents (National Research Council, 2012) are calling for the integration of engineering into K-12 science standards as a mechanism to not only improve the quantity and quality of the STEM workforce but to increase STEM literacy for all. This study investigated the classroom practices of high school physical science teachers following an intensive professional development on engineering integration. These teachers incorporated engineering design lessons, such as wind turbine design, into their physics instruction. Our findings show that teachers oftentimes miss the mark in explicitly integrating physics content in these lessons. This resulted in lessons that became stand-alone engineering design challenges where students neglected to apply known physics concepts to their design. These findings occurred in all classrooms regardless of the teachers' physics content knowledge. In this paper we explore physics teachers' struggles to integrate physics and engineering in ways that will enhance the learning of physics concepts.

PST1C33: 8:30-9:15 p.m. Content Knowledge for Teaching Energy: Tasks of Teaching

Poster – Robert C. Zisk, Rutgers University, 10 Seminary Pl., New Brunswick, NJ, 08901; robert.zisk@gse.rutgers.edu

Eugenia Etkina, Drew Gitomer, Rutgers University

Jim Minstrell, Facet Innovations

Stamatis Vokos, Seattle Pacific University

Content knowledge for teaching (CKT) is a practice-based theory of the professional knowledge that a person needs in order to be able to effectively teach a subject (Ball, Thames and Phelps, 2008). Originally conceptualized in the subject of mathematics, our work is centered on CKT for physics, specifically in the area of energy. In developing the framework for CKT for teaching energy, we have indentified the aspects and tasks of teaching physics, and more specifically, of teaching energy, that are needed for effective instruction. This poster will describe the process of identifying generic tasks of teaching physics, as well as the domains, sub-domains and individual tasks that have been identified as essential to the teaching of physics and energy.

PST1C34: 9:15-10 p.m. Interactive Laboratory Experience (ILE) – Closing the Knowledge Gap

Poster – Mark D. Greenman, Boston University, Boston, MA 02215; greenman@bu.edu

During the summers of 2008 through 2012 five cohorts totaling 114 secondary school teachers responsible for teaching physics concepts enrolled in a Massachusetts Department of Elementary and Secondary Education funded summer institute hosted at area Universities to enhance the teachers' physics content knowledge and to improve their use of research-based best practices in teaching physics. The content knowledge gap between male and female science teachers was reduced from a gap of 25% to 6%, and the gap between physics majors teaching physics and other science majors teaching physics was reduced from a gap of 31% to 8%. The average paired fractional gain (FMCE) for these participants was .68 with teachers in every comparison group showing strong gains (.57 to .74). Just as encouraging, these gains showed little decay over time.

PST1C35: 8:30-9:15 p.m. PhysTEC at Boston University: Supporting Excellence in Physics Teaching & Learning

Poster – Mark D. Greenman, Boston University, Boston, MA 02215; greenman@bu.edu

The PhysTEC grant awarded to Boston University is helping to encode in the DNA of the physics department a culture that sees basic physics research and excellence in teaching as dual missions of a strong physics department. Boston University, a large research university located in an urban center, is working with area school districts to increase the number of highly qualified high school physics teachers. The experience of working with pre- and in-service physics teachers has had the added benefit of encouraging reflection within the physics department on strategies for effective teaching and learning. Physics majors are being encouraged to become undergraduate Learning Assistants, so physics majors graduating from Boston University will provide more effective instruction in physics, whether in the role of high school teacher, teaching assistant in graduate school, or research physicist mentoring and educating another generation of physicists.

D – Teacher Training/Enhancement

PST1D01: 8:30-9:15 p.m. Connecting Three Pivotal Concepts in K-12 Science State Standards and Maps of Conceptual Growth to Research in Physics Education

Poster – Chandralekha Singh, University of Pittsburgh, 3941 Ohara St., Pittsburgh, PA 15260; clsingh@pitt.edu

Christian Schunn, University of Pittsburgh

We discuss three conceptual areas in physics that are particularly important targets for educational interventions in K-12 science. These conceptual areas are force and motion, conservation of energy, and geometrical optics, which were prominent in the U.S. national and four state standards that we examined. The four state standards that were analyzed to explore the extent to which the K-12 science standards differ in different states were selected to include states in varied geographic regions and size. The three conceptual areas that were common to all four state standards are conceptual building blocks for other science concepts covered in the K-12 curriculum. We discuss the nature of difficulties in these areas along with pointers toward approaches that have met with some success in each conceptual area.

PST1D02: 9:15-10 p.m. Content and Depth of Reflection on Teaching: Does Evolution Occur?

Poster – Marina Malysheva, Rutgers University, 10 Seminary Place, New Brunswick, NJ 08901-1183; malyshev@eden.rutgers.edu

Marianne Vanier, Eugenia Etkina, Rutgers University

The poster will show the patterns that emerged from our analysis of preservice teachers' reflections on teaching in an introductory physics course. The teaching occurred before and after the formal student teaching internship. Over 300 reflections were coded for the study. We were interested in the changes in reflections, specifically the content (what the preservice teachers focus on) and the nature of the reflections (how deeply they analyze teaching situations). To accomplish this goal we developed and validated a coding scheme.

PST1D03: 8:30-9:15 p.m. Physics Teachers' Arguments About Physics Content: A Comparison Between Verbal and Written Arguments

Poster – Eun Kyung Lee, Korea National University of Education, San 7 Darakri, Gangnaemyeon Chungwonkun, Chungbuk 363-791, The Republic of Korea; skddlwndls@naver.com*

Nam-Hwa Kang, Korea National University of Education

The purpose of this study was to explore whether physics teachers argue about physics content between verbal and written arguments. In this study, five physics teachers who were enrolled in a graduate-level physics education course completed a series of tasks in which they had opportunities to argue about physics content. Data sources included group discussions, written arguments, and individual interviews. Group discussions and interviews were transcribed for analyses. Using Toulmin's argumentation scheme (Toulmin, 2003), the physics teachers' arguments during group discussion and in writing were analyzed. The finding showed that the teachers constructed much more elaborated arguments in writing than in group discussion. They used more grounds and warrants in making claims. Another finding was that the teachers selectively utilized what their colleagues' ideas shared during group discussion in their written arguments. In particular, other teachers' ideas were utilized in constructing rebuttals. Reasons behind these findings were inferred.

*Sponsored by Nam-Hwa Kang

PST1D04: 9:15-10 p.m. The Education Program for Physics Teachers in South Korea from the Viewpoint of PCK

Poster – Chang Hyun Lee, Korea National University of Education, San 7 Darakri, Gangnaemyeon Chongwongun, Chungbuk 363-791, The Republic of Korea; findingnemo@naver.com*

Nam-Hwa, Kang Korea National University of Education

Teaching quality is the most important factor in determining the quality of education. The teacher is the critical medium of teaching quality. As for subject matter teaching, pedagogical content knowledge is the core of teacher quality. Even though preservice physics teachers exit a teacher education program with some preparation in PCK, their knowledge is further developed through various kinds of professional development courses sponsored by Korea Ministry of Education, Local Educational Agencies after appointment in schools. The purpose of this study was to examine the degree to which PCK was emphasized in continuing professional development provided to inservice physics teachers and whether the opportunities were meeting the needs of the teachers. Data included observation and survey of four physics teachers in a professional development course. Findings showed that among the currently available PD programs, 32% were about PCK. The PCK content mostly focused on teaching strategies while knowledge about students and resources were less focused. The four teachers interviewed indicated that the PD programs were short of meeting their professional needs. Implications from the findings were discussed.

*Sponsored by Nam-Hwa Kang

PST1D05: 8:30-9:15 p.m. What Happens When Light from the Sun Shines on Earth?

Poster – Emily H. van Zee, Oregon State University, 267 Weniger Hall, Corvallis, OR 97331; Emily.vanZee@science.oregonstate.edu

Henri Jansen, Kenneth Winograd, Oregon State University

This question was the guiding theme for a physics course for prospective elementary and middle school teachers. Emphasis was on questioning, predicting, exploring, and discussing what one thinks and why. The course also emphasized integrating physics and literacy learning. Units included the nature of light phenomena, the nature of thermal phenomena, the influence of light and thermal phenomena on local weather, the influence of light and thermal phenomena on global climate, the nature of astronomical phenomena such as the phases of the moon, and reflection on science teaching and learning. The course engaged the prospective teachers in identifying resources upon which to build, developing powerful ideas based on evidence, using those powerful ideas to develop an explanation for an intriguing physical phenomenon, developing mathematical representations for the phenomenon, and then using those mathematical representations to estimate a quantity of interest. Partially supported by National Science Foundation Grant No. DUE-0633752.

E – Pre-college/Informal and Outreach

PST1E01: 8:30-9:15 p.m. CA$HEd: Integrating Heliophysics Concepts into the Classroom

Poster – Kathryn Whitman, University of Hawaii at Manoa, 2644 Pacific Heights Road, Honolulu, HI 96813; ktindiana@hotmail.com

Michael Nassir, Mary Ann Kadaooka, University of Hawaii at Manoa

At the beginning of 2010, the Center for Advancing $ystemic Heliophysics Education (CA$HEd) was established to promote the education and outreach of solar astronomy and heliophysics. CA$HEd strives to engage teachers, students, and the general public through educational activities that promote the conceptual understanding of the Sun and solar physics. Over the past three years, CA$HEd has applied many approaches to advancing heliophysics outreach including public lectures, workshops for students and teachers, curriculum development with Master Teachers, mentoring science fair research projects by middle and high school students, and classroom visits by astronomers. CA$HEd scientists have worked closely with 10 Master Teachers in Hawaii to develop classroom curriculum that provides students with the concepts they need to understand topics in heliophysics while satisfying science standards. An overview of the CA$HEd program and a selection of key heliophysics concepts will be presented.

PST1E02: 9:15-10 p.m. Comprehensive Model for Meaningful STEM Integration in the Physics Classroom

Poster – Heather E. Buskirk, Johnstown High School, 1 Sir Bills Circle, Johnstown, NY 12095; heather.buskirk@gmail.com

Bradford K. Hill, Beaverton School District

Together, the Patterns Approach for Physics, data driven engineering projects, and computational reasoning provide a comprehensive approach to teaching and learning physics. Instruction throughout the course is framed using the question "How do we find and use patterns in nature to predict the future and understand the past"? Each instructional unit begins with scenario and accompanying research question which prompts them to an investigation. Students start by making initial guesses which is contrasted with a data-informed prediction, found through extrapolation of the pattern in the data. Additionally, each unit involves an iterative, data- driven engineering project require students to apply patterns of physics, mathematical problem solving, and the tools of technology to solve a problem. Throughout the experience students are repeatedly modeling the real work of scientists and engineers and thus gain a greater understanding of the nature of both physics and engineering.

PST1E03: 8:30-9:15 p.m. Connecting Scientists and Children through In-Person and Virtual Lab Tours*

Poster – Robert D. Niederriter, University of Colorado-Boulder, 390 UCB, Boulder, CO 80309-0390; robert.niederriter@colorado.edu

Kathleen Hinko, University of Colorado-Boulder

Through the Partnerships for Informal Science Education in the Community (PISEC) program, undergraduate and graduate student volunteers from the University of Colorado aim to increase interest in and understanding of science among students at local elementary and middle schools. Many children might never imagine themselves as scientists without the chance to get to know scientists and see the daily work they do. Field trips to the University of Colorado, featuring tours of labs, have long been a staple of PISEC and are much enjoyed by students. To further connect students to the science and scientists, we have filmed virtual lab tours which give an inside view into the research of PISEC scientist volunteers. We expect these videos to further bridge the gap between students and scientists, encouraging children to consider studying science.

*(More about PISEC: http://www.colorado.edu/physics/PISEC/)

PST1E04: 9:15-10 p.m. Physical Science Day: Design, Implementation, and Assessment*

Poster – Liang Zeng, The University of Texas-Pan American, Department of Physics and Geology, 1201 W. University Drive, Edinburg, TX 78539; zengl@utpa.edu

Mark Cunningham, Steven Tidrow, Dorina Chipara, Chris Smith, Hector Leal, The University of Texas-Pan American

Maria Luisa Guerra, Edinburg Consolidated Independent School District, Edinburg, TX

Science coordinators from local school districts have reported their students do not know what physics is about or about the wide range of professions physicists qualify for, and thus lack interest in learning physics. Physical Science Day at The University of Texas- Pan American (UTPA), in collaboration with Edinburg Consolidated Independent School District, has been designed, developed, and implemented to raise the awareness of physics as a foundation of science, engineering, and technology disciplines and promote students to study in physical science degree programs at UTPA. Through activities including lab experiments and student testimonies, our results show that the event is effective at increasing student knowledge about Physics, Physical Science and Chemistry programs as well as in stimulating youth interest toward studying such disciplines at UTPA. Due to the success of Physical Science Day, we are currently expanding the scale of the event to support the participation of other interested school districts.

*This project would not have been possible without the great guidance and strong support of Ms. Maria Luisa Guerra. She proposed the idea that we need to bring high school students to college campus rather than we go to high school campuses to recruit because students need to see what the college has to offer.

PST1E05: 8:30-9:15 p.m. CAPStone: An MSP Program in Durham, NC*

Poster – Alice D. Churukian, University of North Carolina at Chapel Hill, Department of Physics and Astronomy, Chapel Hill, NC 27599; adchurukian@unc.edu

Cynthia Copolo, Summit Solutions Consultancy

Durham Public Schools and members of the UNC Physics and Astronomy Department partnered to develop a professional development program in physical science content for K-8 teachers' Curriculum Alignment in Physical Science: Taking Ownership of New Essentials (CAPStone). The focus of the program is improving physical science education for kindergarten through 8th grade students by providing a high-quality professional development program that will increase teachers' content knowledge and provide them with an instructional toolkit for teaching physical science content. In its third year, the program has reached nearly 100 teachers in Durham and surrounding school districts and impacted over 10,000 students. An overview of the program and its impact on teachers and students will be discussed.

*Supported by United States Department of Ed; Title II, Part B Funds NC MSP grant Cohort 7 (ref. OMB No. 1810-0669)

F – Other A

PST1F01: 8:30-9:15 p.m. F=qvxB: v is With Respect to What?

Poster – Kent W. Scheller, University of Southern Indiana, 8600 University Blvd., Evansville, IN 47712; kschelle@usi.edu

Tom Pickett, University of Southern Indiana

The magnetic force, F=qvxB, on a charged particle moving in a magnetic field is typically introduced in the second semester of the introductory physics sequence. When presented to students, it is often assumed that the velocity of the charge used in this calculation is relative to the magnetic field in which it travels. Here we demonstrate with a couple of gedanken experiments the actual relativity of the magnetic force and to what the charge's velocity is relative.

Tuesday, July 16 Highlights

REGISTRATION	7 a.m–4:30 p.m.	Plaza Foyer
Fun Run/Walk	6:30–7:30 a.m.	Offsite
Exhibit Hall Opens	10 a.m.–4 p.m.	Exhibit Hall
Gift Card Raffle	10:15 a.m.	Exhibit Hall

PLENARY 9–10 a.m. **Grand Ballroom I**

Alan Nathan — The Physics of Baseball

APS PLENARY 2–3:30 p.m. **Grand Ballroom I**

Producing Superheavy Elements

***TPT* 50th Anniversary Session** 10:30-12:30 Pavilion East

COMMERCIAL WORKSHOPS

Perimeter Institute	9:30-10:30 a.m.	Galleria III
Physics2000	9:30-10:30 a.m.	Galleria I
Pearson	9:30–10:30 a.m.	Salon I
Perimeter Institute	12:30–2 p.m.	Galleria III
Expert TA	12:30–2 p.m.	Skyline III
Vernier	12:30–2:30 p.m.	Pavilion East
PASCO	1–2 p.m.	Skyline IV

COMMITTEE MEETINGS, 12:30–2 p.m.

–Laboratories	Executive Suite
–Interests of Senior Physicists	Directors Suite
–Teacher Preparation	Council Suite
–Physics in Undergrad. Educ.	Studio Suite
–Women in Physics	Forum Suite
–PTRA Institute Followup	Senate Suite

Afternoon Break	3:30–4 p.m.	Exhibit Hall
Kindle Raffle	3:45 p.m.	Exhibit Hall

COMMITTEE MEETINGS, 5–6:30 p.m.

–Bauder Fund	Senate Suite
–ALPhA Meeting	Studio Suite
–Graduate Education in Physics	Council Suite
–Science Education for the Public	Forum Suite
–Educational Technologies	Directors Suite
–Awards (closed)	Executive Suite

AAPT SUMMER PICNIC SPONSORED BY VERNIER

6:30–8 p.m. Portland Center for Performing Arts

DEMO SHOW – PHYSICS CENTER STAGE

8–9:30 p.m.

Portland Center for Performing Arts – Newmark Theatre

Session CA: PIRA Session: Managing Instructional Resources in an Era of Increasing Enrollments

Location: Broadway I/II
Sponsor: Committee on Apparatus
Date: Tuesday, July 16
Time: 7:30–8:40 a.m.

Presider: Keith Warren

CA01: 7:30-8 a.m. Demonstrations in Larger Lecture Halls

Invited – Samuel Sampere, Syracuse University, Department of Physics, 201 Physics Building, Syracuse, NY 13244; smsamper@syr.edu

We can find most any apparatus desired to teach any physics course in commercial catalogues. These items are typically intended for smaller classroom environments. Large enrollments make small classrooms rare at larger colleges and universities. Certainly at my institution, such small-scale apparatus is less than impressive when viewed in a room filled with 300 students. Instructional resource managers must make use of increasingly smaller budgets while still meeting the educational needs of our instructors and students. Fortunately it is often cheaper to construct apparatus in-house, and of equal or superior quality, to that obtained commercially. While you're at it, you may as well scale up the apparatus, giving the audience an improved view. I will show several examples of apparatus that are more flexible and impressive than their commercial counterparts, constructed at Syracuse University, and even some not found in catalogs, but certainly in every introductory physics textbook.

CA02: 8-8:30 a.m. Using Students' Personal Electronic Devices in Teaching Laboratories*

Invited – Michael Paesler, North Carolina State University, Physics Department, Raleigh, NC 27695-8202; Paesler@ncsu.edu

Colleen Lanz, William Sams, North Carolina State University

In the current academic environment, educational institutions are often forced to respond to increased enrollments. Laboratory courses that involve space, equipment, and personnel resources are particularly stressed. The introduction of kitlabs can ease this stress. Furthermore, synchronous kitlabs where students' live video-chat with their lab TA can provide a laboratory experience much like traditional laboratories. Data collection and manipulation, however, often suffer due to a lack of electronic equipment associated with kits. An effort at NC State exploits the rapidly emerging capabilities of the students' own personal electronic devices to address this issue. Employing smartphones (as well as tablets and laptops), the program utilizes students' electronic devices' internal sensors for data collection. We describe this program initially designed for the first semester of a college-level general physics course, showing how specific laboratories can be developed with no sacrifice in data-taking or manipulation as compared to the traditional laboratory experience.

*Research is supported by the NC State Large Course Redesign Program and the National Science Foundation.

CA03: 8:30-8:40 a.m. Labs Outside the Lab: Addressing Enrollment Increase with Portable Labs

Contributed – William R. Sams, North Carolina State University, Raleigh, NC 27604; wrsams@ncsu.edu

M A. Paesler, North Carolina State University

eTALK, Enhanced Teaching Assistance to aid Learning with Kitlabs, is a teaching laboratory reform under development at NC State University. It offers an alternative to traditional laboratory courses that use proprietary loggers and probes. eTALK instead utilizes students' personal electronic devices, portable kits, and online teaching assistant contact. An eTALK lab thus allows students to focus on the experiment rather than on the mastery of a learning curve associated with unfamiliar probes and equipment. Furthermore, a portable eTALK lab does not sacrifice the important real-time TA interactions that characterize traditional lab courses and are often missing in endeavors to develop distance learning labs. The eTALK project is currently deployed in first-semester calculus-based general physics labs at NC State. Results from the project, including a comparison with traditional labs, will be presented.

*eTALK is supported by the NC State Large Course Redesign Program and the National Science Foundation.

Session CB: Using Simulations and Models for Pre-High School Teaching

Location: Broadway III/IV
Sponsor: Committee on Physics in Pre-High School Education
Date: Tuesday, July 16
Time: 7:30–9 a.m.

Presider: Nina Morley Daye

CB01: 7:30-8 a.m. Models and Simulations with Preservice Elementary Teachers

Invited – Wendy K. Adams, University of Northern Colorado, Department of Physics, Greeley, CO 80631; wendy.adams@unco.edu

At the University of Northern Colorado our Teacher preparation program for preservice elementary teachers includes a capstone course titled "Principles of Scientific Inquiry – Finding Order in Chaos." The overarching learning objectives for the course include understanding what it means to "do science" and to provide ideas about how to teach this explicitly to elementary students; although, it is not a methods course. One of the subobjectives of "doing science" relates to models—what are different types of models and what makes them useful. In this presentation I'll describe how this objective is integrated throughout the course and present several specific activities where the students engage with scientific models. Some of the activities use everyday hands-on materials, some use ideas or representations, while others use PhET Interactive Simulations.

CB02: 8-8:30 a.m. PhET's Future: Enhanced Teacher Resources, HTML5, and Touch!

Invited – Ariel J. Paul, PhET Interactive Simulations, University of Colorado, Boulder, CO 80309; ariel.paul@colorado.edu

Katherine Perkins, Emily Moore, Noah Podolefsky, The PhET Team, University of Colorado

The PhET Interactive Simulations project (http://phet.colorado.edu) has several new efforts to support K-12 teachers in the modern classroom. For the past three years, we have been specifically researching design and use of our interactive simulations at the middle school level. This endeavor has improved our design principles and led to the development of guidelines for effective implementation and facilitation of our simulations in the classroom. To share the resources we have created for teachers, we are creating a companion website specifically devoted to teachers and the fostering of our teacher user community. In addition, we have begun a large-scale effort to port PhET sims to HTML5 to support the changing landscape of technology and allow our sims to run on touch-enabled devices. This effort will not only increase the accessibility of PhET, but also opens exciting possibilities to study the learning opportunities afforded by a touch interface.

CB03: 8:30-9 a.m. Simulations and Models that Engage Students in Thinking about Physics

Invited – Susan B. Ramsey, Virginia Advanced Study Strategies, 820 Bruce St., South Boston, VA 24592; susanramsey@svhed.org

In this session, we will look at a variety of online simulations and models as well as paper and pencil simulations and models that help connect students to physics concepts with meaningful understanding. The use of student prediction prior to the introduction of a simulation or model is crucial, and adequate time must be given for students to correct their misconceptions and explore the concept. Online simulations and models are also great pre-teaching material so that students come to class with exposure to a concept and more quality questions. I will provide a list of current online resources that span physics as well as other science concepts to help students develop an interest in physics.

Session CC: Teaching Physics Online

Location: Skyline III
Sponsor: Committee on Physics in Two-Year Colleges
Date: Tuesday, July 16
Time: 7:30–8:40 a.m.

Presider: Brian Holton

CC01: 7:30-7:40 a.m. The Effect of Online Lecture on Performance in a Physics Class

Contributed – John Stewart, University of Arkansas, Physics Building, Fayetteville, AR 72701; johns@uark.edu

This talk will describe the difference in student performance between students attending lecture in person and students choosing to watch the lecture on video as part of an online class. The video part of the class was implemented mid-semester so that the performance of the same set of students could be compared. Video watching patterns will be presented. The difference in performance of students primarily watching video to those primarily attending lecture on in-semester examinations and the Conceptual Survey of Electricity and Magnetism will be presented. The effect of the access to video on student study behavior and time management will be analyzed. In general, while the students electing to primarily watch video were a measurably different population than the students electing to primarily attend lecture, the shift in performance from attending lecture to watching video was small.

CC02: 7:40-7:50 a.m. Barriers to Effective Online Physics Laboratory Courses*

Contributed – Ann M. Reagan, IEC Services, PO Box 22, Lusby, MD 20657; annreagan@live.com

Many barriers exist to providing laboratory content online, including faculty acceptance, accreditation, student expectations, cost, liability, academic integrity, accessibility, transferability, persistence rates, student privacy, and a lack of objective assessment standards for evaluating the pedagogical effectiveness of lab courses. This study focuses on the transferability of online lab credits between institutions of higher learning. Methodology and results are given for a nationwide survey of 120 college/university department chairs and transfer specialists assessing the transferability of credits for laboratory courses delivered in various online formats. A preliminary assessment is also made of the pedagogical effectiveness of each of these online formats against the AAPT "Goals of the Introductory Physics Laboratory" and the goals of laboratory experiences identified in the NRC "America's Lab Report."

*See http://tiny.cc/w7vpsw pp 34-35 for descriptions of formats for delivery of online lab content.

CC03: 7:50-8 a.m. Collaborative Online Experimentation and Pooling Data with Google Docs

Contributed – Dean A. Zollman, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506; dzollman@phys.ksu.edu

Adrian Madsen, Kansas State University

In some experiments or simulations collecting a large number of measurements can be very helpful in understanding a concept. A difficulty arises because repeating measurements many times by an individual student is somewhat tedious. We have addressed this issue by asking each student in a class to collect several points and then enter the results into a common Google spreadsheet. In one case the probabilistic nature of quantum measurement was investigated through collapse of the wave function in an interactive visualization (http://phet.colorado.edu/en/simulation/quantum-tunneling). By making repeated "Quantum Measurements" using a button in the program, students see that the wave function collapses at different locations. Another activity had students run the Rutherford Scattering experiment at a remote location (http://rcl-munich.informatik.unibw-muenchen.de/). Each student collected data at several different angles. For both the remote experiment and the visualization the pooled data were analyzed in class.

CC04: 8-8:10 a.m. Online Astronomy

Contributed – James Dickinson, Clackamas Community College, 19600 S. Molalla Ave., Oregon City, OR 97045; jamesd@clackamas.edu

Clackamas Community College offers a full one year sequence of general astronomy in an online format. The laboratory portion of the course is accomplished using a combination of Starry Night College planetarium software, interactive websites, and simple at home activities. In this talk examples of these will be presented and demonstrated.

CC05: 8:10-8:20 a.m. Einstein via MOOC

Contributed – Larry Lagerstrom, Stanford University, Sweet Hall, Stanford, CA 94305-3085; lagerstrom@stanford.edu

I will report on the experience of teaching a massive open online course on "Understanding Einstein: The Special Theory of Relativity" to a wide range of students. The course offered participants the choice of three approaches to the material: a more quantitative approach (involving weekly problem sets), a more qualitative approach (involving a creative project), and an auditing approach. Course content was presented via video clips, handouts, and discussion forums, along with two recommended readings: Einstein's original paper on the special theory of relativity, and a profile on the life and work of the young Einstein (L. Randles Lagerstrom, "Young Einstein: From the Doxerl Affair to the Miracle Year," http://www.amazon.com/dp/B00BKKHS4U).

CC06: 8:20-8:30 a.m. Online Tools for Supporting Teaching and Learning About Energy

Contributed – Jim Minstrell, FACET Innovations, 1314 NE 43rd St., Ste. 207, Seattle, WA 98105; JimMinstrell@FACETInnovations.com

Adam Schmirer, Union HS, Evergreen SD, Vancouver WA

James Cantonwine, Shahala MS, Evergreen SD, Vancouver WA

Visit Diagnoser.com. The research-based site gives teachers tools to help support teaching and learning key energy ideas that build on learner thinking. The online system presents diagnostic assessments and instructional activities that address learning goals and misconceptions. Elicitation questions help teachers learn what students are thinking initially about core ideas or a common energy related situation. Activities can motivate students to want to know and to pursue inquiry. When students seem to understand, the teacher can assign a set of online diagnostic questions that will identify students' specific conceptual difficulties. The students get feedback on what they need to work on. Meanwhile, the data also go into a Teacher Report from which the teacher can know the problematic facets of thinking that still seem to be impeding deeper understanding. Then, there are prescriptive activities and links to scenarios to address the diagnosed problematic facets of thinking.

CC07: 8:30-8:40 a.m. Teaching an Online, Synchronous Class Across Multiple Institutions

Contributed – Michael J. Reese, Johns Hopkins University, 3400 N. Charles St., Baltimore, MD 21218; mreese@jhu.edu

Meiyun Chang-Smith, Oak Ridge National Laboratory

Collin Broholm, Johns Hopkins University

Neutron scattering is a specialized tool too narrow for individual schools to support an entire graduate course. Recognizing this challenge, the Oak Ridge National Lab formulated the concept of coordinating with six research universities to deliver a synchronous, online course on neutron scattering in quantum condensed matter physics. Faculty at each of the six institutions led multiple lectures and discussions with students online. While specifically created for students at the core institutions, the course was made available to the general public and was accessed by graduate students and researchers around the world. While only three to seven students per hosting institution enrolled in the course, over 150 individuals have accessed the materials at the course website. The presenter will describe the course design process, technologies chosen, and the support structure used. He will also discuss the challenges encountered from the perspective of both faculty members and the instructional support staff.

Session CD: Teaching Assistants and Learning Assistants

Location: Skyline IV
Date: Tuesday, July 16
Time: 7:30–8:50 a.m.

Presider: Connie Wells

CD01: 7:30-7:40 a.m. Impact of a Learning Assistant Program on Student Outcomes in a Calculus-based Mechanics Course

Contributed – David Donnelly, Texas State University-San Marcos, 601 University Drive, San Marcos, TX 78666; donnelly@txstate.edu

Hunter G. Close, Eleanor Close, Texas State University-San Marcos

The calculus-based introductory mechanics course at Texas State University-San Marcos is a four-credit hour course with approximately three hours of lecture and three hours of lab per week. As part of its strategic plan, the department has set a goal of introducing Learning Assistants in all introductory classes in the next five years. To initiate this, a Learning Assistant program was piloted in spring 2012 in one section of calculus-based mechanics, and expanded to all sections of calculus-based mechanics in fall 2012. We will discuss the structure of the program, and present data on the impact it has had on student learning outcomes, including FCI gains, Mechanics Baseline Test scores, and student retention.

CD02: 7:40-7:50 a.m. Learning Assistants and Relationships. Baiting the Hook

Contributed – Doug C. Steinhoff, University of Missouri, Columbia, MO 65203; steinhoffd@missouri.edu

Dr. Karen King, University of Missouri

The Learning Assistant (LA) program at the University of Missouri was designed to recruit and prepare preservice physics teachers. Other institutions reported low percentages of LAs choosing teaching careers, so we decided to take a slightly different approach. We listed the greatest attributes of teaching and decided that the relationships we build with our students was near the top. With the collaboration of our local public school district and very supportive freshman physics teachers, we placed our LAs in ninth grade physics classrooms on a daily basis. This increase over a typical field experience allowed them to develop relationships with students and be more helpful in the classroom. Our LAs are enthusiastic about the program and the field of education. The students love having them in class as an extra resource. In less than a year, over 80% of our LAs have either considered or strongly considered becoming teachers!

CD03: 7:50-8 a.m. Physics Learning Assistants – Discuss the Value of the LA Program*

Contributed – Geraldine L. Cochran, Florida International University, 11200 S.W. 8th St., ZEB 212, Miami, FL 33199; gcoch001@fiu.edu

Laird H. Kramer, David T. Brookes, Eric Brewe, Florida International University

At Florida International University we have implemented a learning assistant (LA) program based on the Colorado Learning Assistant Model (Otero, Pollock, Finkelstein, 2010), designed to help prospective and preservice science and mathematics teachers to develop pedagogical content knowledge, develop as reflective practitioners, and gain experience in teaching early in their academic careers. As a part of the program, LAs are helped to develop reflective practice. We believe that reflective practice is a kind of deliberate practice that helps novice teachers to hone their teaching skills as they strive toward expertise in teaching. To better understand the needs of our LAs in this development, we interviewed a number of them to better understand their perspectives in regard to teaching, reflection, and expertise. Analysis of these interviews revealed LAs' perspectives on the value and purpose of the LA program. LA viewpoints in this regard will be presented.

*Research funded by NSF grant # 0802184

CD04: 8-8:10 a.m. Training Student-Centered Teachers: TAs Help TAs Adopt Researched Pedagogy

Contributed – Anneke Timan, Queen's University, 99 University Ave., Kingston, ON K0H2T0, Canada; anneke.timan@gmail.com

James Fraser, Queen's University

Teaching assistants (TAs) are both the present and the future of sustainable quality physics education. However, prior research has raised concerns with limited TA training and/or training that attempts to "fix" TAs without giving sufficient respect to their prior beliefs and teaching experiences. In our study of four first-year physics courses, we applied a community-centered model to TA professional development. During weekly course-specific tutorial preparation meetings, we encouraged TAs to experiment with research-based pedagogy and share their successes and failures. The facilitator of these weekly preparation sessions attended some tutorials to provide feedback and promote teaching peer review. We observed interconnected influences from perceptions of professors' commitment to teaching, TAs' and peers' teaching experiences, and department teaching culture on fostering or discouraging TA buy-in to researched pedagogy. Respectful TA professional development that builds physics teaching communities shows promise for increasing adoption of active learning pedagogy in physics education.

CD05: 8:10-8:20 a.m. Improving the Role of Teaching Assistant

Contributed – Chu Dang, The Chinese University of Hong Kong, Rm224, Science Center, North Block, CUHK Hong Kong, HK 999077 Hong Kong, China; chudang.cuhk@gmail.com

Teaching assistants play a very important role in teaching university physics. They not only help grading assignments, but also conduct exercise classes, tutorials, and even some lectures. Research seldom has focused on how to improve TA's role. As a teaching assistant myself, I have encountered difficulties and challenges when helping students understand physics concepts. My investigation is on how to best assist teacher and students and what kind of bridge should the TA build between teacher and students.

CD06: 8:20-8:30 a.m. Exploring Pedagogical Content Knowledge of Physics Instructors and Teaching Assistants Using Force Concept Inventory*

Contributed – Chandralekha Singh, University of Pittsburgh, Department of Physics, Pittsburgh, PA 15213; hitren86@gmail.com

Alexandru Maries, University of Pittsburgh

The Force Concept Inventory (FCI) has been widely used to assess student understanding of introductory mechanics concepts by a variety of educators and physics education researchers. One reason for this extensive use is that many of the items on the FCI have strong distractor choices that correspond to students' alternate conceptions in mechanics. Instruction is unlikely to be effective if instructors do not know the common alternate conceptions of introductory physics students and explicitly take into account students' initial knowledge state in their instructional design. We used the FCI to evaluate the pedagogical content knowledge of both instructors and Teaching Assistants (TAs) of varying teaching experience. For each item on the FCI, the instructors and TAs were asked to identify which incorrect answer choice they believed would be most commonly selected by introductory physics students. We used the FCI pretest and post-test data from a large population (~900) of introductory physics students to assess the pedagogical content knowledge of these educators. We will present these results.

*Work supported by the National Science Foundation.

CD07: 8:30-8:40 a.m. Examining and Connecting Physics Teaching Assistants' Beliefs and Practices

Contributed – Benjamin T. Spike, University of Colorado, Boulder, Department of Physics, UCB 390, Boulder, CO 80309-0390; spike@colorado.edu

Noah D. Finkelstein, University of Colorado, Boulder

Physics Teaching Assistants (TAs) play an important role in supporting transformed learning environments, often by engaging students in ways that may differ from their own experience as learners. Through their participation in these environments, TAs are developing beliefs about not only what it means to teach, but also how to put it into practice. In this talk we present a validated and refined framework for connecting TAs' stated beliefs about teaching to their enacted instructional practices, and apply this framework to sample interview and classroom video data. We conclude with a discussion of how this framework may be used to examine variation in beliefs and practices, track the development of beliefs over time, and inform TA preparation.

CD08: 8:40-8:50 a.m. Institutionalizing Doctoral Students' Training

Contributed – Raluca Teodorescu, The George Washington University, 725 21st St., NW, Washington, DC 20052; rteodore@gwu.edu

Elisabeth Rice, Michelle Allendoerfer, Hartmut Doebel, Patricia Dinneen, The George Washington University

The George Washington University, a major research university, is also strongly committed to outstanding teaching. An important part of the teaching commitment refers to training doctoral students to become future faculty. This training seeks to expose these students to active learning techniques. We will present how the university and the Department of Physics initiatives led to an approach to train the students, including: a) a mandatory online graduate teaching assistant certification course, b) a mandatory in-class training program within the department, and c) an optional in-class future faculty training program. We will discuss our framework and our multi-dimensional assessment that features graded papers, graded classroom observations, interviews with outstanding teachers, surveys, and instructors' and students' evaluations. This project is sponsored in part by the GW Teaching and Learning Collaborative and the GW Office of Graduate Student Assistantships and Fellowships.

Session CE: Student Attitudes, Confidence, Self-Efficacy, and Motivation

Location: Salon Ballroom II/III
Sponsor: AAPT
Date: Tuesday, July 16
Time: 7:30–8:50 a.m.

Presider: Natan Samuels

CE01: 7:30-7:40 a.m. Assessing Student Learning by Gain in their Confidence

Contributed – Niklas Hellgren, MGAessiah College, One College Ave., Suite 3041, Mechanicsburg, PA 17055; NHellgren@messiah.edu

Abaz Kryemadhi, Messiah College

A concern with multiple-choice concept tests is whether a correct answer reflects true knowledge or just a lucky guess. We report on a study where for each question of a standard concept test we also asked the students on a 1-to-5 scale how confident they were in their answer. As expected, in most cases we observed a correlation between gain in correct answers and gain in confidence. However, we give examples where learning is demonstrated by an increase in confidence only, even when there is no actual gain in number of correct answers. In addition, using this approach, student misconceptions can easily be identified by a high confidence level associated with an incorrect answer.

CE02: 7:40-7:50 a.m. Shedding Light on Confusion

Contributed – Jason E. Dowd, Duke University, Box 90338, 130 Science Drive, Durham, NC 27708; jason.dowd@duke.edu

Ives S. Araujo, Universidade Federal do Rio Grande do Sul

Eric Mazur, Harvard University

Physics instructors typically try to avoid confusing students. However, educators have challenged the truism, "confusion is bad," as far back as Socrates, who asked students to question assumptions and wrestle with ideas. So, how should instructors interpret expressions of confusion? During two semesters of introductory physics involving Just-in-Time Teaching (JiTT) and research-based reading materials, we evaluated performance on reading assignments while simultaneously measuring students' self-assessment of their confusion over the material. We examined the relationship between confusion and performance, confidence in reasoning, pre-course self-efficacy and other measures of engagement. We find that expressions of confusion are negatively related to initial performance, confidence in reasoning and self-efficacy, but positively related to final performance when all factors are considered simultaneously. In other words, we are able to identify and largely isolate a productive role of confusion. Ultimately, this approach allows instructors to assess students' metacognition and perhaps even promote such constructive confusion.

CE03: 7:50-8 a.m. In-the-Moment Affective Experience in Calculus-based Physics

Contributed – Jayson M. Nissen, University of Maine, 120 Bennett Hall, Orono, ME 04469; jayson.nissen@maine.edu

Jonathan T. Shemwell, Univerisity of Maine

Utilizing an in-the-moment measurement technique called the Experience Sampling Method (ESM), we collected affective experience data from students in a university calculus-based physics course and in the students' other STEM and non-STEM courses. Participants in the ESM completed very quick surveys in the midst of classes and other activities during two one-week periods. Surveys were prompted by text message at semi-randomly chosen points throughout each day. Students exhibited lower self-efficacy and greater frustration and stress in the physics course than in the other subject courses. The presentation will describe the ESM method and present our findings with implications for physics instruction.

CE04: 8-8:10 a.m. Characterizing Physics Students' Scientific Communication Skills for Non-Expert Audiences

Contributed – Kathleen A. Hinko, University of Colorado, Boulder, 440 UCB, Boulder, CO 80309; kathleen.hinko@colorado.edu

Cameron Gil, Noah D Finkelstein, University of Colorado, Boulder

The ability to effectively communicate scientific content to non-expert audiences is of increasing importance to scientists and the public at large. Drawing on both observations of and literature about expert practitioners, we present a framework for assessment of basic scientific communication skills of scientists communicating with non-expert audiences. Drawing from this framework, we measure scientists' use of language, style, and gesture to infer their broader models of communication that are enacted in varying settings. Demonstrating the utility of this framework, we analyze videos of physics undergraduate and graduate students charged with explaining 1) the concept of velocity and 2) their scientific research, as if they were speaking to an audience of middle school children. Using these data, we characterize university physics students' scientific communication skills and inferred models of communication. Improvement in scientific communication is observed for university students after volunteering in an after school physics education program even after one semester.

CE05: 8:10-8:20 a.m. Boundary Objects that Mediate Students' Motivation to do Physics

Contributed – Ben Van Dusen, CU Boulder, School of Education, 249 UCB, Boulder, CO 80309; benjamin.vandusen@colorado.edu

Valerie Otero, CU Boulder

This physics education research examines how specific tools can serve as boundary objects that mediate between a student's intrinsic motivation and physics. Intrinsically motivating activities are characterized by the extent to which they facilitate a sense of competence, autonomy, and relatedness (known in the literature as basic psychological needs). In our study, we operationalize these constructs and demonstrate that students develop a sense competence, autonomy, and relatedness when engaging in an iPad-enhanced classroom environment. We attribute students' development of motivation for physics to the role of tools--specifically iPads acting as "boundary objects," bridging students' everyday cultural worlds with physics classroom content. The social construct of a "boundary object" will be elaborated to demonstrate how learning physics is, at its heart, a socio-cultural cognitive task. R.M. Ryan. *Journal of Personality*, **63** (1995)

CE06: 8:30-8:40 a.m. Attitudinal Assessment of Curriculum on the Physics of Medical Instruments

Contributed – James K. Johnson, Portland State University, Portland, OR 97201; jojk@pdx.edu*

Warren Christensen, North Dakota State University

Ralf Widenhorn, Grace Van Ness, Elizabeth Anderson, Portland State University

Over the past several years, a curriculum targeting pre-health students and focused on the physics behind biomedical instruments has been in development at Portland State University. Recently, an effort to assess the curriculum's impact on students has begun. Given the hands-on focus of the course and positive feedback from students, we hypothesized that it would positively impact their attitudes toward physics and physics learning. We administered the Colorado Learning Attitudes about small, non-significant shift in student attitudes. This is a promising result, when contrasted with the significant negative shift that is the norm among introductory courses and occurred in our introductory algebra-based physics course. Science Survey (CLASS) in order to cast light on students' attitudes. The survey was administered to the summer course and to introductory algebra-based physics courses at the same university. The summer course "Physics in Biomedicine" produced a small, non-significant shift in student attitudes. This is a promising result, when contrasted with the significant negative shift that is the norm among introductory courses and occurred in our introductory algebra-based physics course.

*Sponsored by: Ralf Widenhorn

CE07: 8:40-8:50 a.m. EBAPS Correlations: The Importance of Epistemology

Contributed – Cameron G. Summers, BYU-Idaho, Department of Physics, Provo, UT 84604; sum11003@byui.edu*

Brian A. Pyper, BYU, Idaho

In looking at correlations between subsets of the EBAPS (Epistemological Beliefs Assessment for Physical Science) and various other measures of student abilities and conceptual understanding, we found some surprisingly strong correlations with some predictable and some unexpected aspects of the students' background, attitudes, and conceptual understanding. We'll report on these data, as well as implications for instruction.

*Sponsored by Brian Pyper

Session CF: Research in Undergraduate Mathematics Education

Location: Galleria II
Sponsor: Committee on Research in Physics Education
Date: Tuesday, July 16
Time: 7:30–9 a.m.

Presider: Warren Christensen

CF01: 7:30-8 a.m. Analyzing Student Understanding in Linear Algebra Through Mathematical Activity

Invited – Megan Wawro, Virginia Tech, Mathematics Department, 460 McBryde Hall, Blacksburg, VA 24061; mwawro@vt.edu*

The purpose of this study is to investigate how students conceptualize span and linear (in)dependence, and to utilize the construct of mathematical activity to provide insight into these conceptualizations. The data under consideration are portions of individual interviews with students in an inquiry-oriented linear algebra course. Through grounded analysis via the framework of concept image (Tall & Vinner, 1991), the range of student conceptions of span and linear (in)dependence are organized into four concept image categories: travel, geometric, vector algebraic, and matrix algebraic. To further illuminate participants' conceptions, a framework was developed to classify engagement in types of mathematical activity: defining, proving, relating, example generating, and problem solving. The coordinated analysis of concept image with engagement in mathematical activity facilitates a nuanced and rich characterization of students' connections within and between the concepts of span and linear (in)dependence.
*Sponsored by Warren Christensen

CF02: 8-8:30 a.m. Beliefs and Strategies for Comprehending Mathematical Arguments

Invited – Keith Weber, Rutgers University, 10 Seminary Place, New Brunswick, NJ 08901; keith.weber@gse.rutgers.edu

In the upper-level collegiate mathematics courses taught for mathematics majors, lectures largely consist of having professors prove theorems for their students. An important assumption behind this instruction is that students can learn mathematics from studying the proofs of others. Unfortunately, both mathematics educators and mathematicians question whether this assumption is true. In this talk, I present strategies that students can use to understand the mathematical arguments that they read as well as unproductive beliefs that students hold that may inhibit them from gaining this understanding. These strategies and beliefs were hypothesized based on qualitative studies in which students were observed reading proofs and confirmed by a quantitative survey with 83 mathematicians and 175 mathematics majors that demonstrated that mathematicians desired that their students use strategies that they did not hold and that students held beliefs that mathematicians found undesirable.

CF03: 8:30-9 a.m. Three Interpretations of the Matrix Equation Ax=b

Invited – Michelle Zandieh, Arizona State University, Tempe, AZ 85284; zandieh@asu.edu

Christine Larson, Florida State University

Over the past years we have come to reflect on the nature of the cognitive demands that a sophomore or junior level linear algebra course places on students. Many of the central ideas in introductory linear algebra can be interpreted through the lens of the matrix equation Ax=b where A is an mxn matrix, x is a vector, and b is a vector. We describe a framework that highlights the challenges involved in interpreting Ax=b both symbolically and graphically as (1) a system of equations, (2) a vector equation, and (3) as a linear transformation. In particular we note how differently the vector x must be viewed in each of these interpretations. We present vignettes of student thinking that illustrate how the framework may be used to make sense of the ways in which students blend ideas as they begin learning linear algebra.

Session CG: Assessment of Informal Science Education

Location: Parlor A/B
Sponsor: Committee on Science Education for the Public
Date: Tuesday, July 16
Time: 7:30–9 a.m.

Presider: Amber Stuver

CG01: 7:30-8 a.m. Practical Approaches to Evaluating Informal Science Learning

Invited – Scott Pattison, Oregon Museum of Science and Industry, 1945 SE Water Ave., Portland, OR 97214; spattison@omsi.edu*

The opportunities for science learning outside of school are rich and varied, including visits to museums and science centers, after-school programs and science clubs, outdoor experiences, conversations with families and friends, reading, surfing the web, watching educational television programs, and more. As educators and researchers increasingly recognize, these experiences are a critical part of the nation's science education infrastructure. In this session, the speaker will draw upon over a decade of experience in informal science education to discuss the unique opportunities and challenges associated with evaluating and studying informal learning and describe a variety of evaluation strategies used at the Oregon Museum of Science and Industry as part of program and exhibit development. He will also introduce a more practical approach for non-evaluation professionals, called team-based inquiry, designed to empower educators to incorporate evaluation into their work in order to create more effective informal science learning experiences.
*Sponsored by Amber Stuver

CG02: 8-8:30 a.m. Little Shop of Physics: It's Fun, But Is It Effective?

Invited – Brian Jones, Colorado State University, Physics Department, Fort Collins, CO 80523; brian.jones@colostate.edu

Michael Lacy, Matthew Aronson, Leonard Albright, Andrea Weinberg, Colorado State University

A glance at the energy and enthusiasm levels of the K-12 students working with Little Shop of Physics hands-on experiment stations reveals an obvious fact: They are having fun. But a decade of careful assessment shows that they are learning science concepts as well. In this talk I'll share the progress of our assessment program, from informal early efforts to our later more formal testing. I will also discuss how assessment of all aspects of our program has guided our efforts. How much time does a student spend with one of our experiment stations? What is the best level of engagement of our undergraduate interns? What is the best way to engage both male and female students? What is the benefit of taking part in the program to our undergraduate interns? The lessons we've learned may be useful to others as they develop their own informal science programs.

CG03: 8:30-9 a.m. Evaluating Informal Learning Experiences

Invited – David R. Heil, David Heil & Associates, Inc., 4614 SW Kelly Ave., Suite 100, Portland, OR 97239; dheil@davidheil.com*

Evaluation is an increasingly important element of both public and private funded projects. This session will explore the nature of informal learning and the role that evaluation plays in helping a project team successfully meet their goals and objectives, introduce a variety of approaches used in informal education evaluation, and share lessons learned from the field. The presenter will describe the value and methodologies of three types of evaluation: Front End, which measures an audience's prior knowledge, interests, needs, and expectations as well as assessing the landscape within which a program or exhibit will be used; Formative, which helps inform the design and revisions of educational programs and exhibits with real data; and Summative, which measures the efficacy and impact of an educational experience. Examples from a range of informal learning experiences will be shared and attendees will be given the opportunity to ask questions about evaluating their own projects.

*Sponsored by Amber Stuver

Session CH: What Does Success Mean in Graduate School?

Location: Pavilion East
Sponsor: Committee on Graduate Education in Physics
Co-Sponsor: Committee on Physics in Undergraduate Education
Date: Tuesday, July 16
Time: 7:30–9 a.m.

Presider: Steve Turley

CH01: 7:30-8 a.m. Highlights From the Second Conference on Graduate Education in Physics

Invited – Renee D. Diehl, Penn State University, University Park, PA 16802; rdiehl@psu.edu

The Second Conference on Graduate Education in Physics was held in January 2013 with more than 100 participants from 74 different institutions. The conference aimed at fostering innovation and creativity in our approach to graduate education in physics, which for many departments is a rather new concept. The fact that the majority of physics PhDs ultimately find permanent employment outside academia, and the changing demands on academic physicists, have led many departments to review their programs and procedures. Presentations and discussions at the conference included the increasing attention being paid to broader and more flexible graduate curricula, forming industrial partnerships, strategies to increase diversity, professional skills training for graduate students and postdocs, improving mentoring practices and instituting family-friendly policies for graduate students. The participants in this conference included diverse group faculty from large and small departments, staff from industry and national labs, and graduate students and postdocs.

CH02: 8-8:30 a.m. Physics Graduate Students: Assess the Program or the Individual?

Invited – Kathie E. Newman, University of Notre Dame, Department of Physics, 225 Nieuwland Science Hall, Notre Dame, IN 46556; newman@nd.edu*

Graduate physics programs are run in a very different way than undergraduate ones. While the early years for a graduate student tend to be spent in graduate courses, serving as teaching assistants, and passing any required examinations, the PhD student spends an even longer period of apprenticeship under a senior research adviser. Graduate programs can be assessed by input (admissions) and output (graduations), research productivity (conference attendance, papers published), and external funding support. A new tool is developing, that of more individual assessment of a given student, what is the student's desired outcome, does he or she obtain success in graduate school, and who decides that? Annual assessments of students help departments as a community to take responsibility globally for all of its students, encouraging soft skills development in addition to the more traditional academic and research related skills.

*Sponsored by Steve Turley

CH03: 8:30-9 a.m. Motivations, Outcomes, and Implications for Reform in Graduate Physics

Invited – Geoff Potvin, Clemson University, M-13 Holtzendorff Hall, Clemson, SC 29634; gpotvin@clemson.edu

Graduate physics has been understudied compared to other levels of education, in part due to its smaller size and the complexity of graduate student experiences. Graduate programs often continue to be organized in ways that have developed organically over many years, rather than as the result of an intentional, evidence-driven cycle of research, assessment, and reform. This has resulted in stagnant retention rates, degree completion times, and particularly low representation of women and other traditionally marginalized students. Further, the factors that lead to successful graduate outcomes remain the subject of much speculation and private empiricism. Drawing from research on student motivations, graduate school outcomes, and productivity, I will present evidence that emphasizes the need for improvement, factors that are critical to the development of productive physicists (which are often overlooked in graduate school), and the impact of the graduate school experience on the careers of physicists.

Session CI: Gender and Sexual Diversity Issues in Physics

Location: Pavilion West
Sponsor: Committee on Women in Physics
Date: Tuesday, July 16
Time: 7:30–8:50 a.m.

Presider: Ramon Barthelemy

CI01: 7:30-8 a.m. Meeting the Needs of Lesbian, Gay, Bisexual, and Transgender Learners in the Physics Classroom

Invited – Mary Hoelscher, University of Minnesota, St. Paul, MN 55108; hoel0039@umn.edu

There is a high need for all teachers to support lesbian, gay, bisexual, transgender, and questioning (LGBTQ) students in the K-12 classrooms to improve students' educational outcomes such as attendance, grades, pursuit of higher education, and to improve psychological health outcomes (Meyers, 2010; GLSEN, 2012; Robinson & Espelage, 2012 and 2013). This presentation provides an overview of recommended actions for teachers generally including advocating for explicitly LGBT-inclusive school policies; providing support for LGBT learners; and generating LGBT-inclusive curriculum (GLSEN, 2012). Specific suggestions for how this translates into practices for physics teachers will be highlighted (Hoelscher, unpublished).

CI02: 8-8:30 a.m. Women's Careers in Physics: Results from the Global Survey of Physicists

Invited – Rachel Ivie, American Institute of Physics, 1 Physics Ellipse, College Park, MD 20740; rivie@aip.org*

Casey Langer Tesfaye, American Insitute of Physics

Previous studies of women in physics have mostly focused on the lack of women in the field. The Global Survey of Physics goes beyond the obvious shortage of women and shows that there are much deeper issues. For the first time, a multinational study was conducted with 15,000 respondents from 130 countries, showing that problems for women in physics transcend national borders. Across all countries, women have fewer resources and opportunities and are more affected by cultural expectations concerning child care. We show that limited resources and opportunities hurt career progress, and because women have fewer opportunities and resources, their careers progress more slowly. We also show the disproportionate effects of children on women physicists' careers. Cultural expectations about home and family are difficult to change. However, for women to have successful outcomes and advance in physics, they must have equal access to resources and opportunities.

*Sponsored by: Ramón Steven Barthelemy

CI03: 8:30-8:40 a.m. Transformative Teaching Techniques: A Women's Studies Course for STEM Majors

Contributed – Elizabeth Holden, University of Wisconsin-Platteville, 219 Engineering Hall, 1 University Plaza, Platteville, WI 53711; holdene@uwplatt.edu

Tammy Salmon-Stephens, University of Wisconsin-Platteville

This session will benefit educators who are looking for transformative teaching methods to develop a better understanding of gender issues, more knowledge, and more strategies to become active in eliminating gender bias, specifically within the fields of physics and engineering. The presenter will discuss strategies to create a safe classroom environment to discuss issues related to women in science, technology, engineering, and mathematics (STEM). She will also discuss techniques to help college students understand their specific roles in gender diversity and how to introduce women and other underrepresented students to support networks, especially in the STEM fields.

CI04: 8:40-8:50 a.m. SPS Leadership and Gender

Contributed – Karen A. Williams, East Central University, Physics Department, PMB D-5, Ada, OK 74820; USA kwillims@ecok.edu

Toni Sauncy, Society of Physics Students & Sigma Pi Sigma

This research will examine the number of women within the Society of Physics Students leadership over time. Leadership in this research includes advising local chapters as well as leadership on the SPS National Council. As the number of women faculty has risen over the past few years, has the number of women mentoring female students in SPS risen as well? If not why?

Plenary:

The Physics of Baseball, Alan Nathan

Location: Grand Ballroom I
Date: Tuesday, July 16
Time: 9–10 a.m.

Presider: Jerry Feldman

Alan M. Nathan

"You Can Observe a Lot by Watching" ...*Yogi Berra*

Alan M. Nathan, University of Illinois at Urbana-Champaign, 403 Loomis Laboratory of Physics, Urbana, IL 61801; a-nathan@illinois.edu

Alan M. Nathan, Prof. Emeritus, University of Illinois at Urbana-Champaign, will give a plenary presentation entitled " 'You Can Observe a Lot by Watching'...*Yogi Berra*." Following Yogi's advice, Nathan will use high-speed video clips to highlight some of the interesting physics underlying the game of baseball. The talk will focus on the subtleties of the baseball-bat collision, the intricacies of the flight of a baseball, and many other things. Nathan will also lead a workshop, "Major League Physics – Using Baseball to Teach Physics."

Check out the resource rooms during the meeting:

PIRA Resource Room

Sunday, 8–10 p.m.
Monday, Tuesday, 9-5 p.m.
Exhibit Hall
Apparatus competition, demos, physics "toys" and more

TYC Resource Room

Monday, Tuesday, 8–5 p.m.
Wed., 8–4 p.m.
Ballroom II

Session DA: *The Physics Teacher:* Celebrating 50 Years

Location: Pavilion East
Sponsor: AAPT
Date: Tuesday, July 16
Time: 10:30 a.m.–12:30 p.m.

Presider: Chris Chiaverina

For a half-century The Physics Teacher *journal has been the go-to source for information on the art and science of physics teaching, history and philosophy of physics, applied physics, curriculum development, and lab equipment, as well as book reviews and other monthly features. Come celebrate the 50th anniversary of the venerable journal that we all rely on for the latest ideas, apparatus, and methods in physics education. Five invited speakers who have been closely associated with* TPT *will share their experiences with the journal that has influenced their professional lives, as well as how their contributions have affected the journal. Cake will be served at a reception after the program.*

Invited Speakers:

– Pamela R. Aycock
– Albert A. Bartlett
– Thomas B. Greenslade, Jr.
– James L. Hicks
– Karl C. Mamola

Session DB: Introductory Courses

Location: Parlor A/B
Sponsor: AAPT
Date: Tuesday, July 16
Time: 10:30 a.m.–12:20 p.m.

Presider: TBD

DB01: 10:30-10:40 a.m. Singing the Harmonics

Contributed – Harold T. Stokes, Brigham Young University, Department of Physics and Astronomy, Provo, UT 84606; stokesh@byu.edu

When we teach students about harmonics of sound waves, we often allow the students to hear the harmonics. I go one step further: I sing the harmonics. The computer projects a sound spectrum of my voice onto the screen. The students clearly see the harmonics in the spectrum. I then sing the pitch of each of the first eight harmonics, spanning three octaves! The students are both enlightened and entertained.

DB02: 10:40-10:50 a.m. Case Studies and Community-based Inquiry in Introductory Physics

Contributed – Bruce Palmquist, Central Washington University, 400 E University Way, Ellensburg, WA 98926; palmquis@cwu.edu

Andrew A. Piacsek, Central Washington University

Students often complain that the physics in their textbook is not relevant in the real world. In addition, national stakeholders are concerned with the inability of college students to think critically. The authors set out to address both issues in their introductory physics course covering energy, waves, and simple harmonic motion. Using the interrupted case study approach, students were guided through papers from sports science and biology that utilized physics principles from the course. Students iteratively inferred and analyzed different aspects of each paper, reporting their ideas at each step. Using a community-based inquiry project, students analyzed sound level data from local wind turbines and shared their results with the community. The instructors developed a Google Docs template to facilitate the inquiry process. Case studies, templates, and rubrics will be displayed at this presentation. Student pre- and post-test scores on a critical thinking exam will also be shared.

DB03: 10:50-11 a.m. Using Historical Case Studies in Introductory Physics

Contributed – Debora M. Katz, United States Naval Academy, Physics Department, Annapolis, MD 21402; dkatz@usna.edu

Physics derives much of its beauty and power from the process of discovery. But our traditional classrooms and textbooks are dogmatic and impersonal. We rarely tell the stories of historical discovery. I have written historical case studies to show students how people develop and apply the laws of physics. Case studies do the same things for physics education as they do in legal and business education. First, case studies tap into our natural love of stories. Second, case studies make abstract concepts more tangible. Finally, historical case studies give insight into how physicists think. I have written a case study based on Benjamin Franklin's research into electricity and his development of the lightning rod. While many students know that Franklin flew a kite during a storm; many don't know that he was trying to test one of his scientific hypotheses or that he subsequently invented the lightning rod.

DB04: 11-11:10 a.m. The Cat Twist Explanation Simplified

Contributed – J. Ronald Galli, Weber State University, 2508 University Circle, Physics Department, Ogden, UT 84408-2508; jrgalli@weber.edu

It is well established that cats can execute a torque-free 180-degree twist to successfully land on their feet from an inverted position. Leg motion is not required. Videos with various explanations are readily available on YouTube, etc. A working mechanical model (available through www.teachersource.com) can be observed on my website.[1] The first published correct explanation is given in a *TPT* article.[2] I will give a recently developed simplified explanation that will enable each of you (or a student) to perform the "cat twist" about a vertical axis by standing on your own lecture turntable and swinging your hips in hula-hoop fashion, assisted by a dumbbell weight which you swing full circle from hand to hand around your back.

1. physics.weber.edu/galli
2. John Ronald Galli, *Phys. Teach.* **33**, 404 (1995).

DB05: 11:10-11:20 a.m. The Aether: Past and Present

Contributed – Robert A. Close, Clark College, 1933 Fort Vancouver Way, Vancouver, WA 98663; rclose@clark.edu

Nineteenth-century scientists modeled the universe as an elastic solid "aether" in order to understand light waves. Thomas Young used the analogy to explain light's constant speed and polarization. Refraction was attributed to variations in aether density in the presence of matter. James MacCullagh assumed a "rotationally elastic" aether to derive an equation for transverse light waves. James Clerk Maxwell modeled the aether as elastic cells interspersed with rolling particles to derive the relativistic equations of electromagnetism. The "aether" rejected by Michelson and Morley was a solid-fluid hybrid, similar to a mixture of cornstarch and water. Although the aether is rarely invoked in modern times, it can still be a useful concept in modeling the behavior of matter. We will discuss how the simple model of an elastic solid aether may be used to explain a variety of phenomena including special relativity, atomic spectra, Dirac wavefunctions, quantum statistics, antimatter, and gravity.

DB06: 11:20-11:30 a.m. Rethinking How We Teach Kepler's Law in the Exoplanet Age

Contributed – Kristen A. Larson, Western Washington University, Physics/Astronomy Department, Bellingham, WA 98229 kristen.larson@wwu.edu

When we teach about orbits, we usually teach Kepler's third law as a proportionality between orbital size cubed and orbital period squared. Using Newton's law of gravitation, we derive the constant of proportionality to be the mass of the central object. While historically accurate and useful for our Solar System, this approach leaves students ill-prepared to apply their understanding of orbits to most modern astronomical discoveries. In particular, students cannot use this form of Kepler's law to explore how the Doppler velocity method is used to characterize newly discovered exoplanets. I propose an alternate path to Kepler's law that both preserves the observational importance of velocity and includes the motions of both objects, while still maintaining the elegance and pedagogical simplicity. With exciting developments in the news and real data easily accessible, exoplanet science presents a valuable new opportunity to motivate students and change how we teach about orbits.

DB07: 11:30-11:40 a.m. On Equivalent Resistance

Contributed – Mikhail Kagan, PennState Abington, 1600 Woodland Road, Abington, PA 19001; mak411@psu.edu

One of the basic tasks related to electrical circuits is computing equivalent resistance. In some simple cases, this task can be handled by combining resistors connected either in series or in parallel, until the original circuit reduces to a single element. When this is not possible, one resorts to the "heavy artillery" of Kirchhoff's rules. What traditionally receives little to no attention in the introductory E&M class is the method of nodal potentials. At the same time, it may often be both mathematically and conceptually simpler. In this talk, I will review the method of nodal potentials and use it to find the unknown currents and voltages in the Wheatstone-Bridge-like circuit. At the end, I will derive —in a closed form—the equivalent resistance of a generic circuit. The latter result unveils a curious interplay between electrical circuits, matrix algebra, graph theory and its applications to computer science.

DB08: 11:40-11:50 a.m. Modifying Gauss's Law for Two-Dimensional Electric Fields

Contributed – David Keeports, Mills College, 5000 MacArthur Blvd., Oakland, CA 94613; dave@mills.edu

While the electric field due to a point charge is inversely proportional to the square of the distance from the point, the electric field due to an infinite line of charge is inversely proportional to the distance from the line. This talk will consider charge configurations built from parallel infinite lines of charge. For such charge configurations, the electric field in the xy-plane fully determines the electric field everywhere in space, and Gauss's law can be reformulated in terms of an integral of the electric field around a closed planar loop. A proof of "two-dimensional Gauss's law" will be presented. This proof closely parallels the proof of Gauss's law from Coulomb's law and is well adapted to the instructor's planar blackboard and to the student's page.

DB09: 11:50 a.m.-12 p.m. Creative Exercises in Introductory Physics

Contributed – Delena Bell Gatch, Georgia Southern University, PO Box 8031, Statesboro, GA 30460; dbgatch@georgiasouthern.edu

Creative exercises are a new alternative to traditional assessments. During creative exercises students are given a prompt and asked to write down as many distinct, correct, and relevant facts about the prompt as possible. The prompt does not pose a direct question for students to answer; instead the prompt is open ended. Students receive credit for each correct fact they include which is related to the prompt and distinct from the other facts they list. Creative exercises encourage students to focus on the physical situation presented instead of the question posed. Multiple examples of creative exercises developed and implemented in an introductory physics course will be presented. The benefit of using creative exercises to promote students' mastery of the course material will be described. In addition students' perceptions of the impact of creative exercises on the learning process will be discussed.

DB10: 12-12:10 p.m. Making Learning Physics "Phun"

Contributed – Samya Zain, Susquehanna University, 514 University Ave., Selinsgrove, PA 17870; zain@susqu.edu

In a small liberal arts college, like Susquehanna University, students come to the Introductory Physics class with all backgrounds. For my classes, I prepared crosswords mostly comprising important vocabulary words from the chapter. They were offered as a part of extra credit towards the final grade, and were due before the start of every chapter. The crosswords are structured such that they did not require a lot of effort; however they made a huge impact in terms of a student's familiarity with the materials. The strategy for team ork is simple and recognized widely as a good way to engage the students. I have tweaked this to include "team quizzes." In a graded team quiz, all students make sure that their team members contribute, since the team is only as good as its weakest link. This strategy has delivered mixed results, depending on the individual student and the team dynamic, from panic to triumph to ah-ha moments.

DB11: 12:10-12:20 p.m. Why Are Pigeons' Heads Purple or Green but Never Red?

Contributed – Lawrence B. Rees, Brigham Young University, Department of Physics and Astronomy, BYU Provo, UT 84602; lawrence_rees@byu.edu

We know that thin film interference is responsible for a number of effects such as the variable color of birds' feathers and the colorful reflection of soap bubbles. But it is a difficult thing to explain why a pigeon's green feathers look purple and its purple feathers look green when viewed at oblique angles or why there are alternate pink and green stripes between white bands in a soap film. A short PDF presentation (available online) with embedded animations shows how these phenomena can be understood in terms of the absorption spectra of cone pigments and pseudo-primary colors. Soap films are analyzed with reflection spectra that vary with film thickness. Pigeon feathers are analyzed with reflection spectra that vary with observation angle.

Session DC: Best Practices in Educational Technology

Location: Broadway I/II
Sponsor: Committee on Educational Technologies
Co-Sponsor: Committee on Research in Physics Education
Date: Tuesday, July 16
Time: 10:30 a.m.–12:30 p.m.

Presider: Andrew Gavrin

DC01: 10:30-11 a.m. RAWR: Rapid Assessment and Web Reports

Invited – Scott Franklin, Rochester Institute of Technology, Department of Physics/RIT, Rochester, NY, 14623; United States svfsps@rit.edu

Eleanor Sayre, Kansas State University

Physics courses are structured so as to build upon prior knowledge. Kinematics concepts are used to learn dynamics, which themselves are used in the study of energy, momentum, and conservation. When this assumption fails, however, the results can be mystifying. Why, for example, should instruction in circuits hurt students' understanding of Newton's third law? Surprisingly, new knowledge can negatively impact student understanding (interference}, suggesting a more subtle dynamic than simple layering. In this talk I will describe recent technological advances that allow instructors to investigate student learning on a finer time scale than pre-/post-testing. RAWR (Rapid Assessment and Web Reports) contains web-based conceptual quizzes, the ability to upload extant data, and easy-to-use online analysis techniques. The pedagogical consequences are immense, allowing instructors to consider how new topics reinforce or interfere with prior knowledge, and adapt their instruction to the particular state of their students.

DC02: 11-11:30 a.m. Flipping Intro Physics at the University of Illinois

Invited – Mats A. Selen, University of Illinois, Department of Physics, 1110 W. Green St., Urbana, IL 61801; mats@illinois.edu

We have all faced the problem of students coming to class unprepared. Assigned readings from the textbook are often ignored, and many students are seeing the material for the first time as you present it. The Physics Education Research Group at the University of Illinois has developed a suite of online pre-lecture activities to address this problem. Before each class, animated Multimedia Learning Modules present students with all of the required concepts, and Just in Time Teaching questions provide feedback to both students and professor. This preparation allows peer instruction to transform a passive lecture into an active learning environment. In this talk I will describe our success with the above approach, and will provide a sneak peek at our current efforts to integrate hands-on activities into the same technological framework.

DC03: 11:30 a.m.-12 p.m. Integrating Direct Measurement Video into Physics Instruction

Invited – Peter H. Bohacek, Henry Sibley High School, 1897 Delaware Ave., Mendota Heights, MN 55118; peter.bohacek@isd197.org

The growing collection of Direct Measurement Videos for teaching physics will be presented, as well as methods to integrate them into physics instruction. Direct Measurement Videos are short videos of events that can be analyzed using physics concepts. Grids, rulers, frame-counters, and other overlays allow students to make quick and precise measurements directly from the video. Students use these measurements to answer questions and solve problems. Three ways to use direct measurement videos will be discussed. First, a series of related videos can be used as part of a guided inquiry where students develop and explore physics concepts. For example, students analyze a series of videos to develop and apply the concept of momentum conservation. Second, videos can be used for problem-solving practice, where students make measurements from the video to solve problems. Finally, a collection of questions based on Direct Measurement Videos is available from WebAssign.

Session DD: Methodologies for Identifying and Investigating Cognitive 'Resources' in Physics Thinking

Location: Broadway III/IV
Sponsor: Committee on Research in Physics Education
Date: Tuesday, July 16
Time: 10:30 a.m.–12:30 p.m.

Presider: Ian Beatty

DD01: 10:30-11 a.m. What Are Resources and How Can We Tell?

Invited – Eleanor C. Sayre, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506; esayre@ksu.edu

I study how physics students become physicists through both identity development and content knowledge learning. My work focuses on upper division physics lab and theory classes, where students must learn to coordinate physics and mathematics content resources with cultural and epistemological resources for becoming a physicist. I take two complementary perspectives on how to find resources in data. In a loose sense, the idea of resources is an epistemological choice on the part of the researcher to look for little bits of reusable good ideas in student thinking. It's a framing away from evaluating veracity and towards investigating how people are being productive. In a stricter sense, resources have specific properties: they are reusable, nestable, networkable, and nameable. To illustrate these properties and their entailments in observational, video-based data, I discuss a class of resources that bridge cultural physics shibboleths with technical physics and mathematics content.

DD02: 11-11:30 a.m. Methods for Identifying Students' Knowledge About Complex Systems

Invited – Lauren A. Barth-Cohen, University of California, Berkeley, Unit 309-6309, Larkin Drive, Vancouver, BC V6T 1Z4 Canada; lbarth@berkeley.edu

In my work I focus on students' competencies in generating scientific explanations within the domain of complex systems, an interdisciplinary area in which students tend to have difficulties. I have data from open-ended clinical interviews with students who have a variety of academic backgrounds from 8th grade through PhD in physics and astronomy. These students were asked to reason about seven problem contexts, all of which exhibit behaviors associated with complex systems (e.g. the movement of sand dunes, the formation of traffic jams, and the diffusion of juice in water). In this talk I discuss how I used the microgenetic learning analysis cycle of observation, schematization, and systematization (OSS) (Parnafes and diSessa, 2013) to build a mini-theory of four categories of intuitive prior knowledge students activate about complex systems in this context.

DD03: 11:30 a.m.-12 p.m. Identifying Knowledge-In-Use and In-Development: The Dialogue Between Data and Theory

Invited – Mariana Levin, Michigan State University, Wells Hall C-721, 619 Red Cedar Road, East Lansing, MI 48824; mlevin@msu.edu

This talk will engage the issue of honing our ability to analyze video records of real-time reasoning processes from a "resources" perspective. In qualitative analyses of reasoning processes we face several methodological challenges, in part because as analysts, we have no direct access to learners' conceptual systems. So, then, how do we argue that our descriptions of resources capture something psychologically real for subjects? How can we operationalize our descriptions of resources so that they can be useful beyond local analyses? In my talk, I will discuss the theoretical constraints a heuristic epistemological framework (e.g., diSessa, 1993) puts on the identification and characterization of relevant knowledge resources, systems, and their dynamics. To illustrate this interplay between the development of local descriptions of knowledge-in-use and in-development and the orienting epistemological framework, I will discuss data from a recent study investigating the emergence of new strategies during episodes of mathematical problem solving.

DD04: 12-12:30 p.m. Using The 'Resources' Framework Without Identifying Specific Resources: Huh?

Invited – Andrew Elby, University of Maryland, Department of TLPL, Benjamin Bldg. #2311, College Park, MD 20742; elby@physics.umd.edu

What counts as evidence that a proposed cognitive resource exists? Other speakers in this session provide thoughtful answers. I, by contrast, argue that it's often OK to sidestep the question, because the resources framework does productive intellectual work even when specific resources aren't identified. An analogy with atomic theory clarifies my argument. Even without identifying specific atoms, atomic theory helps explain phenomena such as why the pressure of a gas increases with temperature. But other phenomena, such as the relative stabilities of different chemical bonds, cannot be explained without identifying and characterizing particular atoms in detail. Similarly, thinking in terms of the resources framework without identifying specific resources "like thinking in terms of atomic theory without identifying specific atoms" is generative for addressing some research questions but not others. I illustrate this point using work on student and teacher epistemologies, and explore methodologies appropriate for such research agendas.

Session DE: Teaching Physics to the Liberal Arts Major

Location: Galleria II
Sponsor: Committee on Physics in Undergraduate Education
Date: Tuesday, July 16
Time: 10:30 a.m.–12:30 p.m.

Presider: Chris Moore

DE01: 10:30-11 a.m. Building Scientific Literacy in a Liberal Arts Population

Invited – Jeffrey D. Marx, McDaniel College, 2 College Hill, Westminster, MD 21157; jmarx@mcdaniel.edu

Karen Cummings, Southern Connecticut State University

Under an award from the National Science Foundation, we implemented and assessed course materials for a liberal arts science class with a primary and explicit goal of improving students' scientific reasoning ability, science process skills, and understanding of the nature of science (collectively: "scientific literacy"). To facilitate the development of the students' scientific literacy, we have crafted activities and discussion points that draw from a wide range of science disciplines. However, specific science content serves not as the principle focus of the class, but only as a mechanism to more deeply engage the students. In this talk we will discuss our specific goals for the course and the materials and in-class and out-of-class activities we have crafted to achieve our scientific literacy goals. We will also present our assessment data, specifically focusing on the initial and final states of our students' attitudes and beliefs about the scientific enterprise.

DE02: 11-11:30 a.m. Going Beyond the Content: Teaching Scientific Reasoning in the Classroom

Invited – Louis J. Rubbo, Coastal Carolina University, Department of Chemistry & Physics, 109 Chanticleer Drive, East Conway, SC 29526; lrubbo@coastal.edu

Christopher Moore, Coastal Carolina University

University courses in conceptual physics and astronomy typically serve as the terminal science experience for the liberal arts student. Within this population significant content knowledge gains can be achieved by utilizing research verified pedagogical methods. However, from the standpoint of the University, students are expected to complete these courses not necessarily for the content knowledge but instead for the development of scientific reasoning skills. Results from physics education studies indicate that unless scientific reasoning instruction is made explicit students do not progress in their reasoning abilities. How do we complement the successful content based pedagogical methods with instruction that explicitly focuses on the development of scientific reasoning skills? This talk will explore methodologies that actively engages the non-science students with the explicit intent of fostering their scientific reasoning abilities.

DE03: 11:30-11:40 a.m. Lessons Learned from Teaching Liberal Arts Students

Contributed – Rebecca Lindell, Purdue University, West Lafayette, IN 47907-2036; rlindell@purdue.edu

The teaching of liberal arts majors is often more difficult than teaching science students. Not only do they not have the mathematics background, but also they may only be in the course to satisfy a general education requirement. Instructors often choose to keep the level of the course quite low, requiring little reasoning or computation. However, for many students, this is the last science course they will ever take and our job should be to help develop scientific reasoning skills. With over 10 years experience of teaching liberal arts majors in astronomy and conceptual physics, I have learned many lessons on how to accomplish this goal. This talk will focus on the lessons I have learned over the 10 years of teaching Liberal Arts majors.

DE04: 11:40-11:50 a.m. Teaching Physics Concepts to Students with a Basic Algebra Background

Contributed – Elizabeth E. Chain, Arizona State University, Polytechnic Campus, School of Letters and Sciences, MC2780, Mesa, AZ 85212; elizabeth.chain@asu.edu

Melinda Rudibaugh, Chandler-Gilbert Community College

Undergraduate students enrolled at Arizona State University, as well as at community colleges and other institutions of higher learning, have trouble distinguishing between the concepts of speed, velocity, and acceleration. A combination of appropriate lecture demonstrations and Socratic questioning, together with Active Learning strategies and team-building exercises used in both the classroom and laboratory can improve basic conceptual understanding in this group of non-physics majors. Major lecture themes are reinforced through the use of Challenge Problems which must be completed by each Team working together. The importance of creating a supportive environment for the students, one in which they are not afraid to ask questions, is stressed. The students gain when they are given the very important opportunity to make mistakes and learn from them. A number of examples are provided, combined with typical student reactions to such learning methods.

DE05: 11:50 a.m.-12 p.m. Science of Technology: A Course for Liberal Arts Majors

Contributed – Rhoda Berenson, New York University, 726 Broadway, New York, NY 10003; rb143@nyu.edu

This course was designed specifically for students in the Global Liberal Studies Program at NYU. It follows the intertwined histories of science, technology, and society, focusing mainly on the technology of communication. It elucidates how technological developments are inspired by scientific investigations and these investigations are, in turn, inspired by inventive technology. The course balances hard science with liberal arts students' interests in history, people, and societal issues. The science is learned through inquiry-based group activities rather than text or lectures. Homework, readings, and discussions are concerned with the history of and effects of technology on society.

DE06: 12-12:10 p.m. Energy Science: A Physics Course for Liberal Arts Majors

Contributed – Dyan L. Jones, Mercyhurst University, Deparment of Physics, 501 E 38th St., Erie, PA 16546; djones3@mercyhurst.edu

The Energy Science course at our institution was created to serve as an introductory course for non-science and particularly liberal arts majors. This course allows us the opportunity to teach some basic physics within the context of an issue that resonates with many students. This talk will review the goals and objectives of this course and focus on general issues that may be important for any science course for liberal arts students.

DE07: 12:10-12:20 p.m. Circuit Theater: Kinesthetic Learning for Simple Circuits

Contributed – Alex M. Barr, University of Texas at Austin, Austin, TX 78759; ambarr@physics.utexas.edu

Circuit Theater is a group activity in which students act out the motion of individual charges as they move through a circuit. The activity is designed to help students develop a physical and intuitive understanding of concepts such as current and voltage and series and parallel connections. This talk will introduce the format of circuit theater and discuss concepts that have been successfully introduced through circuit theater as well as concepts that have proven difficult to grapple with in this format.

DE08: 12:20-12:30 p.m. Optics for Visual Liberal Arts Students

Contributed – Scott W. Bonham, Western Kentucky University, 1906 College Heights Blvd. #11077, Bowing Green, KY 42101-1077; scott.bonham@wku.edu

Light, Color, and Vision is a course for non-science majors that draws students with a strong interest in visual phenomena such as art, photojournalism, film, and broadcasting majors. I take a different approach in many aspects to engage and challenge this population. Principles are introduced through hands-on inquiry working in groups. Drawings, in particular ray diagrams, provide a way to be rigorous without a lot of "math." Assignments involve photographing examples of phenomena and then explaining them with drawings and text. Artwork from different historical periods is used to illustrate physical phenomena and ways that science and technology have influenced its development. The history of ideas about light, color, and vision are traced through reading about different figures and selected historical texts by them. This approach draws upon the many skills my students bring into the classroom and connect the course to their interests.

Session DF: Innovations in Teaching High School Astronomy

Location: Skyline IV
Sponsor: Committee on Space Science and Astronomy
Co-Sponsor: Committee on Physics in High Schools
Date: Tuesday, July 16
Time: 10:30–11:20 a.m.

Presider: Trina Cannon

DF01: 10:30-11 a.m. GEARS Astronomy, Bring Astronomy into Your Science Classroom

Invited – Lindsay E. Bearden, 585 Blackwell Road, Chatsworth, GA 30705; lindsaybearden@hotmail.com

The GEARS Project (Georgians Experience Astronomy Research in Schools) was developed with the goal of transforming the way high school astronomy is taught in Georgia's public schools. This NASA rich curriculum was created by two college professors and a team of high school teachers. It was dispersed throughout the state via professional development opportunities. Resource teachers were trained via workshops and graduate-level astronomy courses, then led their own workshops illustrating how astronomy can be used within the physical science, chemistry, and physics curriculum. Come and learn more about this program and how astronomy can be brought into your classroom! GEARS was Funded by NASA Office of Education Grant NNX09AH83A and supported by the Georgia Department of Education, Columbus State University, and Georgia Southern University.

DF02: 11-11:10 a.m. Parallax and Aberration: Evaluating Robert Hooke's 1669 Parallax Measurement

Contributed – Todd K. Timberlake, Berry College, 2277 Martha Berry Hwy. NW, Mount Berry, GA 30149-5004; ttimberlake@berry.edu

The annual parallax of a star is a very slight apparent wobble caused by Earth's orbital motion around the Sun. In 1669 Robert Hooke sought to measure the annual parallax of the star gamma Draconis, and thus to prove the Copernican theory of an orbiting Earth. Hooke claimed success but his contemporaries were skeptical. Almost 60 years later James Bradley discovered the aberration of starlight and conclusively showed that Hooke could not possibly have detected the parallax of gamma Draconis. Bradley also showed that Hooke had not simply misinterpreted a detection of aberration (although later astronomers, like John Flamsteed, had done so). We will examine Hooke's claims and Bradley's evidence against them, offer some speculation about what it was that Hooke was seeing, and discuss how this episode can be used in an introductory astronomy course to illustrate important aspects of the nature of science.

DF03: 11:10-11:20 a.m. Teaching the Nature of Science with 'The Pluto Debate' Role-Playing Game

Contributed – Anthony Crider, Elon University, 2625 Campus Box, Elon, NC 27244; acrider@elon.edu

The Next Generation Science Standards call for students to learn the nature of science in addition to the core ideas of the disciplines. We have developed a series of science role-playing games that allow students to debate aspects of science from the perspective of scientists in real historical settings. One of these games, The Pluto Debate, introduces students to the nature of science, as well as the properties of the Kuiper Belt. Students argue passionately that science knowledge is not fixed but is revised with new evidence. The class uses both data and rhetoric to argue either that Pluto should or should not be a planet. Some students also argue that the 2006 vote on a definition of planet is itself unscientific. The Pluto Debate and many other chapter-length science games developed through our NSF-CCLI grant are suitable for use in either high school or introductory college classrooms.

Session DG: Introductory Course Laboratories and Hands-on Activities for Life Science Majors

Location: Pavilion West
Sponsor: Committee on Laboratories
Co-Sponsor: Committee on Physics in Undergraduate Education
Date: Tuesday, July 16
Time: 10:30 a.m.–12:30 p.m.

Presider: Mark Reeves

DG01: 10:30-11 a.m. Reinventing the Introductory Physics Laboratories for Future Biologists*

Invited – Wolfgang Losert, University of Maryland, IREAP, Paint Branch Drive, Bldg. 223, College Park, MD 20742; wlosert@umd.edu

Kim Moore, John Giannini, University of Maryland

We have developed a set of laboratories and hands-on activities to accompany a new interdisciplinary physics course that has been successfully developed and tested in a small class of students at the University of Maryland (UMD). With input from a large group of biologists, physicists, chemists, and education researchers at UMD, we have designed a course to be taken in the student's second year, with calculus, biology, and chemistry as prerequisites. This permits the laboratories to include significant content on physics at cellular scales, from chemical interactions to random motion and charge screening. We developed a lab that introduces the students to modern equipment such as microfluidics and microscopy and physics analysis tools in contexts relevant to biology, while keeping it simple enough to maintain the pedagogically valuable open-ended laboratory structure.

*The laboratory development is part of the HHMI supported NEXUS project

DG02: 11 a.m.-12:30 p.m. Laboratory Experiments for the Life Sciences

Poster – Joel C. Berlinghieri, The Citadel, Physics Department, Grimsley Hall, 171 Moultrie St., Charleston, SC 29409; berlinghieri@citadel.edu

Christina Leidel, Rene Hurka, The Citadel

Students majoring in biology and pre-medicine take a dedicated section of introductory physics, both lecture and laboratory. Two of the experiments performed in the laboratory are presented. The first experiment studies mechanical advantage and measures the strength of materials. A modified PASCO stress-strain apparatus is used to measure the forces experienced in an analog of the arm. Tensile forces are measured in the analog of the bicep tendon and compressional forces in the analog of the bone. Scaling and its effect on fracture of these analogs are studied. The second experiment measures pressures of a fluid during a pumping-rest cycle. A pump and valve are used to cyclically pump fluid into a chamber that has a restrictive outlet of changeable size. The chamber wall is made of material of varying flexibility. The pressure is recorded as a function of time through a complete pump and rest cycle and compared as a function of wall flexibility and outlet size.

DG03: 11 a.m.-12:30 p.m. Attitudinal Assessment of Curriculum on the Physics of Medical Instruments

Poster – James K. Johnson, Portland State University, Portland, OR 97201; jojk@pdx.edu*

Warren Christensen, North Dakota State University

Ralf Widenhorn, Grace Van Ness, Elizabeth Anderson, Portland State University

Over the past several years, a curriculum targeting pre-health students and focused on the physics behind biomedical instruments has been in development at Portland State University. Recently, an effort to assess the curriculum's impact on students has begun. Given the hands-on focus of the course and positive feedback from students, we hypothesized that it would positively impact their attitudes toward physics and physics learning. We administered the Colorado Learning Attitudes about Science Survey (CLASS) in order to cast light on students' attitudes. The survey was administered to the summer course and to introductory algebra-based physics courses at the same university. The summer course "Physics in Biomedicine" produced a small, nonsignificant shift in student attitudes. This is a promising result, when contrasted with the significant negative shift that is the norm among introductory courses and occurred in our introductory algebra-based physics course.

*Sponsored by Ralf Widenhorn

DG04: 11 a.m.-12:30 p.m. Physics for Biologists: A Laboratory Curriculum Project

Poster – Kimberly A. Moore, University of Maryland, College Park (PERG), College Park, MD 20741; MoorePhysics@gmail.com

John Giannini, Ben Geller, Wolfgang Losert, University of Maryland

It can be a challenge to create a laboratory curriculum for an introductory physics class with a strong focus on biology/chemistry connections, while maintaining an emphasis on real scientific practices. We have created "open-ended"/"non-cookbook" labs addressing relevant physical issues at biological scales using a variety of tools, including microscopy, image and video analysis, electrophoresis, and spectroscopy. In doing so, we have learned some important lessons for creating IPLS labs: 1) the connections of physics concepts to biology/chemistry must be explicit; 2) students need help adapting lab strategies from the protocol-rich, data-rare labs found in their majors to these protocol-rare, data-rich labs; 3) to construct an open-ended experience with minimal teacher guidance requires frequent iterations of equipment assessment and curriculum creation; and 4) the writing of a "minimal guidance" curriculum is best approached in an unusual order—supporting documents first! (Part of UMd-PERG NEXUS/Physics; Supported by funding from HHMI and NSF.)

DG05: 11 a.m.-12:30 p.m. Hands-on Activities Integrated with Online Resources in a Life Science Physics Course*

Poster – Nancy Beverly, Mercy College, 555 Broadway, Dobbs Ferry, NY 10522; nbeverly@mercy.edu

Hands-on activities can be integrated with online animations and interactive simulations to help the life science student explore the physical mechanisms which underlie living processes and human functioning. Multiple examples throughout the introductory physics curriculum will be presented.

DG06: 11 a.m.-12:30 p.m. Impact of Targeted Scientific Reasoning in the Introductory Physics Lab*

Poster – Carol Fabby, University of Cincinnati, 400 Geology/Physics Bldg., PO Box 210011, Cincinnati, OH 45221-0011; fabbyc@mail.uc.edu

Kathy Koenig, Zach Huard, University of Cincinnati

Recent research indicates that students entering college with formal reasoning abilities are more proficient learners. However, typical college courses do not significantly impact these abilities because they do not include targeted instruction in scientific reasoning. These courses do not provide the foundation for typical students to develop the necessary scientific reasoning skills to be successful. In an effort to better target our students' development of scientific reasoning, we have revised the structure and topics of the activities in our introductory physics lab courses. Students are more involved in the actual design of the experiments with more emphasis placed on student use of evidence-based reasoning in lab report writing. Online homework and quizzes between lab sessions provide further targeted support. This poster provides details on how the new lab curriculum and practice of skills impacts initial development of scientific reasoning abilities through gains on a midterm and pre- and post-test assessments.

*Partially supported by the National Institutes of Health 1RC1RR028402-01

DG07: 11 a.m.-12:30 p.m. Physiology, Physique, and Physics: Integration of Physics, Anatomy, and Physiology

Poster – Bijaya Aryal, University of Minnesota-Rochester, 300 University Square, 111 S Broadway, Rochester, MN 55904; baryal@umn.edu

Robert Dunbar, University of Minnesota-Rochester

We designed and implemented an activity to explore learning gains associated with integration of physics content into an anatomy and physiology classroom. This activity is a modified case study used in three semesters over the last three years when we systematically altered the activity to explore the impact of specific variables. The changes allowed us to explore the degree to which students successfully incorporate understanding of physics concepts when the learning activity is connected to a student designed electromyography (EMG) lab compared to gains when the activity is only associated with a hands-on activity. Other changes allowed us to explore how using different scenarios effects student understanding of physics concepts. We studied the impact of the level of abstractness in a test question that is expected to test students' quantitative skill related to physics concepts covered. Student performance across multiple semesters was evaluated at the individual and small group level.

DG08: 11 a.m.-12:30 p.m. Connecting the Dots: Links Between Kinetic Theory and Bernoulli's Principle*

Poster – Katherine Misaiko, University of New England, Biddeford, ME 04005; kmisaiko@une.edu

James Vesenka, University of New England

Kinetic theory and Bernoulli's principle are fundamental concepts life science students can use to explain a variety of important biological phenomena. We are using a series of simple experiments to help pinpoint student learning gaps in fluid dynamics based on paired student interviews. Students were asked to use multiple representations (diagrams, graphs, math and written descriptions) to explain the following: 1. An "empty" sealed balloon expanding inside a glass jar being evacuated. 2. A dented Ping-Pong ball expanding upon heating when in contact with boiling water. 3. A manometer liquid level changing due to air flowing away from an open end. The interviews suggest that understanding Bernoulli's principle requires a solid conceptual understanding of kinetic theory, in particular equating pressure with particle collisions. A "modeling centered" ideal gas law lab has been developed using semi-quantitative diagrammatic tools that we propose will help to improve student understanding of Bernoulli's principle.

*Supported by DUE 1044154, Sponsored by James Vesenka

DG09: 11 a.m.-12:30 p.m. Apparent Paradox Between Bernoulli's and Hagen-Poiseuille's Principles*

Poster – Elizabeth Whitmore, University of New England, Biddeford, ME 04005; ewhitmore@une.edu

James Vesenka, University of New England

The research objective is to reconcile the counterintuitive result students have when applying the Bernoulli principle to a constricted blood vessel. Students find the pressure decrease with increasing fluid speed to be at odds with their understanding of the resulting pressure increase of a blocked artery. In order to evaluate the apparent paradox generated by Bernoulli's principle and Hagen-Poiseuille's principle, students were asked to explain the following three fluid dynamics experiments diagrammatically, graphically, mathematically, and verbally: 1). A simulated blood vessel constriction. 2). Flow through a Venturi apparatus and 3). A free-fall microgravity simulation. Pairs of students were interviewed before and after coverage of the content in class. In the post-interview they were given an open-ended question to answer regarding why blood pressure rises when blood vessels are blocked. Preliminary results indicate that hands-on exposure to the tactile demonstrations enables qualitative explanations without relying on mathematical tools.

*Supported by DUE 1044154. Sponsored by James Vesenka

DG10: 11 a.m.-12:30 p.m. Teaching Fluids to IPLS Students from a Microscopic Viewpoint

Poster – Daniel E. Young, University of New Hampshire, 9 Library Way, Durham, NH 03824; deq27@wildcats.unh.edu

Dawn C. Meredith, University of New Hampshire

For introductory life science students, fluid dynamics is a topic that is important, relevant to biology, and yet difficult to understand conceptually. Our study focuses on probing understanding of pressure differentials and friction which underpin ideas of viscosity and fluid flow. Data were collected from think-aloud/demonstration interviews and were analyzed using the resource framework to look for productive student reasoning such as a microscopic viewpoint and gradient driven flow. We investigated if a multiple-scale view of matter is useful for students when constructing a model of viscosity and we will present both our model and feedback from students who have worked through it.

DG11: 11 a.m.-12:30 p.m. Pulse-oximeter and Light Absorption

Poster – Justin C. Dunlap, Portland State University, PO Box 751, Portland, OR 97207-0751; jdunlap@pdx.edu

Ellynne Kutchera, Misti Byrd, Casey Norlin, Ralf Widenhorn, Portland State University

The pulse-oximeter is a commonly found device in any hospital or doctor's office. The device is capable of measuring a patient's blood oxygen content and pulse simply by slipping a small device over a finger tip or ear lobe. We present a laboratory based around the pulse-oximeter and the physics behind its design and function. Light of two different wavelengths are passed through the patient's finger and the transmitted light intensity is measured. Absorption of light at the two wavelengths varies with the oxygen content of blood. Students in the laboratory will work with bromothymol-blue instead of blood. Its absorption characteristics vary with C02 content and serve as an analog to blood, but permits for easier handling in the laboratory. The laboratory exercise allows for optics to be targeted at pre-health students and presented in a biological context.

DG12: 11-12:30 p.m. Obstacle Course DC Circuits Activity

Poster – Kristin Walker, Pfeiffer University, PO Box 960, Misenheimer, NC 28109; kristin.walker@fsmail.pfeiffer.edu

Carol Ann Midersk,i Catawba College

Although the typical water pipe analogy for DC circuits is helpful for some, for many students the behavior of water flowing through pipes is not intuitive. An obstacle course analogy activity was created to provide an alternative DC circuit model. In this activity, students are given cards with an obstacle course element on one side and the corresponding circuit element on the other such as ladder/battery or slide/bulb. The students create obstacle courses meeting design specifications such as alternate paths (parallel) or sequential elements (series) and they respond to questions regarding how contestants proceed through various parts of the course. The students then flip over the cards to reveal the circuit diagram equivalent, build the circuit, and relate the brightness of the bulb(s) to their obstacle course analysis. Although this activity was originally created for middle school age, it was successfully used in a college introductory physics course.

DG13: 11 a.m.-12:30 p.m. Medical Imaging with Photogates: A High School or College Activity

Poster – Elliot Mylott, Portland State University, SRTC, 1719 SW 10th Ave., Room 134, Portland, OR 97201; emylott@pdx.edu

Ryan Klepetka, Justin Dunlap, Ralf Widenhorn, Portland State University

We present a laboratory activity in computed tomography (CT) primarily composed of a photogate and a rotary motion sensor that can be assembled quickly and partially automates data collection and analysis. We use an enclosure made with a light filter that is largely opaque in the visible spectrum but mostly transparent to the near IR light of the photogate (880nm) to scan objects hidden from the human eye. This experiment effectively conveys how an image is formed during a CT scan and highlights the important physical and imaging concepts behind CT such as electromagnetic radiation, the interaction of light and matter, image artifacts and windowing. The lab has been used in physics courses for pre-health and life science majors and results of student assessments will be presented.

DG14: 11 a.m.-12:30 p.m. Measuring Human Power Outdoors Using GPS and Heart Rate

Poster – Haraldur Audunsson, Reykjavik University, Menntavegur 1, Reykjavik, IS 101, Iceland; haraldura@ru.is

GPS devices make it easy to track one's motion, and therefore potentially calculate the power output, and at the same time record the heart rate (HR). The power output calculated from the raw GPS data may depend on the rate of vertical climb, acceleration, air drag and rolling friction if biking. Normally the HR increases linearly with the power output. Therefore the simultaneous analysis of the data from GPS and HR requires the use of basic physics, numerical methods, programming and physiology. We will present an example of a student experiment performed outdoors, showing good correlation between calculated power output and heart rate, but also a poor correlation, depending on the person's activity. This experiment and its analysis can be made as intricate as appropriate, and it appears to be very motivating since students are using basic physics and common devices to measure their own performance.

Meet the Editors of AAPT's Journals During the Meeting

They will be in the AAPT Booth in the Exhibit Hall during the following times:

Gary White, incoming editor, *The Physics Teacher*

Sunday: 8–8:30 p.m. Monday: 12–1 p.m. Tuesday: 1–2 p.m.

David Jackson, editor, *American Journal of Physics*

Sunday: 8–8:30 p.m. Monday: 10–10:30 a.m. and 3–4 p.m.

Tuesday: 10–10:30 a.m. and 3:30–4:30 p.m.

Gary White

David Jackson

Session DH: Investigating Classroom Strategies

Location: Galleria I
Sponsor: AAPT
Date: Tuesday, July 16
Time: 10:30 a.m.–12:30 p.m.

Presider: TBD

DH01: 10:30-10:40 a.m. PER User's Guide Plus: PER-based Assessment Guide and Results Database

Contributed – Adrian M. Madsen, American Association of Physics Teachers, 4210 Riley Drive, Longmont, CO 80503; adrian.m.madsen@gmail.com

Sarah B. McKagan, American Association of Physics Teachers

Eleanor C. Sayre, Kansas State University

As part of the PER User's Guide (http://perusersguide.org), we are developing an online database of PER-based assessment instrument scores and an accompanying data explorer. Here physics instructors can upload their students' assessment data and compare it to the larger data set. The system includes "one-click analysis," enabling users to visualize their data, make comparisons, and view statistics such as gain scores, effect sizes, and statistical significance. Users can compare their data in a variety of ways, such as to data from peer institutions, national data, or before and after a change in teaching method. We plan to conduct a large-scale comparison of assessment data from traditional and interactive-engagement classes as the database is populated. Additionally, we are developing guides to these PER-based assessments, including information about their background, research validation, and guidelines for administration. We solicit your feedback on our system and your assessment data to include in our database.

DH02: 10:40-10:50 a.m. Case Studies of Successfully Propagated Educational Innovations

Contributed – Raina Khatri, Western Michigan University, 817 Vine Place, Kalamazoo, MI 49008; raina.m.khatri@wmich.edu

Charles Henderson, Western Michigan University

Renee Cole, Courtney Stanford, University of Iowa

Jeffrey Froyd, Texas A&M University

Research-based Instructional Strategies (RBIS) designed to improve science education are numerous but often not widely used. While most RBIS do not spread much beyond the original developers, there are some RBIS that have been successfully propagated. As part of a larger project we are conducting case studies of several well-propagated educational innovations. Through these case studies we hope to develop a better understanding of the conditions necessary for successful propagation. This talk will present the preliminary results of case studies of two RBIS: Peer-Led Team Learning (PLTL), a small group-based instructional strategy originating in chemistry, and PhET, a set of flexible interactive simulations originating in physics. Through document analysis of publications and emergent analysis of interviews we construct a narrative of the propagation of each RBIS, including a timeline of events and the propagation strategies used. Implications for practice and for future work will be discussed.

DH03: 10:50-11 a.m. The Mismatch Between Faculty and Their Institutions Regarding the Assessment of Teaching Effectiveness*

Contributed – Charles Henderson, Western Michigan University, 1903 W Michigan Ave., Kalamazoo, MI 49008-5252; charles.henderson@wmich.edu

Melissa Dancy, University of Colorado Boulder

Chandra Turpen, University of Maryland

Tricia Chapman, Western Michigan University

Assessment of teaching effectiveness is one part of the educational system that influences the use of research-based instructional strategies. We have previously reported that faculty and institutions use different assessment methods.[1] In this talk we expand the previous results to 72 physics faculty from diverse institutions and discuss qualitative differences in the ways that institutions and faculty use the same evaluation tools. For example, most faculty said that their institutions use student evaluations of teaching and many indicated that they also value feedback from student evaluations. Although this may appear like an area of agreement, the qualitative data shows that faculty find little value in the numerical results from student evaluation forms, but instead value students' open-ended comments. Institutions, though, primarily focus on the numerical results. We argue the mismatch between faculty and their institutions is an important barrier to educational change that the PER community can help to minimize.

1. Turpen, C., Henderson, C., & Dancy, M. H. (2012). Faculty perspectives about instructor and institutional assessments of teaching effectiveness. In N. S. Rebello, P. V. Engelhardt, & C. Singh (Eds.), *Proceedings of the 2011 Physics Education Research Conference* (pp. 371-374). Melville NY: American Institute of Physics. doi:10.1063/1.3680072 .

*Supported by NSF #1122446

DH04: 11-11:10 a.m. The Interrogation Method: Framework for Helping Students Read a Textbook

Contributed – Robert C. Zisk, Rutgers University, 10 Seminary Place, New Brunswick, NJ 08901; robert.zisk@gse.rutgers.edu

Elana M. Resnick, Eugenia Etkina, Rutgers University

Being able to read and interpret scientific texts is an essential scientific ability for our students. One method that has been developed to enhance students' ability to read texts is a question-based reading strategy, the interrogation method. Students read a section of the text and then use the information found in the section to answer the question "Why is this sentence true?" for a paraphrased sentence from that section. Critical to the efficacy of this method is the selection of productive sentences for students to interrogate. Sentences that are highly interrogatable require students to reason through the text and connect concepts in order to completely respond to the prompt. We have explored the use of this method in an introductory physics course. In this talk we will discuss the framework we have developed for choosing productive sentences that are both highly interrogatable and have a high epistemological value.

DH05: 11:10-11:20 a.m. The Interrogation Method and Its Effects on Student Learning

Contributed – Elana M. Resnick, Rutgers University, 10 Seminary Place, New Brunswick, NJ 08901; resnick.e.m@gmail.com

Robert C. Zisk, Eugenia Etkina, Rutgers University

The interrogation method is a strategy that has been developed to help students read and interpret science texts. In this method, students are prompted to read a section of the text, and then answer why a sentence from the text is true based on the reading. We have explored the use of this method in an introductory physics course for non-physics science majors. Students were required to respond to two to four interrogation sentences each week on their homework based on the sections there were reading each week. Each exam then included three sentences for the students to interrogate without the text. In this talk, we will discuss the student responses to the sentences, as well as the evolution of their responses throughout the semester. We will then discuss the relation between the students' homework responses and their responses on the exam questions as well as their overall performance in the course.

DH06: 11:20-11:30 a.m. Reading Habits and Fragile Knowledge in Physics Introductory Courses

Contributed – David Pundak, Kinneret College and ORT Braude College, Jordan Valley, NA 15155, Israel; dpundak@gmail.com

Miri Schaham, ORT Braude College, Israel

Orit Herscovitz, Technion, Israel

The study deals with the freshman engineering students' perceptions of the importance of textbooks. Two worrying phenomena concerning engineering students' reading habits emerged from previous studies (a) most students rarely derive assistance from textbooks for basic courses, and (b) knowledge learned in basic courses is 'fragile' knowledge that quickly dissipates. Students therefore gain little knowledge from introductory courses to prepare them for advanced courses. To overcome these phenomena, a teaching method was designed to guide students to derive regular assistance from textbooks. The method credits active reading in the final course grade. The research population comprised from engineering students studying a physics course taught with the reading embedded approach. Respondents' attitudes were compared through an attitudes questionnaire administered at the course's end, with engineering students' attitudes from a previous study. Results indicated that students from the reading embedded course were helped by textbooks and thought they were very significant.

DH07: 11:30-11:40 a.m. What Is Said Matters: Relating Voting Question Prompts to Participation

Contributed – Dedra Demaree, Oregon State University, Physics, 301 Weniger Hall, Corvallis, OR 97331; demareed@physics.oregonstate.edu

Emily Smith, Kyle McLelland, Oregon State University

Jennifer Roth

Sissi Li, California State University, Fullerton

During four quarters of introductory physics at Oregon State University, participation and engagement in voting activities was measured in 200-person lecture settings. The measure was in part based on students turning to or discussing with neighbors, or gesturing during in-lecture activities. Episodes of high and low participation were selected and both the questions and the instructional prompts were analyzed using emergent coding. This presentation will focus specifically on the discourse analysis of the instructional prompts, and outline what prompts correlated with high participation and what prompts correlated with low participation. It was found that even subtle statements that can impact the students' affective experience impacted their participation. This presentation expands on previous findings that included only a fraction of the full data set. The author would like to acknowledge the entire research group that contributed to this project; too many to name as co-authors of this presentation.

DH08: 11:40-11:50 a.m. Enculturation Using Contrastive Sets and Framing

Contributed – Paul J. Camp, Spelman College, Physics Department, 350 Spelman Lane, Atlanta, GA 30314; pcamp@spelman.edu

I describe an instructional technique used in lab to learn how to write a scientific paper using contrastive sets to prepare for a discussion. This activity was implemented twice, once as an in-class discussion and once as out of class activities with an online discussion. I summarize the striking differences in performance and engagement, which I hypothesize is due to a framing effect, and is an extraordinarily striking example of how strongly the students' frame can alter their engagement and performance.

DH09: 11:50 a.m.-12 p.m. Introducing Students to Active Learning: "Framing" Strategies*

Contributed – Stephanie V. Chasteen, University of Colorado, Boulder, 390 UBC, Boulder, CO 80309; stephanie.chasteen@colorado.edu

Andrew Boudreaux, Western Washington University

Jon D.H. Gaffney, Eastern Kentucky University

How can we introduce our students to active learning strategies? An interactive course can challenge or even conflict with student views of learning, and of the roles of the instructor and students in the classroom. Instructors are often concerned about lack of engagement and sometimes face active push-back against interactive teaching strategies. How can we let students know what is expected of them, to support productive engagement and buy-in? How can we "frame" for them what the class is about? Through an informal poll, we have gathered a wide variety of materials from instructors around the country in order to provide shared resources for instructors. We will report on common themes and approaches in how instructors frame active learning classrooms for their students, and describe future work in this area.

*Materials can be found at http://www.colorado.edu/sei/fac-resources/

DH10: 12-12:10 P.M. Lecture Supported Mini-studio Approach to Algebra-based Physics: First Steps

Contributed – Jacquelyn J. Chini, University of Central Florida, 4000 Central Florida Blvd., Orlando, FL 32816, jacquelyn.chini@ucf.edu

Talat S. Rahman, University of Central Florida

We will describe and present evidence about the efficacy of the lecture-supported mini-studio we are designing to overcome some of the potential barriers to implementing reformed teaching structures at large universities. At our university, we offer up to 10 sections of studio-based introductory physics, but these courses serve only half of our introductory students. To improve learning in our lecture-format classes, we are redesigning our three-hour lab into a "mini-studio" that combines recitation and laboratory activities. We have multiple goals for the design of the mini-studio. To meet the barrier of disparity in instruction between students attending mini-studio at the beginning and end of the week, the curriculum must be flexible. The curriculum should build conceptual understanding as well as mathematical and problem-solving skills. Additionally, teaching mini-studio should develop the studio-mode teaching skills of faculty and graduate students. Our initial efforts have shown improvements in students? performance on standard assessments.

DH11: 12:10-12:20 p.m. Examining the Use of Tutorials in a Large Lecture Environment

Contributed – David P. Smith, University of North Carolina, Department of Physics and Astronomy, Chapel Hill, NC 27599; smithd4@email.unc.edu

Andrew Boudreaux, Western Washington University

Mila Kryjevskaia, North Dakota State University

The implementation of *Tutorials in Introductory Physics*[1] has been widespread throughout the United States. Tutorials are typically implemented in recitation-style sections of an introductory calculus-based physics course, although their use has been extended to other modes of instruction. At UNC at Chapel Hill, we are examining the use of tutorials in a large lecture environment of an introductory algebra-based physics course. In each lecture, tutorial instruction is integrated with traditional instruction, with tutorial questions often serving as motivation for the introduction of new concepts. The efficacy of the instruction is currently being investigated through the comparison of online conceptual pretest results to those on post-test questions administered on course exams. Preliminary findings and relevant comparisons to data from other universities will be presented.

1. L.C. McDermott, P.R.L. Heron, P.S. Shaffer, and the Physics Education Group at the University of Washington, *Tutorials in Introductory Physics,* Pearson Custom Publishing, 2012.

DH12: 12:20-12:30 p.m. Comparing Problem-based Learning and Video Analysis as Strategies in Learning Concepts of Force and Motion

Contributed – Manuel T. Eusebio, Higher Colleges of Technology-Abu Dhabi Men's College, Abu Dhabi, United Arab Emirates; manuel.eusebio@hct.ac.ae

Two groups of 20 students each from the Bachelor Engineering Technology Program of the Abu Dhabi Men's College, Higher Colleges of Technology, who are currently enrolled in Physics I in spring 2012-2013, will serve as respondents in this study.The groups will alternately be exposed to problem-based learning and video analysis instruction strategies. A pre-test and a post-test utilizing selected items from Forced Concept Inventory and researcher-constructed items in force and motion together with a perceptions inventory related to the use of the two strategies will be administered to the respondents. Mean achievement in each topic will be investigated and students' reactions regarding the use of the two strategies, specifically students' attitude, motivation, and enjoyment afforded by the two strategies in understanding the lessons will be extracted from the data.

Session DI: Learning Assistants and Supplemental Instructors in TYCs

Location: Salon Ballroom II/III
Sponsor: Committee on Physics in Two-Year Colleges
Date: Tuesday, July 16
Time: 10:30 a.m.–12:30 p.m.

Presider: Tony Musumba

DI01: 10:30-11 a.m. The Colorado LA Model: Variations, Trade-Offs, and Differential Goals*

Invited – Valerie K. Otero, University of Colorado, Boulder, 249 UCB, Boulder, CO 80309; valerie.otero@colorado.edu

The Colorado Learning Assistant (LA) model was designed with an adaptable but definite structure and with specific goals for student, faculty, and institutional learning. Throughout the past decade, multiple variations have been adopted in different departments throughout CU Boulder and at different universities throughout the nation. We have begun to systematically study these variations in efforts of understanding which features are critical for which end goals. Some models use LAs to facilitate active discussion in lecture while others use LAs to help students make inferences from data. Still others take advantage of the programs' community aspect and use it to facilitate students' transition from two-year colleges to large research universities. I will discuss foundations of the model and how different types of goals are embraced and enacted by faculty members using the LA model. Finally, I will describe some institutional and economic benefits with a focus on sustaining the program.

*Program supported by NSF grant #554615

DI02: 11-11:30 a.m. One Program, Two Sites: A Collaborative University-TYC Learning Assistants Program*

Invited – Edward Price, California State University, San Marcos, 333 S. Twin Oaks, Valley Road, San Marcos, CA 92096; eprice@csusm.edu

Learning Assistants (LA) programs are catalysts for course transformation and teacher recruiting. These goals are important at four-year universities and two-year colleges, and LA programs are relevant for both institutions. However, the particular features of each institution present distinct challenges in establishing and maintaining an LA program. We are exploring the effectiveness of a single, unified LA program at two sites—a four-year university and a two-year college. We have extended the CSU San Marcos LA program to nearby Palomar Community College, with the goals of promoting course transformation and teacher recruiting at both institutions, and building inter-institutional connections. The LA program thus takes on an additional role of promoting institutional collaboration and facilitating student transfer. This talk will describe the program, challenges, and early outcomes from this effort.

*Supported in part by National Science Foundation STEP Grant #1068477 and PhysTEC.

DI03: 11:30-12 p.m. Reflecting on the Experiences of LAs in an Evolving, Collaborative, Teacher Preparation Effort*

Invited – Mel S. Sabella, Chicago State University, Department of Chemistry and Physics, Chicago, IL 60628; msabella@csu.edu

The City Colleges of Chicago and Chicago State University have been collaborating on physics education projects for over five years and have been involved in the National Science Foundation CCLI Program and the APS PhysTEC Program. Throughout this period, the collaboration, involving Harold Washington College, Malcolm X College, Olive Harvey College, and Chicago State University, we have implemented a Learning Assistant (LA) Program that builds on the ideas from the LA Program at the University of Colorado. The Chicago LA Program has evolved over the years to fit our particular set of shared needs and resources. In this talk we explore the evolution of the model and share data on the experiences of students who are exploring physics teaching through our LA Program.

*Supported by the American Physical Society PhysTEC Program and the NSF Robert Noyce Scholarship Program.

DI04: 12-12:30 p.m. A Collaboration to Introduce Physics Teaching to Two-Year College Students

Invited – Anthony Escuadro, Harold Washington College/City Colleges of Chicago, 30 E Lake St., Chicago, IL 60601; aescuadro@ccc.edu

Jaime Millan, Harold Washington College/City Colleges of Chicago

Joshua Oladipo, Malcolm X College/City Colleges of Chicago

David Zoller, Olive-Harvey College/City Colleges of Chicago

Mel Sabella, Chicago State University

The City Colleges of Chicago and Chicago State University have recently partnered to provide early teaching experiences to two-year college students through the Chicago Learning Assistant Program, which provides participants the opportunity to learn about, practice, and reflect on physics teaching. Through this collaboration, the City Colleges community has been able to address some of the challenges that many two-year colleges face when attempting to establish and sustain peer teaching programs. In addition, we have found that incorporating Learning Assistants has helped to cement a culture of active learning and cooperative engagement in the classroom. We describe this shared effort as a potential model for four-year institutions to broaden their efforts to reach out to and recruit from their larger communities, while two-year colleges can obtain access to financial resources, pedagogical support, and mentoring that may not otherwise be available.

Session DJ: Physics Preparation of Preservice Elementary Teachers

Location: Skyline III
Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on Physics in Pre-High School Education
Date: Tuesday, July 16
Time: 10:30–11:40 a.m.

Presider: Wendy Adams

DJ01: 10:30-11 a.m. Teaching the Process of Science to Preservice Elementary Teachers

Invited – Courtney Willis, University of Northern Colorado, 1716 13th Ave., Greeley, CO 80631; courtney.willis@unco.edu

During a revamp of the preservice elementary teacher program at the University of Northern Colorado several years ago the concern was raised that the future elementary teachers were learning only "facts" of science and not the "process" of science. A new capstone elementary course (SCI 465) was developed for the purpose of teaching the future teachers how science is actually done and not just its discoveries. The class looks at science from a variety of science disciplines and requires the students to apply the knowledge they have learned in other classes to new situations and actually do science. SCI 465 has now been taught for several semesters by numerous professors and a number of activities have been developed particularly for this course. Several of these activities will be discussed along with others successes and a few failures.

DJ02: 11-11:30 a.m. Coordinating Instruction Across the Sciences for Preservice Elementary Teachers*

Invited – Leslie J. Atkins, California State University, Chico, 400 W. 1st St., Chico, CA 95929-0535; ljatkins@csuchico.edu

In 2007, the College of Natural Sciences at CSU, Chico hired three tenure-track faculty in biology, physics, and geoscience education and launched the Science Education Department in 2008. Over the past five years, these faculty have focused their efforts on the science content preparation of preservice elementary students, establishing a core sequence of content courses that all preservice students take. Our initial approach was to divide and conquer: ensuring that each standard was addressed in at least one of our core courses. With NGSS and Framework in mind, we have recently begun work to coordinate instruction, presenting core ideas, representations, and scientific writing in greater depth throughout our sequence. In this talk I will present some of our early work in coordinating this instruction, including challenges and preliminary outcomes.

*This work has been supported by NSF grants 0837058, 0942391, and 1140860.

DJ03: 11:30-11:40 a.m. Pedagogical Content Knowledge in a Course for Future Elementary Teachers

Contributed – N. Sanjay Rebello, Kansas State University, Physics Department, 116 Cardwell Hall, Manhattan, KS 66506; srebello@phys.ksu.edu

Dean A. Zollman, Kansas State University

We integrate pedagogical content knowledge into the fabric of a course for future elementary teachers structured around an instructional model called the pedagogical learning bicycle (PLB)—an adapted two-layered 3E learning cycle. This model intertwines the construction of science content knowledge (CK) with the development of pedagogical content knowledge (PCK). This course aims to provide opportunities for future teachers to develop skills reflecting on their own learning of physical phenomena, understanding how children talk and learn about physical phenomena, and learning how research literature describes ways in which children think about physical phenomena. It also expects future elementary teachers to apply their integrated understanding of CK and PCK to developing age-appropriate lesson plans to teach physical science concepts in an elementary science classroom. We describe the results of the first implementation of the course and its impact on student learning.

CKRL06: Crackerbarrel: Planning Future TYC Meetings

Location: Broadway I/II
Sponsor: Committee on Physics in Two-Year Colleges
Date: Tuesday, July 16
Time: 12:30–2 p.m.

Presider: Renee Lathrop

The Two-Year College committee has been coordinating and planning tandem meetings that focus on two-year college concerns and interests. This session will be a planning session where we are looking for ideas and suggestions on topics for future TYC meetings.

APS Plenary: Producing Superheavy Elements

Location: Grand Ballroom I
Date: Tuesday, July 16
Time: 2–3:30 p.m.

Presider: Renee Diehl

1. The Quest for Superheavy Elements

W. Loveland, Oregon State University, Corvallis, OR 97331

Walter Loveland

I will examine the current status of heavy element research. Among the questions addressed are: Why are heavy elements important? What is their unique role in chemistry? How has the Periodic Table evolved with time and what are the limits of the Periodic Table? How do you make new heavy nuclei? How does one do chemistry one atom at a time? What are the prospects for the synthesis of new heavy nuclei? What are the new ways of studying the atomic physics and chemistry of the heaviest elements?

2. Exploring the Limits of Nuclear Stability: Glimpsing the Island of Stability*

Mark A. Stoyer, Lawrence Livermore National Laboratory, Livermore, CA 94550

Mark A. Stoyer

The Dubna/LLNL collaboration has been investigating the nuclear and chemical properties of the heaviest elements since 1989. Elements 113-118 have been synthesized and characterized using fusion-evaporation nuclear reactions of 48Ca beams on actinide targets (237Np, 242,244Pu, 243Am, 245,248Cm, 249Bk, and 249Cf, respectively) at the U400 cyclotron located at the Flerov Laboratory of Nuclear Reactions in Dubna, Russia. This talk will discuss the ramifications of the experimental work during the last 10-15 years on the synthesis of elements 113 – 118, including the recent IUPAC acceptance of element names for 114 (flerovium) and 116 (livermorium). Prediction of the heaviest element possible is highly uncertain because of the complex interplay of strong nuclear forces, Coulomb forces, surface/volume effects, and shell corrections. For some combination of protons ($Z > 118$) and neutrons, the strong nuclear force which binds nucleons together will not be able to counter the Coulomb repulsion of the protons in a nucleus, and thus nuclei will cease to exist. Experimental and theoretical efforts to locate and access the next region of doubly magic spherically shaped nuclei, the Island of Stability, will be presented.

*This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

CKRL07: Crackerbarrel: There's an App for That

Location: Broadway III/IV
Sponsor: Committee on Educational Technologies
Co-Sponsor: Committee on Physics in High Schools
Date: Tuesday, July 16
Time: 12:30–2 p.m.

Presider: Andrew Duffy

The world of apps has exploded in recent years, and there are now many apps, on different platforms, that are useful for both the teaching and learning of physics. If you have a favorite physics app, please come and take a few minutes to demonstrate what it can do and how to use it. If you'd just like to see what other people are doing with mobile devices, this crackerbarrel session is also for you.

CKRL08: Crackerbarrel: Bringing Apparatus to Conferences and Organizations Nationally

Location: Galleria II
Sponsor: Committee on Apparatus
Date: Tuesday, July 16
Time: 1–2 p.m.

Presider: David Sturm

An observation of AAPT meetings has been the reduction of apparatus on display in as many sessions as once was common. How can organizers, presenters and attendees work together to encourage the demonstration of apparatus at AAPT national meetings, and also at section meetings, APS and NSTA meetings? Can we increase familiarity with apparatus in the community? Join us for a crackerbarrel to develop ideas on how to broaden the reach of demonstration of apparatus.

Session EA: Science and Society

Location: Galleria I
Sponsor: AAPT
Date: Tuesday, July 16
Time: 4–5 p.m.

Presider: Jim Mallmann

EA01: 4-4:10 p.m. Great Issues in Science & Society – An Interdisciplinary Science Course

Contributed – Andrew S. Hirsch, Purdue University, Lafayette, IN 47907; hirsch@purdue.edu

Buster Dunsmore, Michael Fosmire, Jane Yatcilla, Purdue University

A core requirement for College of Science students at Purdue University is the completion of a "great issues" course in which critical thinking and analytical skills developed through discipline specific studies are applied to the global conversation of the impact of science on society and the ramifications of scientific advances. Several "flavors" of such courses arose. At one extreme were those dealing in depth with a single topic such as oil. At the other extreme was a course that examined the interrelated issues involving energy, climate change, food, and water. We will describe the content, organization, and functioning of the latter, as well as its challenges, assessment of learning outcomes.

EA02: 4:10-4:20 p.m. Teaching About Cosmic Timescales When the Creation Museum's Your Neighbor

Contributed – Richard Gelderman, Western Kentucky University, Bowling Green, KY 42101-1077; richard.gelderman@wku.edu

The Creation Museum opened near Cincinnati in May 2007 as a $27 million, 70,000-square-foot, state-of-the-art, high-tech facility with the goal of presenting a "young Earth" account of the origins of the universe and life on Earth according to a literal reading of the Book of Genesis. The founders proudly claim a million visitors in the museum's first three years "exposed the bankruptcy of evolutionary ideas." We report on interviews and open-response surveys collected before and after a tour of the museum with a group of middle-school science teachers. The results provide some reassurance but also suggest cautionary warnings for those who wish to help their students appreciate the vast distances and ages that comprise our majestic cosmos.

EA03: 4:20-4:30 p.m. The Physics of AP Environmental Science

Contributed – James J. Lincoln, Tarbut V' Torah, 5 Federation Way, Irvine, CA 92603; lincolnphysics@gmail.com

For the past four years I have been teaching AP Environmental Science from the unusual perspective of a physicist (the class is normally taught by biologists). To my delight and surprise the class involved a lot of physics, and I was able to use my physics content knowledge to enhance the science of the class. In this talk I outline what to expect and how to structure a successful AP Environmental Science class from the perspective of a veteran physics teacher.

EA04: 4:30-4:40 p.m. Capacity Building in Energy Sector: The Role of Physical Sciences

Contributed – Nnabugwu C. Peace, National Centre for Energy Efficiency and Conservation, Faculty of Engineering, University of Lagos Akoka-Yaba, 01 234 Nigeria; puzondu@unilag.edu.ng

Oluwole Adegbenro, Oluwabori A. Babatunde, Azizat O Gbadegesin, National Centre for Energy Efficiency and Conservation

Today, our nation finds itself in an energy/power crisis as a consequence of a complex interplay of factors, some of which will take years to unravel and straighten. The universally accepted knowledge that Energy Efficiency and Conservation can be employed to ameliorate the situation is gradually being given a chance in the country but capacity building in this sector has to be rigorously pursued to make the necessary impact. In this presentation, we outline a roadmap that will ensure that more young Nigerian graduates invest their mental acuities in academic pursuits in physical sciences so as to earn a livelihood in Energy Efficiency and Conservation. The role of the physical sciences is to prepare students for effective professional careers in the many new career areas available in today's technologically and globally interdependent society. Physical science integrates physics, mathematics and chemistry as core components of its curriculum.

EA05: 4:40-4:50 p.m. Marie Anne Paulze Lavoisier: An 18th-Century Woman Learns Science

Contributed – Ruth Howes, Ball State University, 714 Agua Fria St. Santa Fe, NM 87501; rhowes@bsu.edu

Marie Anne Paulze met Antoine Lavoisier, the great French chemist, who was a friend and business colleague of her father's when she was 13 years old. She had been brought from a convent school to act as her father's hostess. She married him a year later and began to learn chemistry as well as other skills such as drawing and foreign languages so that she could act as his assistant. Although Marie's training was certainly hands-on, she also learned, as was typical of the time, by acting as hostess for the leading scientists of the day. After Lavoisier died by the guillotine on May 8, 1794, Marie managed to escape death herself and to edit and publish Mémoires de chimie, her husband's final multivolume work.

EA06: 4:50-5 p.m. Western Science and the Social Context in 19th Century India

Contributed – Rajive Tiwari, Belmont Abbey College, 100 Belmont-Mt. Holly Road, Belmont, NC 28012; rajivetiwari@bac.edu

Modern science was introduced in India in the 19th century during the British colonial rule. The native response to this science was influenced by several political, social, and cultural factors. By way of exploring these responses, science-related articles in contemporary popular Hindi magazines and newspapers were investigated. It was found that the reception offered to the new science was not one of simple acceptance or rejection. Instead, a complex and nuanced response was observed which was shaped by the prevailing nationalist climate, spread of Christian missionary activities facilitated by colonial rulers, growth of Hindu reform movements, and the preexistence of a body of indigenous scientific scholarship. Excerpts from relevant articles that illustrate a range of attitudes towards European science will be presented.

Session EB: Physics Majors: High School to Doctorate

Location: Galleria III
Sponsor: AAPT
Date: Tuesday, July 16
Time: 4–4:40 p.m.

Presider: Joe Kozminski

EB01: 4-4:10 p.m. Supporting Students in their Transition from High School to University

Contributed – Dimitri R. Dounas-Frazer, Compass Project at UC Berkeley, Physics Department, Berkeley, CA 94720-7300; dimitri.dounasfrazer@gmail.com

Jacob Lynn, Nathaniel Roth, Anna M Zaniewski, Compass Project at UC Berkeley

Given the size of the UC Berkeley Physics Department, integrating with the community and developing a physics network can be a daunting task for incoming freshmen. To fold students into the Physics Department and promote retention of students from all backgrounds, the Compass Project offers a wide range of services, including a residential summer program for incoming freshmen. The Compass Summer Program incorporates aspects of Modeling Instruction, Complex Instruction, and philosophies which have developed organically within our organization. We describe our pedagogical approach in the context of the 2011 program on non-Newtonian fluids, and we show that the Compass Summer Program is having a positive impact on retention, diversity, and community in the Berkeley Physics Department.

EB02: 4:10-4:20 p.m. Undergraduate Research as Curriculum: Perspective from a Physics Department

Contributed – Michael R. Braunstein, Central Washington University, Physics, MS 7422, CWU, 400 E University Way, Ellensburg, WA; 98926 braunst@cwu.edu

The physics department at Central Washington University currently requires majors to complete an undergraduate research project. This initiative is supported by a variety of resources both within the department and at the university. Our experience suggests that a valuable perspective on undergraduate research programs in such an environment is explicit consideration of them as curriculum. There are a number of implications of this perspective, ranging from identifying learning outcomes and assessment mechanisms, to allocation of resources and establishing criteria for selecting appropriate research projects, and we will present some of the results, benefits, and consequences of our efforts to frame undergraduate research in this manner.

EB03: 4:20-4:30 p.m. Redesign of Introductory Labs to Increase Retention of STEM Students

Contributed – Nina Abramzon, Cal Poly Pomona, 3801 W. Temple Ave., Pomona, CA 91768; nabramzon@csupomona.edu

Barbara M. Hoeling, University of Applied Sciences Landshut

Phu Tran, Norco College

Peter B. Siegel, Claudia L. Pinter-Lucke, Cal Poly Pomona

Programs aimed at increasing retention and graduation rates have been implemented at Cal Poly Pomona and at Norco College. As part of these programs there were interventions done to the freshman physics labs. The new labs were designed to follow the inquiry- based approach. The design elements will be presented in detail together with assessment of student learning and student attitudes.

EB04: 4:30-4:40 p.m. Physics on the Levels

Contributed – Stacy Palen, Weber State University, 2508 University Circle, Ogden, UT 84408; spalen@weber.edu

Non-academic models of teaching and learning sometimes have interesting parallels to academic practice. I will present the model of teaching and learning that has been in use in dressage training for more than 3000 years, and compare it to physicist preparation in the U. S. today. This comparison has led me to think about physicist preparation (from novice to PhD) in a new way. I will present a possible model for a physics "learning pyramid," and some thoughts about how this model might inform the response of the community to the brave, new world of academic instruction.

Session EC: Panel – Fighting Over Lab Goals

Location: Broadway I/II
Sponsor: Committee on Laboratories
Co-Sponsor: Committee on Physics in Undergraduate Education
Date: Tuesday, July 16
Time: 4–5 p.m.

Presider: Dick Dietz

Welcome to the Portland Physikz Pub which has been the home of many memorable arguments (mostly nonviolent) about contentious issues in physics. Who will ever forget the night devoted to tachyonic neutrinos? Today we have seated about the disputation table several experienced and opinionated physics laboratory mavens. The barkeep has already cut them off, so for the next hour they will be able to devote their entire attention to answering questions about one of their favorite subjects, the goals of physics labs. The presider will do his best to keep the proceedings provocative and perhaps even civil.

Speakers:

– **Mark Masters**, Department of Physics, Indiana-Purdue University, Fort Wayne, IN

– **Dean Hudek,** Physics Department, Brown University, Providence, RI

– **Gabe Spalding**, Physics Department, Illinois Wesleyan University, Bloomington, IL

– **Heather Lewandowski,** Department of Physics, University of Colorado, Boulder, CO

– **Randy Tagg**, Department of Physics, University of Colorado, Denver, CO

Session ED: Introductory Courses II

Location: Broadway III/IV
Sponsor: AAPT
Date: Tuesday, July 16
Time: 4–4:40 p.m.

Presider: Debora Katz

ED01: 4-4:10 p.m. Going to the Physical Situation: Making the Implicit Explicit – 1

Contributed – Dennis Gilbert, Lane Community College, 4000 E. 30th Ave., Eugene, OR 97405; gilbertd@lanecc.edu

Jared Stenson, Gonzaga University

Dennis Gilbert will describe a pedagogical approach in which Calc-based General Physics Students are challenged and supported to explicitly implement a perspective of "going to the physical situation" in developing both conceptual knowledge and problem solving ability. This approach effectively engages a number of physics learning challenges, such as moving beyond "plug and chug" and moving to principle-based understanding. It also addresses student expectations about the nature of science and physics, the nature of knowing, and identity as physics learners. The talk will introduce a graphic chart presented during the course on problem solving.

ED02: 4:10-4:20 p.m. Going to the Physical Situation: Making the Implicit Explicit – 2

Contributed – Jared R. Stenson, Gonzaga University, 502 E Boone Ave., Spokane, WA 99258; stenson@gonzaga.edu

Dennis Gilbert, Lane Community College

Jared Stenson will provide a deeper look at several practical issues from his experience implementing the perspective of "going to the physical situation" (see part 1) in developing conceptual knowledge and problem solving ability in the Classical Mechanics section of Calc-based General Physics. This presentation describes challenges and efforts of effectively engaging students who are sometimes resistant due to their familiarity and previous success using a different approach. These efforts include framing elements of the course, the choice of problems for discussion, and the exam structure. A joint working paper about the issues of this talk and the one above can be obtained from the presenters.

ED03: 4:20-4:30 p.m. Supplemental Problem Solving Sessions in the Calculus-based Physics Sequence

Contributed – Julie L. Talbot, University of West Georgia, 1601 Maple St., Carrollton, GA 30118; jtalbot@westga.edu

Problem solving is a skill that students are expected to master when taking physics courses. Many departments require their students to take physics because they want their students to gain problem-solving skills. However, this part of physics does not come naturally for many students. In order to give students extra opportunities to grapple with difficult physics problems, I have implemented problem-solving sessions where students work in groups to solve a variety of physics problems. In the sessions, the problems range from conceptual problems where students have to explain a situation using physics concepts, to estimation questions, to context-rich problems, such as the ones used at the University of Minnesota[1,2]. After three semesters, the DFW rates for the Physics I course are 25% for students who have attended workshop, while it is 75% for students who did not attend regularly.

1 P. Heller, et al. *Am. J. Phys.* **60,** 627, (1992).
2 P. Heller and M. Hollabaugh, *Am. J. Phys.* **60**, 637, (1992).

ED04: 4:30-4:40 p.m. Enhancing the Modern Physics Course by Including Waves

Contributed – Paul Weber, Utah Valley University, 800 West University Parkway, Orem, UT 84058; paul.weber@uvu.edu

I describe a curriculum revision made at the University of Puget Sound, where a waves course and the sophomore modern physics class were merged into a yearlong "enhanced" modern physics sequence now required for the physics major. This approach has many pedagogical and experimental advantages including a stronger intuitive and mathematical foundation for quantum physics, more effective inclusion of error analysis and theory of distributions into the laboratories, and the ability to cover all the areas of the standard modern physics textbook. It is effective in bridging the gap from a freshman physics student to the junior-level physics major capable of taking upper-level classes and laboratory courses. A separate preamble of mathematical material for oscillations and waves was written to supplement the traditional modern physics text. I will discuss key lessons taken from teaching this sequence for four years at UPS, including challenges and successes of the method.

Session EE: Physics Students' Identity and Community Building

Location: Salon Ballroom II/III
Sponsor: AAPT
Date: Tuesday, July 16
Time: 4–5 p.m.

Presider: Leslie Atkins

EE01: 4-4:10 p.m. Sustainability and Physics Identity: Revitalizing Physics Education for Traditionally Marginalized Groups

Contributed – Zahra Hazari, Clemson University, Department of Engineering & Science Education, 104 Holtzendorff Hall, Clemson, SC 29634; zahra@clemson.edu

Geoff Potvin, Clemson University

There is a growing need to help students better understand global sustainability issues while also empowering them in their science learning. The goal of this work is to explore how sustainability topics are addressed in high school physics classes and how addressing these topics might impact students' self-perceptions towards learning physics, particularly for students from traditionally marginalized groups. We employ a physics identity theoretical lens tat incorporates students' perceptions of being recognized, interested, and competent in physics. Drawing on data from a large national survey of college students about their high school science experiences, we found that, compared to biology and chemistry, physics classes are reported to cover sustainability topics far less frequently, including topics such as energy supply. Regression results reveal that for female, black, and Hispanic students, coverage of certain sustainability topics in high school physics was positively correlated to their physics identity.

EE02: 4:10-4:20 p.m. Student Collaborative Networks and Academic Performance in Physics

Contributed – David R. Schmidt, Colorado School of Mines, 2015 Infinity Circle, #191 Goden, CO 80401; dschmidt@mines.edu

Ariel M. Bridgeman, Patrick B. Kohl, Colorado School of Mines

Undergraduate physics students commonly collaborate with one another on homework assignments, especially in more challenging courses. However, it is not well known if the types of collaboration students engage in affect their performances. We empirically investigate collaborative networks and associated performances through a required collaboration reporting system in two sophomore- level and three junior-level courses during the 2012-2013 academic year. We employ social network analysis to quantify the structure and time evolution of these networks, which involve approximately 140 students. Analysis includes analytical and numerical assignments in addition to exam scores. We discuss results from this analysis.

EE03: 4:20-4:30 p.m. Research on Building Supportive Undergraduate Communities Through Physics Seminars

Contributed – Gina M. Quan, University of Maryland, College Park, 082 Regents Drive, Physics, College Park, MD 20742, gina.m.quan@gmail.com

Andrew Elby, University of Maryland, College Park

Many universities have created programs to improve undergraduate retention through problem solving and community building. At the University of Maryland, we are running a pilot seminar for freshmen physics majors that seeks to give students opportunities for meaningful collaboration. One component of the seminar has students develop physics disciplinary problem-solving skills by working on Fermi-style estimation problems, developing explanations of natural phenomena, and making sense of equations in small-group and whole-class discussions. The second half of the seminar actively works on building a community by having students discuss what it is like to be a physics major, which includes how to form study groups and students' sense of identity as physicists. In this talk, we will present classroom and interview episodes to discuss how the classroom community evolved as well as how students' sense of community relates to attitudes and approaches toward learning physics.

EE04: 4:30-4:40 p.m. Coming Out of the Physics Closet

Contributed – Paul W. Irving, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506-2600, paul.w.irving@gmail.com

Eleanor C. Sayre, Kansas State University

As part of an ongoing investigation into identity development in upper-level physics students, we present the case study of Sally. Upon entering our study, Sally is a sophomore chemistry major and physics minor. She identifies as a "chemist." As the study progressed, Sally began working part time in a physics research group and developed a greater affinity for physics as a discipline. She struggles with reconciling her identity as a chemist and chemistry major with her growing aspiration to do physics and be a physicist. In her junior year, Sally "comes out of the closet" and declares a physics major, to her delight and relief. In this talk, we discuss Sally's development in light of a framework that conceptualizes identity as having three integral aspects—personal, practice, and participation—by examining both interview and observational data.

EE05: 4:40-4:50 p.m. Interdisciplinary Connections and Physics Identity

Contributed – Tyler D. Scott, Clemson University, 104 Holtzendorff Hall, Clemson, SC 29634; tdscott@clemson.edu

Zahra Hazari, Geoff Potvin, Clemson University

Interdisciplinary thinking is important for the future of science and engineering as it will help foster broader thinking, open new avenues for research, and increase engagement amongst those who view science as narrow and unconnected. However, it is not well understood how interdisciplinary thinking can be fostered within the current culture of science education, nor how this thinking is related to students' science interests. Drawing on data from a national study, we use a physics identity framework to investigate the relationships between characteristics of interdisciplinary thinking among students and their attitudes towards physics. Furthermore, this study also examines how pedagogical techniques, particularly in physics classes, and school characteristics are related to fostering interdisciplinary thinking.

EE06: 4:50-5 p.m. A Case Study in Leveraging Biology Experiences in Physics

Contributed – Vashti Sawtelle, University of Maryland, College Park, 082 Regents Drive, College Park, MD 20742; vashti.sawtelle@gmail.com

Chandra Turpen, University of Maryland, College Park

Julia Gouvea, University of California, Davis

When we discuss courses designed to be interdisciplinary, such as our course in Introductory Physics for Life Science (IPLS) majors, we often focus on what students can gain from taking a course (physics) outside their chosen discipline (biology). Rarely do we consider what advantages might be gained from students' experience with biology in learning physics. At the University of Maryland we have designed an introductory physics course that attempts to leverage students' biology experiences in an authentic interdisciplinary manner. In this presentation, we will examine case study data of a student who initially describes herself as hating physics. We will look at longitudinal data across her experiences with our yearlong IPLS course and explore how, in an interdisciplinary classroom, her prior experiences as a biology student came to influence her evolving relationship with physics.

Session EF: Interactive Lecture Demonstrations – Whats New? ILDs Using Clickers and Video Analysis

Location: Parlor A/B
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Educational Technologies
Date: Tuesday, July 16
Time: 4–5 p.m.

Presider: Priscilla Laws

EF01: 4-4:30 p.m. Interactive Lecture Demonstrations: Active Learning in Lecture Including Clickers and Video Analysis

Invited – David R. Sokoloff, University of Oregon, Department of Physics, Eugene, OR 97403-1274; sokoloff@uoregon.edu

Ronald K. Thornton, Center for Science and Math Teaching, Tufts University

The results of physics education research and the availability of microcomputer-based tools have led to the development of the Activity Based Physics Suite.[1] Most of the Suite materials are designed for hands-on learning, for example student-oriented laboratory curricula such as RealTime Physics. 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" Suite materials designed to promote active learning in lecture, Interactive Lecture Demonstrations (ILDs),[2] including those using clickers and video analysis.

1. E.F. Redish, *Teaching Physics with the Physics Suite* (Wiley, Hoboken, NJ, 2004). 2. David R. Sokoloff and Ronald K. Thornton, *Interactive Lecture Demonstrations* (Wiley, Hoboken, NJ, 2004).

EF02: 4:30-5 p.m. Interactive Lecture Demonstrations: Effectiveness in Teaching Concepts

Invited – Ronald K. Thornton, Tufts University, Center for Science and Math Teaching, 4 Colby St., Medford, MA 02155; csmt@tufts.edu

David R. Sokoloff, University of Oregon

The effectiveness of Interactive Lecture Demonstrations (ILDs) in teaching physics concepts has been studied using physics education research based, multiple-choice conceptual evaluations.[1] 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.

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

Session EG: Posters on Apparatus

Location: Pavilion West
Sponsor: Committee on Apparatus
Date: Tuesday, July 16
Time: 4–5 p.m.

Presider: N/A

EG01: 4-5 p.m. A Simple Model of Relativity

Poster – Robert A. Close, Clark College, 1933 Fort Vancouver Way, Vancouver, WA 98663; rclose@clark.edu

In the early 1900s many scientists, including Albert Einstein and Louis de Broglie, studied the possibility that matter consists of soliton (or standing) waves. Although this model of matter is no longer in vogue, it is a very good model for teaching special relativity. By modeling matter as waves propagating in circles, time dilation and length contraction can be simply measured with a ruler. This demonstration will show you how.

EG02: 4-5 p.m. Action Cameras – New Perspectives in Video Capture

Poster – Paul M. Nord, Valparaiso University, 1610 Campus Drive E, Valparaiso, IN 46383; Paul.Nord@valpo.edu

The physics lab and classroom have available a new class of video cameras that are small, lightweight, and record high-resolution images. These "action cameras" can be worn on the body, or be mounted to a bicycle, car, or boat. Manufacturers provide a variety of mounting hardware that allows the instructor to easily put a camera almost anywhere. Such perspectives enable new ways of teaching about frames of reference and relative motion. From the camera's frame of reference, the rest of the world seems to move, twist, or spin about. The poster will show measurements of fictitious forces observed from within a rotating frame of reference, and how observations of a ball toss seen from a moving car (a different inertial frame) still follow a parabolic path. If space allows, I will demonstrate some of the mounting hardware as well as wireless remote viewing and control of the cameras using an iPad.

EG03: 4-5 p.m. An Eclectic Potpourri of Physics Labs

Poster – Gregory Puskar, West Virginia University, Physics Department, PO Box 6315, Morgantown, WV 26506; gpuskar@wvu.edu

Wathiq Abdul-Razzaq, Paul Miller, West Virginia University

Students typically regard physics laboratory as a necessary evil. One frequently voiced reason for this dissatisfaction is a perceived lack of relevance. In spite of this, the same experiments with the same methods of presentation persist, hiding the utility of many interesting and broadly useful concepts from most students. A selection of changes to standard physics laboratories that aim to improve student attitudes will be presented.

EG04: 4-5 p.m. An Inexpensive Quantitative Demonstration of Harmonics in Piped Sound Makers

Poster – Stephen A. Minnick, Kent State University, Tuscarawas, 330 University Drive NE, New Philadelphia, OH 44663; sminnick@kent.edu

A simple inexpensive activity, which can be included as part of a larger laboratory experiment, utilizes open-source software and a computer microphone to display the harmonics of open and closed end pipes. Students calculate the theoretical frequencies produced by blowing across the top of short lengths of PVC tubing and compare them to the display of actual frequencies present.

EG05: 4-5 p.m. An Open Source Physics Laboratory Data Acquisition System Project

Poster – Zengqiang Liu, Saint Cloud State University, 720 4th Ave. S, WSB 311, Saint Cloud, MN 56301; zliu@stcloudstate.edu

Open source physics laboratory (OSPL) project is a collection of laboratory data acquisition system (DAQ) hardware and software developed for laboratory physics teaching, similar to commercially available counterparts. However, circuit designs, sensors, and firmware are all open source, meaning no royalties to produce and modify. This not only drastically reduces the cost of a DAQ from hundreds of dollars to $60, but also allows instructors and students to be actively involved in the design, construction, and customization of their own lab equipment, giving them a sense of ownership that commercial units do not offer. With the low-cost OSPL, besides offering regular laboratory curriculum, instructors may now develop new curriculum to extend student experiential learning beyond lab rooms and lab sessions and offer laboratory experience to students enrolled in distance education courses. The software and hardware designs of the OSPL and some curriculum development opportunities are presented.

EG06: 4-5 p.m. Electronics Laboratory Projects with Arduino Microcontrollers

Poster – Herbert Jaeger, Miami University, Department of Physics, Oxford, OH 45056; jaegerh@MiamiOH.edu

Arduino is a popular microcontroller that is easily programmed to perform data acquisition and control functions. We have recently begun to design electronics lab exercises to be used in our sophomore Electronic Instrumentation Laboratory. We will present a number of these experiments to illustrate the Arduino platform's utility and versatility.

EG07: 4-5 p.m. Examining Inelastic Collisions

Poster – Mark F. Masters, IPFW, 2101 Coliseum Blvd. E, Fort Wayne, IN 46805; masters@ipfw.edu

James Otto, IPFW

In introductory physics, we talk about inelastic and elastic collisions. Generally, students are quite happy about elastic collisions because they have conservation of momentum AND conservation of energy. But if we set up a perfectly inelastic collision, the student's dilemma is the decrease in kinetic energy after the collision. The student's question of "where does the energy go?" generally relies upon our describing immeasurable loss mechanisms such as deformation of the object and sound. But that description is a telling rather than the students' discovery. What if the students could perform an investigation that allows them to see what happens to the energy? To this end we built a collision system in which a spring is compressed during a collision and a ratchet holds the spring at maximum collision. This allows the students to actually find the "ost" kinetic energy.

EG08: 4-5 p.m. Make and Take FIZMO Style

Poster – Christopher Doscher, 9335 SW 77 AV, APT 158, Miami, FL 33156; cdoscher@doscher.us

Physics modeling workshops are an intense and powerful way to not only begin a successful career as a physics teacher, but also to sustain and recharge after working for a time. As a participant and workshop leader it is evident that a sustainable professional network can be invaluable. At Florida International University, physics teachers are invited nationally to attend modeling workshops and as part of the year-round professional development support for attendees in the South Florida area, teachers attend periodic FIZics MOdelers meetings where best practices are discussed and laboratory apparatus constructed using the least expensive quality building materials (and anything we can recycle or scrounge for free) in a "Make and Take" back to our classrooms. Make and take ideas are borrowed from past workshops, gleaned from *TPT*, and born from the ideas of new teachers. This poster showcases make and take projects for the introductory mechanics course.

EG09: 4-5 p.m. On the Road with the University of Maine's Mainely Physics

Poster – David E. Sturm, University of Maine, Department of Physics & Astronomy, 5709 Bennett Orono, ME 04469-5709 sturmde@maine.edu

For over eight years (and longer in previous incarnations) the Mainely Physics Road Show has provided physics outreach across Maine and New

England. This poster includes a summary of that history. Adding "upreach" opportunities for student achievement, Mainely Physics has become the statewide organizer for the Maine Middle School State Science Olympiad (M^2S^3O). Also, a new outreach variation called Mainely Physics: P.S.I. (Physics Scene Investigation) alters the Road Show concept into a 'physics hands-on event' with multiple "content learning unit environments" (CLUEs) with ~50 stations of a variety of experiments providing clues to the solution of a "meta-problem" mystery. Poster will detail some of the apparatus used in this programming. Initial support funding from the WYP2005 Physics on the Road program, with additional support from the Bauder Fund.

EG10: 4-5 p.m. Quantized Conductance in a Constricted Gold Wire

Poster – Herbert Jaeger, Miami University, Department of Physics, Oxford, OH 45056; jaegerh@MiamiOH.edu

Anthony J. Silvidi, Khalid F. Eid, Miami University

Quantum mechanical behavior of electrons in a gold wire manifests itself by steps in the conductivity that are clearly observed as the wire is stretched. We present a setup that demonstrates this effect using a manually operated bending beam to break and reconnect the gold wire to obtain the quantized behavior. In order to have better process control we have added a computer-controlled piezo-crystal. Data accumulation is performed with a National Instruments DAQ system controlled by a computer running LabVIEW software. Moreover we will present details on a stand-alone control and acquisition system using the newly introduced Arduino Due microcontroller.

EG11: 4-5 p.m. Stokes-Mueller Polarimeters for the Advanced Lab

Poster– Adam S. Green, University of St. Thomas, 2115 Summit Ave., OWS 153, Saint Paul, MN 55105; asgreen@stthomas.edu

Anthony J. Vella, University of Rochester

Drew M. Mader, University of New Mexico

A versatile, low-cost polarimeter can be constructed from circularly polarizing film and a filter wheel. The polarimeter can incorporate a standard photodiode to measure all four Stokes parameters of light. An optional addition of a chopper wheel and lock-in amplifier allows for detection of low levels of diffusely scattered light. If used with an inexpensive camera in place of the photodiode, the device becomes a Stokes imaging polarimeter, and color filters in front of the camera allow for rudimentary spectropolarimetric imaging. Furthermore, two filter-wheel polarimeters can be used in conjunction; one as a polarization state generator and the other as an analyzer; to determine the complete 4x4 Mueller matrix of a target. As with the Stokes polarimeter, this configuration can be used in imaging or non-imaging applications. These polarimeters, which can be manually operated or automated, open up a broad range of experimental opportunities for students.

EG12: 4-5 p.m. Systematic Error in Ultrasonic Rangefinder Acceleration Measurements

Poster – Chris Kaneshiro, California State University, Chico, Department of Physics, Campus Box 202, Chico, CA 95929-0202; ckaneshiro@mail.csuchico.edu*

Eric Ayars, California State University, Chico

Ultrasonic rangefinders measure the position of an object by sending out a pulse of high-frequency sound and timing how long it takes for an echo to return from the object. When measuring moving objects, the speed-of-sound delay in the outgoing pulse causes a systematic error in the distance measurement. The distance error is generally negligible if object velocities are small compared to the speed of sound; but we show that the functional form of the position error causes a significant systematic error in the acceleration calculated from that position data. The systematic error in calculated acceleration, for a typical free-fall experiment, is sufficient to explain the error seen in an introductory-lab measurement of *g*.

Sponsored by Eric Ayars

EG13: 4-5 p.m. Teaching Labs on Electronics for Instrumentation Training

Poster – Yongkang Le, Fudan University, No. 220 Handan Road, Shanghai 200433; yongkangle@fudan.edu.cn

Mai Ye, Fudan University

Aimed processing of electric signal is a very important part of the realization of many instruments. Teaching labs designed for training on instrumentation should reveal the art and science of this process. Two teaching labs designed for this purpose will be reported. The first lab demonstrates the influence of the sampling resistor on the time response of an optoelectric detector. The second lab demonstrates a simple possibility to extract varying weak signal from a strong DC background.

EG14: 4-5 p.m. The iPAD as a Virtual Oscilloscope in Introductory Physics Laboratories*

Poster – Roberto Ramos, Indiana Wesleyan University, 4201 South Washington St., Marion, IN 46953; roberto.ramos@indwes.edu

Angela Garriott, Robert Burchell, Indiana Wesleyan University

The use of tablets as pedagogical tools in physics and electronics is becoming popular. While the many knobs and switches of a conventional oscilloscope may cause anxiety to non-physics, non-engineering students, a tablet such as an iPAD is less intimidating and has a friendlier touch-pad interface. We report our experience in using the iPAD as a virtual oscilloscope in an introductory algebra-based physics laboratory course. Using a commercial electronic accessory called OSCIUM iMSO-104, we turned the iPAD into a single-channel, virtual oscilloscope for measuring the relaxation time constant of RC- and RL-circuits. Using student surveys and direct observation, we report student responses to this new platform, versus using a conventional oscilloscope. We evaluate the iPAD-based virtual oscilloscope and its current technical limitations.

*Web: http://msdn.cis.indwes.edu/spaswebserver/roberto.ramos/?page_id=11

EG15: 4-5 p.m. Using Smartphones as Science Laboratory Instruments*

Poster – Kyle Forinash, Indiana University Southeast, 4201 Grant Line Road, New Albany, IN 47150; kforinas@ius.edu

Raymond F. Wisman, Indiana University Southeast

Smartphones and tablets available today have the computational power for data analysis such as the Fast Fourier Transform as well as built-in sensors such as accelerometers, magnetometers, microphones, speakers, and GPS. With existing apps, portable electronic devices can potentially bring a laboratory experience to the student outside of the classroom or lab. An additional valuable feature of smartphones and similar devices is the headset port which offers a method to communicate with external circuits and sensors, greatly enhancing the potential for use as a laboratory data collection tool. In this presentation we look at the use of mobile devices as laboratory data collection tools and demonstrate simple examples of a smartphone communicating with an external circuit via the headset port.

* R. Wisman and K. Forinash, "Smartphones as portable oscilloscopes for physics labs," *Phys Teach.* **50**, 242 (2012). K. Forinash and R. Wisman, "Smartphones – Experiments with an external thermistor circuit," *Phys. Teach.* **50,** 566 (2012).

EG16: 4-5 p.m. Wind Tunnel and Fluid Dynamics

Poster – Joel C.. Berlinghieri, The Citadel, Physics Department, Grimsley Hall, 171 Moultrie St., Charleston, SC 29409; berlinghieri@citadel.edu

Ryan Boodee, The Citadel

Undergraduate students at The Citadel majoring in the physical sciences or engineering, and therefore having the proper prerequisites, may add a minor in aeronautics to their major degree. As part of the equipment for that program the Physics Department has an AEROLAB EWT wind tunnel. An experiment for the measurement and analysis of drag coefficients for simple-shaped objects is presented with scaling in size and airspeed. All airspeeds are slow enough that the analysis can treat air as an incompressible fluid.

Session EH: High School

Location: Galleria II
Sponsor: AAPT
Date: Tuesday, July 16
Time: 4–4:40 p.m.

Presider: Lee Trampleasure

EH01: 4-4:10 p.m. Engaging Students in the Scientific Practices Using the Patterns Approach

Contributed – Bradford Hill, Southridge High School, 9625 SW 125th Ave., Beaverton, OR 97008; bradford_hill@beaverton.k12.or.us

The Patterns Approach for Physics is driven by the recurring question: "How do we find and use patterns in nature to predict the future and understand the past?" Students are continually engaged in scientific practices, starting with anchoring experiments that contextualize four common patterns in physics: linear, quadratic, inverse and inverse square. Inquiry and engineering experiences serve to spiral the anchoring patterns with new physics concepts, developing conceptual, graphical, and symbolic understanding. Each experiment begins with an initial guess that is contrasted with a data-informed prediction, found by extrapolation of the pattern in the data. This allows students to explicitly compare low- to high-evidence predictions and builds an experiential case for why we engage in scientific practices. Creating models and discussing their limitations is also key. The Patterns Approach has been used within freshman and IB courses and is published in the March issue of *The Science Teacher.*

EH02: 4:10-4:20 p.m. Three Engineering Projects that Start with Inquiry Experiments

Contributed – Heather E. Buskirk, Johnstown High School, 1 Sir Bills Circle, Johnstown, NY 12095; heather.buskirk@gmail.com

Bradford K. Hill, Beaverton School District

By structuring engineering projects so they start with inquiry experiments students can experience STEM as a truly integrated experience. Three such engineering projects are presented in project-based learning model. In the Wind Turbine, Bridge Design, and Barbie Bungee Adventure students act as members of an Engineering Firm bidding to win a contract. The students must engage in the engineering cycle to address the problem, but then engage in the inquiry cycle to develop data to inform their design. The inquiry cycle often uses technology and mathematics, thus bringing STEM together. These projects, while familiar to many physics classrooms, are presented in the context of the Pattern Approach to teaching Physics so the supporting materials and examples discussed would allow a teacher to easily use them in their own classrooms.

EH03: 4:20-4:30 p.m. Equilibrium of Levers with a 'Rolling' xis of Rotation

Contributed – Qiwei Zhao, Shanghai High School, local division, 400 Shangzhong Road, Shanghai, 200023, China PR; qiwei.zhao@hotmail.com

The lever with a fixed axis is nothing new. But when the axis is movable, even the simplest structure can sometimes present surprise for high school students. In this demonstration a lever is put on an axis that can freely roll on plane, looking for balance between a pair of forces. Then it is shown, experimentally and theoretically, that for equilibrium a set of special conditions must by met (say the inclination of the rod), which are usually beyond the expectation of most students (and me). Although the explanation isn't straightforward, no advanced statics theory beyond the ability of most G11 students is required. The last feature is that the setup is extremely simple and no lubrication is needed at all. Rather, it requires friction to work properly!

EH04: 4:30-4:40 p.m. Bring Wave Interference to Life with an Inexpensive Michelson Interferometer

Contributed – Dale Ingram, LIGO Hanford Observatory, PO Box 159, Richland, WA 99253, ingram_d@ligo-wa.caltech.edu

Interferometers can offer students an interesting view of some of the applications of wave interference, building upon understandings that arise from traditional slit interference experiments. In this session, LIGO (Laser Interferometer Gravitational-wave Observatory) will introduce two versions of simple Michelson interferometers. Construction of each can be accomplished for roughly $100. These devices make a helpful bridge for teachers who introduce their students to the search for gravitational waves. Several uncomplicated experiments of high precision are possible once the instruments are successfully assembled. Session participants will receive interferometer parts lists and assembly instructions and will experiment with assembled examples.

Session EI: PER: Reasoning, Mathematics, and Representations

Location: Pavilion East
Sponsor: AAPT
Date: Tuesday, July 16
Time: 4–5 p.m.

Presider: Beth Lindsey

EI01: 4-4:10 p.m. Measuring Proportional Reasoning with a Research-based Assessment Suite*

Contributed – Andrew Boudreaux, Western Washington University, 516 High St., Bellingham, WA 98225-9164; andrew.boudreaux@wwu.edu

Stephen E. Kanim, New Mexico State University

Suzanne W. Brahmia, Rutgers University

Recent work in PER has examined the impact of scientific reasoning ability on student learning gains in introductory physics courses. Proportional reasoning is typically included as an important part of scientific reasoning. Proportional reasoning, however, is not well defined or monolithic, but rather consists of a variety of components, with expertise characterized by skill in selecting from among these components and fluency in shifting from one to another. An ongoing collaboration between Western Washington University, New Mexico State University, and Rutgers seeks to map the cognitive terrain in this area by developing a set of proportional reasoning components and designing assessment items to probe ability along those components. Free-response versions of these items have been tested extensively with students. Responses have been used to develop a suite of multiple choice items. This talk will describe the assessment suite and present results from a variety of introductory physics courses.

*This work is supported by NSF DUE-1045227, NSF DUE-1045231, NSF DUE-104525.

EI02: 4:10-4:20 p.m. Math in Math, Math in Physics*

Contributed – Steve Kanim, New Mexico State University, PO Box 30001, MSC 3D, Las Cruces, NM 88003; skanim@nmsu.edu

Suzanne Brahmia, Rutgers University

Andrew Boudreaux, Western Washington University

The degree to which students struggle with basic mathematics in introductory physics is often surprising, even to experienced instructors. As part of an ongoing investigation into student use of proportions in introductory physics, we have been looking at student responses to questions about proportions in physics and in everyday contexts. At times it seems that the difficulties we are observing have less to do with the proportions themselves than with fundamental differences between how students and physics instructors think about the purposes of mathematics and about the meanings of mathematical expressions. This in turn has led us to look for ways that math as it is taught in math classes is different from math as it is used in introductory physics classes. In this talk I will describe some of these differences.

*This work is supported by NSF DUE-1045227, NSF DUE-1045231, NSF DUE-104525.

EI03: 4:20-4:30 p.m. Discourse Analysis of Students' Use of Mathematical Idioms in Physics*

Contributed – Ying Chen, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506-2601; cying@phys.ksu.edu

Eleanor C. Sayre, Kansas State University

As students develop their physics identity, their ability to successfully understand the relationship between mathematics and physics plays an integral role. What are their expectations about how mathematics should be done in physics classes? How do they understand typical idiomatic expressions such as "far away" or "blows up"? In this talk, these questions will be discussed using observational video-based data of upper-division physics students using micro-genetic analysis of discourse. Starting with how students become aware of mathematical idioms and use them in problem solving and sense-making, this analysis will give insight into how students understand mathematics in physics using mathematical idioms as a lens.

*This material is based upon work supported by the National Science Foundation under Grant No. 1240782.

EI04: 4:30-4:40 p.m. Understanding External Representations as Computational Tools

Contributed – Elizabeth Gire, University of Memphis, 421 Manning Hall, Memphis, TN 38152; egire@memphis.edu

Edward Price, California State University, San Marcos

In physics, external representations (like graphs or free-body diagrams) are used to document and communicate information about a physical situation, and also as tools for computation. An important instructional goal is to teach students to solve problems using physical representations. Yet, while experts use representations fluently and productively, novices often struggle to interpret them and may not value their utility. In addressing this, we use conceptual blending theory and distributed cognition to gain insight into how meaning and computational power arise from the material and conceptual features of representations. In this talk, we apply these ideas to understanding how students create and use external representations for solving problems. In particular, we discuss how conflicts among material and conceptual elements of representations may lead students to misuse or misunderstand external representations, and how looking for such conflicts may help to identify potential areas of student difficulties.

EI05: 4:40-4:50 p.m. Student Difficulties in Translating between Mathematical and Graphical Representations

Contributed – Alexandru Maries, University of Pittsburgh, 5813 Bartlett St., Pittsburgh, PA 15217; alm195@pitt.edu

Shih-Yin Lin, Chandralekha Singh, University of Pittsburgh

We investigate introductory physics students' difficulties in translating between mathematical and graphical representations and the effect of scaffolding on students' performance. We gave a typical problem that can be solved using Gauss's law to 96 calculus-based introductory physics students. Students were asked to write an expression for the electric field in various regions and graph it. We implemented two scaffolding interventions to help them: (1) students were asked to draw the electric field in each region first (before having to plot it at the end) or (2) asked to draw the electric field in each region and asked to evaluate the electric field at the beginning, mid and end points of each region. The comparison group was only asked to plot the electric field at the end of the problem. We also conducted interviews in order to better understand how the interventions impacted them. We will present some surprising results.

EI06: 4:50-5 p.m. Student Interpretation of Multi-Variable Expressions: Transfer Between Different Contexts

Contributed – Mila Kryjevskaia, North Dakota State University, Department of Physics, PO Box 6050, Fargo, ND 58108-6050; mila.kryjevskaia@ndsu.edu

Student reasoning difficulties with applying and interpreting multi-variable expressions have been reported previously. In the context of a math course, for example, it may be appropriate to reason that, for the given relationship $y = x/a$, if x increases, y must also increase; in such cases, it is commonly assumed that variables (e.g., x and y) and constants (e.g., positive a) have been clearly established. However, a direct mapping of the same reasoning in the context of physics (namely, for the given relationship $f= v/\lambda$, if the propagation speed v increases, frequency f must also increase) leads to an erroneous conclusion. In this investigation we are probing the impact of targeted instruction on student ability to apply multi-variable expressions and to transfer their knowledge and skills between different contexts. Data from introductory calculus-based physics courses will be presented and discussed.

PST2: Poster Session

Location: Grand Ballroom II
Date: Wednesday, July 17
Time: 8:30–10 a.m.

Odd number poster authors should be present 8:30-9:15 a.m.
Even number poster authors should be present 9:15-10 a.m.
(Posters should be set up by 8 a.m. Wednesday and then taken down by 4 p.m. Wednesday)

A – Lecture/Classroom

PST2A01: 8:30-9:15 a.m. Designing Against Plug and Chug

Poster – Eugene Torigoe, Thiel College, 75 College Ave., Greenville, PA 16125; etorigoe@thiel.edu

Just because a question is numeric doesn't mean that it has to be a plug and chug question. This poster will outline some concrete strategies for question design that penalize students who blindly plug numbers into equations. Regularly using these kinds of questions can reconfigure the class reward structure, and shows students that their success will be directly tied to their understanding of the equations they are use.

PST2A02: 9:15-10 a.m. Developing Scientific Reasoning in Pre-H.S. Education Majors by Eliminating Possibilities

Poster – Jon D. H. Gaffney, Eastern Kentucky University, 521 Lancaster Ave., NSB 3140 Richmond, KY 40475; jon.gaffney@eku.edu

One goal for a physics content course for pre-HS education majors is to help students develop scientific reasoning skills, particularly with respect to deductive and hypothetico-deductive reasoning. Opportunities for making such development explicit arise in two separate units that build from "Physics by Inquiry" materials. In magnetism, we use Sudoku to introduce the concept of eliminating possibilities as deduction, and we use that process to determine whether objects are permanent magnets, ferromagnetic objects, or non-magnets. When studying electric circuits, we introduce multiple possible conceptual models for electric circuits, and students are tasked with the job of "busting" them by using hypothetico-deductive reasoning. These activities allow students who are largely inexperienced with scientific reasoning to play at some fundamental processes, providing groundwork for more intense evidence-based reasoning later in the semester.

PST2A03: 8:30-9:15 a.m. Going to the Physical Situation: Helping Students See Beyond Numbers

Poster – Jared R. Stenson, Gonzaga University, 502 E Boone Ave., Spokane, WA 99258; stenson@gonzaga.edu

Dennis Gilbert, Lane Community College

This poster presents a deeper look at several practical issues that arise while implementing a perspective of "going to the physical situation" in developing conceptual knowledge and problem solving ability in the classical mechanics section of Calc-based General Physics. It describes challenges and gives examples of efforts to effectively engaging students who are sometimes resistant due to their familiarity and previous success using a different approach. These efforts include framing elements of the course, the choice of problems for discussion, and the exam structure.

PST2A04: 9:15-10 a.m. Going to the Physical Situation: Problem-solving Chart

Poster – Dennis Gilbert, Lane Community College, 4000 E 30th Ave., Eugene, OR 97405; gilbertd@lanecc.edu

Jared Stenson, Gonzaga University

The poster provides details of a graphic chart on problem solving used in

Wednesday, July 17 Highlights

REGISTRATION 8 a.m.–3 p.m. Plaza Foyer

Poster Session 2 8:30–10 a.m. Grand Ballroom II

H.S. Physics Photo Contest Winners Plaza Foyer

MELBA NEWELL PHILLIPS MEDAL: Lillian C. McDermott
10–11 a.m. Grand Ballroom I

GREAT BOOK GIVEAWAY, 12–12:30 p.m. Plaza Foyer

WALKING TOUR OF PORTLAND, 4:30–6:30 p.m.

PERC Conference and Banquet, 8:30 p.m. Grand Ballroom I

a pedagogical approach in which Calc-based General Physics students are challenged and supported to explicitly implement a perspective of "going to the physical situation" in developing both conceptual knowledge and problem solving ability. This approach effectively engages a number of physics learning challenges, such as moving beyond "plug and chug" and moving to principle-based understanding. It also addresses student expectations about the nature of science and physics, the nature of knowing, and identity as physics learners. The chart frames discourse in the class.

PST2A05: 8:30-9:15 a.m. Graphical Analysis of a Free-Falling Slinky through Viscous Media

Poster – Samuel Moore, Santa Rosa Junior College, Physics, Santa Rosa, CA 95401; senatorsam21@yahoo.com*

The slow motion video of the free fall of a vertically stretched Slinky in air reveals two distinct motions. One would be the collapse of the Slinky while the bottom portion remains motionless and then the free fall of the collapsed Slinky. This surprising phenomena can also be observed when Slinky is dropped in a viscous media, making it possible to conduct the experiment live in the classroom without the need for use of a special camera. Our graphical analysis reveals a collapse time of 0.3, 0.5, 8, 12 and 16 seconds for the fall of Slinky in: water, mineral oil, corn syrup, shampoo and liquid soap, respectively. The stretched portion of the Slinky was measured to be approximately 30 cm.

*Sponsored by Younes Ataiiyan

PST2A06: 9:15-10 a.m. Historical Development of Science in a Course for Non-science Students

Poster – Scott W. Bonham, Western Kentucky University, 1906 College Heights Blvd., Bowling Green, KY 42101-1077; scott.bonham@wku.edu

A major general education goal is understanding of the nature and process of science. My course Light, Color, and Vision addresses it using both hands-on experimental work and reading/discussion of the historical development of ideas about light, color, and vision from antiquity to modern day. Students read about different important figures: Empedocles and Aristotle, Alhazan, Christiaan Huygens, Isaac Newton, Augustin-Jean Fresnel, Albert Michelson, James Clerk Maxwell, and Albert Einstein. They also read accessible writings by three of these figures which illustrate different stages in the development of science. A selection from Aristotle's Sense and the Sensible is an early attempt at systematic explanation of vision and color. Newton's "A New Theory about Light and Colors," represents early scientific communication, and Maxwell's "On the Theory of Colours in relation to Colour-Blindness," is structured much like modern scientific papers. Combined, these help students better understand the processes and nature of science.

PST2A07: 8:30-9:15 a.m. Modeling Matter as Soliton Waves

Poster – Robert A. Close, Clark College, 1933 Fort Vancouver Way, Vancouver, WA 98663; rclose@clark.edu

Quantum mechanics is typically taught as a statistical theory with no classical analogue. However, many scientists have investigated classical analogues which yield some aspects of quantum behavior. Nineteenth-century scientists modeled the universe as an elastic solid "aether" in order to understand light waves. We describe how this simple model can also be used to teach topics such as special relativity, atomic spectra, Dirac wave functions, quantum operators, electromagnetic potentials, quantum statistics, antimatter, and gravity. This approach can serve as simply a good analogy for non-majors, or as an introduction to the mathematics of modern physics for physics majors.

PST2A08: 9:15-10 a.m. Teaching Physics-related Social Topics within General Physics Courses

Poster – Art Hobson, University of Arkansas, Department of Physics, Fayetteville, AR 72701; ahobson@uark.edu

Physics-related social topics can add relevance, human interest, contemporary appeal and, most importantly, significant knowledge to your introductory high school or college physics course. This poster features many societal topics discussed in my conceptual physics textbook for non-science college students, "Physics: Concepts & Connections" (Pearson/Addison-Wesley, 5th edition 2010): global warming, ozone depletion, transportation, risk assessment, biological effects of radioactivity, steam-electric power, fossil fuels, nuclear power, renewable energy, exponential growth, population explosion, energy efficiency, pseudoscience, nuclear weapons, the energy future, and the scientific process. There is also a segment about how to deal with controversial topics.

PST2A09: 8:30-9:15 a.m. Times of Descent Along Tracks of Various Shapes

Poster – Carl E. Mungan, U.S. Naval Academy, Physics Mailstop 9c, Annapolis, MD 21402; mungan@usna.edu

Trevor C. Lipscombe, Catholic University of America Press

The frictionless track of fastest descent between two arbitrary points in a vertical plane is cycloidal. If instead the track is straight, the descent time along it will be longer by some amount. The straight track lies everywhere above the cycloidal track. Intuitively, there must be another track that lies everywhere below the cycloidal track that also takes more time by the same increase. That is, cars started together on the straight track and on this new track will reach the finish line in a tie. What is the shape of this new track? [See C.E. Mungan and T.C. Lipscombe, "Complementary Curves of Descent," *Eur. J. Phys*. **34**, 59-65 (2013).]

PST2A10: 9:15-10 a.m. Using Plumbdads-Quarkles to Examine Student Understanding of Scientific Practice

Poster – Timothy Grove, IPFW, 2101 E. Coliseum Blvd., Fort Wayne, IN 46805; grovet@ipfw.edu

Many of my colleagues have lamented students' inability to examine, analyze, and gain meaning from measured data. To open a discussion with students as well as to examine student thinking, a hypothetical set of data was given to students relating the fictional quantities of plumbdads and quarkles. These two quantities were used rather than physically observable parameters so that students could not "gain insight" through Internet searches (Wikipedia, Google search, etc.) or through the index of a book. The developed exercise asks students a series of questions regarding the "collected data" and two researchers' opinions about the same data. All of the questions have generally agreed upon answers (at least to scientists), but students starting a physics course often have their own ideas.

A – PER: Lecture/Classroom

PST2A11: 8:30-9:15 a.m. Breaking Expectations: International Female Student Performance in Calculus-based Mechanics Course

Poster – Rebecca Lindell, Purdue University, 525 Northwestern Ave., West Lafayette, IN 47907-2036; rlindell@purdue.edu

Jignesh Mehta, Andrew Hirsch, Purdue University

Purdue University has the second largest international student enrollment in the country, which translated to nearly 40% self-reported international students in our fall 2012 calculus-based introductory mechanics course. Surprisingly, both international and domestic populations have 25% female students. Contrary to expectations, preliminary examination of student exams scores show that the international female students were the highest performing students in our introductory calculus-based mechanics course. An obvious conclusion is that the international female population are simply better prepared for the course, except that analysis of pre-test results of the Classroom Test of Scientific Reasoning show no difference between the populations. In this poster we present a further investigation of these results.

PST2A12: 9:15-10 a.m. Evaluation of a Reformed Engineering Mechanics Course at Purdue University

Poster – Andrew Hirsch, Purdue University, 525 Northwestern Ave., West

Lafayette, IN 47907-2036; hirsch@purdue.edu

Kyle Isch, Ethan Stanley, Rebecca Lindell, Purdue University

Purdue University's IMPACT program[1] facilitates the transformation of large enrollment by incorporating interactive engagement methods into a course. As participants in this program, the researchers reformed Purdue's fall 2012 introductory calculus-based mechanics course, Phys 172: Modern Mechanics, by developing a series of Multimedia Learning Modules (MLMs) for use with the *Matter and Interaction* text.[2] In addition, the one-hour weekly recitations were redesigned to enhance students' problem-solving skills by utilizing cooperative group problem solving. Finally, the two-hour weekly labs were partially redesigned to enhance students' computational modeling skills. To evaluate the effectiveness of this reformed course, data analysis included student pre-test/ post-test results from Lawson's Classroom Test of Scientific Reasoning, Primary Trait Analysis of student exams and student responses to an anonymous survey. The IMPACT program provided additional data. This poster presents results of this evaluation, as well as suggestions for improvement for next fall.

1. IMPACT: Instruction Matters: Purdue Academic Course Transformation
2. Ruth Chabay and Bruce Sherwood, *Matter & Interactions: Modern Mechanics,* Third edition (Wiley).

PST2A13: 8:30-9:15 a.m. Online Homework in a Physics Course from the Student's Perspective

Poster – Monica Pierri-Galvao, Marywood University, 2300 Adams Ave., Scranton, PA 18509; mpierrigalvao@marywood.edu

An online homework system is a common practice in introductory physics courses—mainly at institutions where class sizes are large. It greatly reduces the difficult task of grading. It also provides an immediate feedback to the students. There has been a great discussion in the literature about the effectiveness of these systems, however not so much about the student's perception. Therefore, we investigated this issue by adopting an online homework system in an introductory physics course and conducting surveys to examine the students' opinion about the experience.

PST2A14: 9:15-10 a.m. Results of Flipping Introductory Mechanics and E&M College Physics Courses*

Poster – Roberto Ramos, Indiana Wesleyan University, 4201 South Washington St., Marion, IN 46953; roberto.ramos@indwes.edu

Jaki Richter, Adam Wroughton, Indiana Wesleyan University

As part of a year-long project to improve physics learning in a liberal arts college setting, students taking introductory, algebra-based Mechanics and Electricity & Magnetism classes were assigned to watch online lecture videos prior to class. Students were motivated using extra credit to watch five- to 20-minute video bullets prepared by the instructor. Viewing patterns were tracked through Blackboard. Inside the classroom, students were engaged with research-based physics tutorials and classroom that enabled peer instruction and active learning. One faculty and at least one undergraduate TA played the role of "facilitator" in these classes. The results show significant learning gains, as measured by standardized physics diagnostic tests. In this presentation, we report on the successes and challenges encountered in "flipping" College Physics classes. We also compare experiences in flipping mechanics versus E&M classes, as well as student feedback, as measured by surveys and online video interviews.

*Web: http://msdn.cis.indwes.edu/spaswebserver/roberto.ramos/?page_id=11

PST2A15: 8:30-9:15 a.m. SAIL: Student Assessment of Instruction and Learning

Poster – Randall D. Knight, California Polytechnic State University, Physics Department, San Luis Obispo, CA 93407; rknight@calpoly.edu

Thomas Bensky, California Polytechnic State University

Beginning in fall 2012, the Cal Poly physics department replaced a short, generic, in-class course evaluation with an online, multi-question survey designed specifically for introductory physics classes. Questions are focused on specific aspects of instruction and on what the student thinks he or she gained from the course rather than on the instructor's popularity. Lecture sections and lab sections have different surveys, each with questions appropriate to that mode of instruction. Student responses to each question are guided by a rubric, so instructors receive highly specific feedback as to what's working and which aspects of instruction need improvement. In addition, the aggregate data, with instructor names removed, has provided new insight into how well the department is meeting its teaching obligations. A variety of interesting results will be presented.

B – Other

PST2B01: 8:30-9:15 a.m. A Physicist Chairing the Curriculum Committee at a College of Pharmacy?

Poster – Richard P. McCall, St. Louis College of Pharmacy, 4588 Parkview Place, St. Louis, MO 63110; Richard.McCall@stlcop.edu

St. Louis College of Pharmacy is beginning a new academic program in the fall of 2014, which will integrate, over a seven-year period, a BS in Health Sciences with the Doctor of Pharmacy degree. The new curriculum begins with students taking typical liberal arts and science courses for the first three years. What better time for a non-pharmacist to chair the Curriculum Committee. Jumping into this arena has meant learning terms such as ability outcomes, curriculum mapping, assessment reports, performance criteria, DACUM responsibilities, Appendix B content, and ACPE accreditation. All are common in the pharmacy educator's vocabulary, but have been a bit abstract for this physicist. All courses will go through the approval process, so it will be busy for several years. Two good things: (1) students will take two semesters of physics, instead of only one, and (2) a new physics lab is planned.

PST2B02: 9:15-10 a.m. How 'Make' Can Change Science Teaching and Learning

Poster – Jennifer N. Wyld, Oregon State University, 65 W. 35th Place, Eugene, OR 97405; wyld@efn.org*

The Maker movement, with its Maker Faires, Maker Spaces, Make Magazine and vibrant Make website, is an exciting community of people of all ages who are playing, creating, sharing. It is a group of DIYers who are morphing into DIWO (do it with others) and are actively reaching out to youth to reinvigorate interest and skills around making. In the process, they are re-imagining what learning could look like if we gave learners access to tools and materials and skills and a safe environment to try and fail and try again. A new initiative is Maker Ed, started in 2012, to create ways to share the Make culture and values around education-- learning by doing/learning by making. Schools used to have places and opportunities for students to do and Make and could again-- and we can create more spaces for this type of creativity and innovation in our communities.

*Sponsored by Bruce Emerson

PST2B03: 8:30-9:15 a.m. Improving Recruitment and Retention in the Mathematical and Physical Sciences*

Poster – Jane Flood, Muhlenberg College, Physics Department, Allentown, PA 18104; flood@muhlenberg.edu

Funded by an NSF S-STEM grant, Muhlenberg College recruited two cohorts of economically disadvantaged students intending to study chemistry, computer science, environmental science, mathematics, physical science, or physics. Our program includes six elements: financial, academic and psychosocial support, mentoring, professional development for students, and faculty development. Literature on college grants (Fife et al., 1976.), recruitment and retention of minority students (Gandara et al., 1999), and retention of students from all backgrounds in STEM fields (Seymour et al., 1997) supports the structure of our program. This poster describes the current status of our project. Supported by NSF S-STEM Award 0965834

*J.D. Fife and L.L. Leslie, *The College Student Grant Study. Research in Higher Education,* 317-333 (1976); P. Gandara and J. Maxwell-Joly, *Priming the Pump: Strategies for Increasing the Achievement of Minority Undergraduates* (The College Board, NY 1999) 129 pp; E, Seymour and N.M. Hewitt, *Talking About Leaving: Why Undergraduates Leave the Sciences* (Westveiw Press, Boulder CO, 1997) 429 pp.

PST2B04: 9:15-10 a.m. Is Earth's Warming Equally Distributed Geographically?

Poster – Gordon J. Aubrecht, Ohio State University at Marion, 1465 Mt. Vernon Ave., Marion, OH 43302; aubrecht@mps.ohio-state.edu

One consequence of human use of energy is emission of greenhouse gases. Many nonscientists (as well as a few real scientists) do not think that climate change could be caused by human actions. Reasons range from doubt that tiny humans could affect an entire planet to belief that human life on Earth will soon end. Science is about experimental data, reasoning from those data, and theoretical perspectives supported by the data. Svante Arrhenius provided (in 1896) the first theoretical (and compelling) reasons that carbon dioxide could influence Earth's energy budget. Multiple sources of modern data underlie the belief of virtually all climate scientists that humans are changing our climate. Earth's temperature is rising. Is the rise distributed uniformly around the world? We compare the world record to the U.S. and Australian records, and those to records in a small part of the U.S. to see what the temperature data show.

PST2B05: 8:30-9:15 a.m. Twin Paradox? There Is No Twin Paradox! (Really!)

Poster – Stephen M. Rodrigue, Yakima Valley Community College, South 16th Ave., and Nob Hill Blvd., Yakima, WA 98907-2520; srodrigue@yvcc.edu

The Twin Paradox is explored mathematically using the Lorentz coordinate transformations and spacetime diagrams for four different reference frames. Calculated results demonstrate that all observers will agree on the spacetime intervals for the traveling twin and the Earthbound twin, and thus all observers will agree that the traveling twin ages less than the Earthbound twin. The symmetry of time dilation is demonstrated to still be valid, as it must, but in a manner such that no paradox actually arises.

PST2B06: 9:15-10 a.m. The Science Education Initiative: Free Instructor, Course, and Workshop Materials*

Poster – Stephanie V. Chasteen, University of Colorado, Boulder, 390 UBC, Boulder, CO 80309; stephanie.chasteen@colorado.edu

Katherine K. Perkins, University of Colorado

The Science Education Initiative at the University of Colorado has engaged in research and course development in a variety of courses and disciplines for over six years. In this poster we highlight (a) the free, downloadable archives of course materials in physics and other sciences, (b) workshop materials available for facilitating workshops in peer instruction and learning goals, and (c) our "first day framing" project which compiles materials that instructors use to introduce their students to active learning strategies.

*Materials can be found at http://www.colorado.edu/sei/fac-resources/

C – Physics Education Research II

PST2C01: 8:30-9:15 a.m. Examining Identity Development with Cultural Historical Activity Theory

Poster – Sissi L. Li, California State University, Fullerton, 800 N. State College Blvd., Fullerton, CA 92831; sili@fullerton.edu

Michael E. Loverude, California State University, Fullerton

Becoming a physics major involves learning to be part of physics communities. In this process, students socially interact with these communities, grapple with changing expectations over time as students become more physicist-like, and make use of tools in ways that are unique to the field. A theoretical framework is needed to incorporate elements beyond the social ones. Cultural Historical Activity Theory (CHAT) examines human actions through activity systems characterized by a motivation for action; components within the system include social, structural, and temporal artifacts that are often in conflict and drive an individual or group to action. For example, students joining a research group experience conflict between what counted as good lab work in classes and new expectations in the research lab. Using CHAT, we examine the physics major identity development through the interactions within an activity system and between activity systems that shape the trajectory of becoming a physicist.

PST2C02: 9:15-10 a.m. A Case Study in Leveraging Biology Experiences in Physics

Poster – Vashti Sawtelle, University of Maryland, College Park, 082 Regents Drive, College Park, MD 20742; vashti.sawtelle@gmail.com

Chandra Turpen, University of Maryland, College Park

Julia Gouvea, University of California, Davis

When we discuss courses designed to be interdisciplinary, such as our course in Introductory Physics for Life Science (IPLS) majors, we often focus on what students can gain from taking a course (physics) outside their chosen discipline (biology). Rarely do we consider what advantages might be gained from students' experience with biology in learning physics. At the University of Maryland we have designed an introductory physics course that attempts to leverage students' biology experiences in an authentic interdisciplinary manner. In this presentation, we will examine case study data of a student who initially describes herself as hating physics. We will look at longitudinal data across her experiences with our yearlong IPLS course and explore how, in an interdisciplinary classroom, her prior experiences as a biology student came to influence her evolving relationship with physics.

PST2C03: 8:30-9:15 a.m. A Scenario for Exploring the Relationship Between Energy and Free Energy*

Poster – Abigail R. Daane, Seattle Pacific University, 3307 3rd Ave. W, Seattle, WA 98119; abigail.daane@gmail.com

Benjamin D. Geller, Vashti Sawtelle, Edward F. Redish, University of Maryland, College Park

Rachel E. Scherr, Seattle Pacific University

The energy available to do useful work is different from the total energy in a system. This distinction is particularly relevant to biology and pre-health science students who encounter a disconnect between "energy" as described in their introductory physics courses and "free energy" as described in their biology and chemistry classes. It is also relevant to K-12 teachers who are asked to explain how it is that energy can be "used up" even though the total energy is conserved. The relationship between energy and free energy is made visible when learners are asked to compare two systems having the same total energy but different capacities to do work on their surroundings. Unpacking this scenario requires ideas related to entropy, energy degradation, and the second law of thermodynamics. This poster examines how taking up these ideas can help to reconcile seemingly disconnected concepts about energy.

*This material is based upon work supported by the HHMI NEXUS grant and by the NSF under Grant No. 0822342 and NSF-TUES DUE 11-22818.

PST2C04: 9:15-10 a.m. Like Dissolves Like: Unpacking Student Reasoning About Thermodynamic Heruristics*

Poster – Benjamin D. Geller, University of Maryland, College Park, Department of Physics, College Park, MD 20742; geller@umd.edu

Benjamin W. Dreyfus, Vashti Sawtelle, Chandra Turpen, Edward F. Redish, University of Maryland, College Park

In our Physics for Biologists course at the University of Maryland, we are attempting to build interdisciplinary bridges that help students understand thermodynamics better. One aspect of this endeavor involves having students grapple with the physical processes underlying heuristics that they bring to our course from their biology and chemistry classes. In particular, we have implemented a series of activities and problems intended to unpack the hydrophobicity of oil, a key step in understanding the formation of cell membranes. Student reasoning about this process illustrates the challenges we encounter in trying to bridge physics and biochemistry curricula. Understanding the spontaneous separation of oil and water requires careful consideration of the sometimes competing effects of energy and entropy. Reconciling disciplinary distinctions in how these ideas are described is an important step in helping our students develop more coherent thermodynamics concepts.

*Supported by the NSF-TUES DUE 11-22818, and the HHMI NEXUS grant.

PST2C05: 8:30-9:15 a.m. Developing Biologically Relevant Mathematical Competence in Introductory Physics

Poster – Julia S. Gouvea, University of Maryland, College Park, 082 Regents Drive, College Park, MD 20742; jmsvoboda@ucdavis.edu*

Chandra Turpen, Vashti Sawtelle, Joe Redish, University of Maryland, College Park

Quantitative skills and mathematical reasoning are considered central to introductory physics. Increasingly, physics is seen as a place where students can begin to develop skills that are critical for modern biology such as using mathematical representations to organize conceptual understanding, reasoning about parametric dependence and limiting cases, understanding the implications of units as dimensions, and making and justifying quantitative estimations. In our introductory physics course for life science majors our aim is to help students see the relevance and utility of mathematical reasoning. We do so by explicitly integrating biology examples into the course and by emphasizing how math can be used to deepen understanding. In this poster we present an analysis of student reactions to math in this course and discuss the challenges and opportunities of developing biologically relevant mathematical competence in introductory physics.

*Sponsored by Joe Redish

PST2C06: 9:15-10 a.m. NEXUS/Physics: Rethinking Physics for Biology and Premed Students

Poster – Edward F. Redish, University of Maryland, Department of Physics, College Park, MD 20742-4111; redish@umd.edu

Vashti Sawtelle, Chandra Turpen, Benjamin Dreyfus, Benjamin Geller, University of Maryland

Physicists, biologists, and science education specialists at the University of Maryland are redesigning Introductory Physics for the Life Sciences as part of the National Experiment on Undergraduate Science (NEXUS).[1] Our objective is to create a course in which the connections between physics and biology feel authentic to students and disciplinary experts and that emphasizes skills that are the goal of traditional physics instruction: symbolic reasoning, blending mathematical and qualitative thinking, abstraction to the level of toy models to build intuitions, and order-of-magnitude estimation. The content includes topics relevant to biology, such as diffusion, fluid dynamics, and chemical binding. The pedagogy focuses on creating opportunities for students to develop a coherent understanding of core concepts and competencies. These changes are coordinating with reforms in biology, chemistry, and mathematics, so that learning physics supports and is supported by learning in other science classes.

1. Supported by HHMI and the US NSF.

PST2C07: 8:30-9:15 a.m. Reducing Disciplinary Barriers to Learning

Poster – Aseem Talukdar, Madisonville Community College, 2000 College Drive, Madisonville, KY 42431; aseem.talukdar@kctcs.edu

John Lowbridge, Mike Shifflett, Madisonville Community College

Kentucky Community and Technical College System (KCTCS) general education competencies emphasize that students should be able to make connections among disciplines, also to demonstrate an awareness of the relationship of the individual to their biological and physical environment. We will report on our attempt to address these goals by connecting astronomy, chemistry, and physics, through a common fundamental concept, introducing the implications and applications of the knowledge in all three realms in each of the classes.

PST2C08: 9:15-10 a.m. A Diagram Is Valuable Despite the Choice of a More Mathematical Approach to Problem Solving*

Poster – Alexandru Maries, University of Pittsburgh, 5813 Bartlett St., Pittsburgh, PA 15217; alm195@pitt.edu

Chandralekha Singh, University of Pittsburgh

A major focus while helping introductory physics students learn problem solving is to help them appreciate that drawing diagrams facilitates problem solution. We conducted an investigation in which 118 students in an algebra-based introductory physics course were subjected to two different interventions during problem solving in recitation quizzes throughout the semester. They were either (1) asked to solve problems in which the diagrams were drawn for them or (2) explicitly told to draw a diagram. A comparison group was not given any instruction regarding diagrams. We present results for a problem involving standing waves in tubes that can be solved using two different methods, one involving a diagrammatic representation and another involving mathematical manipulation of equations. Interviews were also conducted to better understand student difficulties related to this problem. One major finding is that a good diagram can be a powerful tool for successful problem solving even if students mainly employ a mathematical approach to solving the problem.

*This work is supported by the National Science Foundation

PST2C09: 8:30-9:15 a.m. A Framework of Attentional Cueing in Physics Problem Solving*

Poster – Amy Rouinfar, Kansas State University, Department of Physics, 116 Cardwell Hall, Manhattan, KS 66506; rouinfar@phys.ksu.edu

Jeffrey Murray, Adam M. Larson, Lester C. Loschky, N. Sanjay Rebello, Kansas State University

Attentional cues overlaid on diagrams and animations can help students attend to the relevant areas and facilitate problem solving. We propose a framework of attentional cueing for solving physics problems. Our framework amalgamates concepts from Representational Change Theory (Ohlsson, 1992) and Theory of Multimedia Learning (Mayer, 2001) along with the framework for visual cueing (de Koning, et. al., 2009). To validate our framework we conducted 24 individual interviews with students enrolled in a conceptual physics course. Students worked through a series of introductory physics problems containing a diagram. Students provided a verbal answer and explanation to each problem and received correctness feedback. If incorrect, they were provided with a series of visual cues on the training problems which became increasingly explicit. We map data from the interviews onto our proposed framework and find evidence supporting the framework.

*This work is supported by the National Science Foundation under grant 1138697 as well as the KSU NSF GK-12 Program under grant NSF DGE-0841414.

PST2C10: 9:15-10 a.m. A New Framework for Computer Coaching of Problem Solving*

Poster – Evan Frodermann, University of Minnesota, 116 Church St. S.E., Minneapolis, MN 55455; frodermann@physics.umn.edu

Ken Heller, Leon Hsu, Kristin Crouse, University of Minnesota

The physics education research (PER) group at the University of Minnesota has been developing online computer programs intended to aid students in developing problem-solving skills by coaching them in the use of an expert-like problem-solving framework. An early version was tested in a large calculus based introductory physics class and judged to be helpful by students. The PER group is now working on a second generation of coaches which is more flexible for both students and instructors. The new coaches will allow students to make the decisions critical to problem solving in a non-linear path, more closely resembling the actual way they solve problems. It will also allow instructors without any programming experience to modify both the structure and content of existing coaches and to create new ones. In this poster we will demonstrate the new interface and discuss the rationale behind its design.

*This work is supported by NSF DUE-1226197.

PST2C11: 8:30-9:15 a.m. Effect of Algebraic Formula Relevance and Salience on Problem Solving

Poster – Rebecca Rosenblatt, Illinois State University, 218 Willard Ave., Bloomington, IL 61701; rjrosen@ilstu.edu

We report results from a study testing the effect of algebraic formulas' relevance and salience on physics problem solving. Students were given three progressively more difficult questions about pendulums (period, angular velocity, and string tension). Students were randomly assigned to either: receive only relevant expressions, “formulas,” with each question; or to receive several relevant and non-relevant expressions in the footnotes. Three main interesting results were found. First, the presence of only the relevant formula(s) did not help the students solve these problems. Second, students were significantly more likely to attempt to take a quantitative or algebraic solution path when more formulas were present (footnoted formulas condition) even though the majority of available formulas were not directly relevant and the formula placement would seem to suggest lower usefulness. Lastly, as question difficulty increased, students were less likely to attempt to explain their reasoning despite having done so on previous questions.

PST2C12: 9:15-10 a.m. Eye Movements While Interpreting Graphical Representations of Motion

Poster – Jennifer L. Docktor, University of Wisconsin - La Crosse, Department of Physics, 1725 State S., La Crosse, WI 54601; jdocktor@uwlax.edu

Jose Mestre, University of Illinois at Urbana-Champaign

Elizabeth Gire, University of Memphis

N. Sanjay Rebello, Adrian Madsen Kansas State University

Multiple representations are important for learning physics concepts and solving problems (e.g. interpreting text, equations, pictures, diagrams, and/or graphs), yet students often struggle to make sense of these representations. This study investigates how introductory students and graduate students view and interpret motion graphs. Participants viewed several graphs of position, velocity, or acceleration on a computer screen and were asked to match a region of the graph with a description of the object’s motion. We compare performance on the questions with audio-recorded explanations and eye movements recorded using an eye tracker.

PST2C13: 8:30-9:15 a.m. Negative Energy: Why Interdisciplinary Physics Requires Blended Ontologies

Poster – Benjamin W. Dreyfus, University of Maryland, College Park, Department of Physics, 082 Regents Drive, College Park, MD 20742; dreyfus@umd.edu

Benjamin D. Geller, Vashti Sawtelle, Chandra Turpen, Edward F. Redish, University of Maryland, College Park

Much recent work in physics education research has focused on ontological metaphors for energy (metaphors for what type of thing energy “is”), particularly the substance ontology and its pedagogical affordances. The concept of negative energy problematizes the substance ontology for energy (because there cannot be a negative amount of a substance), but in many instructional settings, the specific difficulties around negative energy are outweighed by the general advantages of the substance ontology. However, we claim that our interdisciplinary setting (an undergraduate physics class that builds deep connections to biology and chemistry) leads to a different set of considerations and conclusions. In a course designed to draw interdisciplinary connections, the centrality of chemical bond energy in biology necessitates foregrounding negative energy from the beginning. We argue that the emphasis on negative energy requires a blend of substance and location ontologies. The location ontology enables energies both “above” and “below” zero.

PST2C14: 9:15-10 a.m. Online Computer Coaches for Introductory Physics Problem Solving – Usage Patterns and Students’ Performance*

Poster – Qing Xu, University of Minnesota-Twin Cities, 116 Church St. SE, Minneapolis, MN 55455, qxu@physics.umn.edu

Kenneth Heller, Leon Hsu, Evan Frodermann, University of Minnesota-Twin Cities

Bijaya Aryal, University of Minnesota-Rochester

The Physics Education Research Group at the University of Minnesota has been developing internet computer coaches to help students become more expert-like problem solvers. During the fall 2011 and spring 2013 semesters, the coaches were introduced into large sections (200+ students) of the calculus-based introductory mechanics course at the University of Minnesota. In this poster, we will discuss the different usage patterns of the coaches and their correlations with student problem-solving performance and attitudes toward problem solving in physics.

*This work was supported by NSF DUE-0715615 and DUE-1226197.

PST2C15: 8:30-9:15 a.m. Problem Solving Reflection in Second-Semester Physics: A Pilot Analysis

Poster – Andrew Mason, University of Central Arkansas, Lewis Science Center 171, Conway, AR 72035; ajmason@uca.edu

Recent effort has been shown in attempting an intervention to teach reflection in problem solving in an introductory physics classroom.[1] One area of interest is fostering a more sustained intervention in order to reinforce the reflection stage of a developing problem-solving framework. We present an attempt to introduce reflection in problem solving into a second-semester algebra-based physics course with a student population consisting predominately of life sciences majors. Analysis of pre- and post-test data from the MPEX survey[2] will be discussed in light of variables that affect the pilot study’s outcome. These variables include general course structure, student population, and data to be gathered for analysis.

1. Yerushalmi et al., *Phys. Rev. ST, PER* **8** (2), 020109 and 020110 (2012). 2. Redish et al., *Am. J. Phys*. **66**, 212-224 (1998).

PST2C16: 9:15-10 a.m. Should Students be Provided Diagrams or Asked to Draw Them While Solving Introductory Physics Problems?*

Poster – Alexandru Maries, University of Pittsburgh, 5813 Bartlett St., Pittsburgh, PA 15217; alm195@pitt.edu

Chandralekha Singh, University of Pittsburgh

Drawing appropriate diagrams is a useful problem-solving heuristic that can transform the problem into a representation that is easier to exploit for solving the problem. A major focus while helping introductory physics students learn problem solving is to help them appreciate that drawing diagrams facilitates further problem solution. We conducted an investigation in which approximately 120 students in an algebra-based introductory physics course were subjected to three different interventions during the problem solving in recitation quizzes throughout the semester. They were either asked to solve problems in which the diagrams were drawn for them or they were explicitly told to draw a diagram, or they were not given any instruction regarding diagrams. We developed a rubric to score problem-solving performance of students in different intervention groups. We will present our findings including some surprising results for problems that involve final/initial situations.

*This work is supported by NSF.

PST2C17: 8:30-9:15 a.m. Exploring Faculty Change in the FIU Science Collaborative*

Poster – Adrienne L. Traxler, Florida International University, 11200 SW 8th St., Miami, FL 33199; altraxle@fiu.edu

Laird Kramer, Eric Brewe, David Brookes, Joseph Lichter, Ophelia Weeks, Florida International University

The FIU Science Collaborative is a four-year project to reform undergraduate science education across three departments at Florida International University. It drives institutional change through community building and faculty development. Interested professors and instructors apply to be “faculty scholars,” undertaking major transformation of a class they teach to incorporate active learning. They also become involved in regular discipline-based education research (DBER) meetings with a wider community of STEM faculty. This project affords both opportunities and challenges for research on faculty change, spanning a range of instructional strategies, disciplines, and course levels. Here we discuss some emerging themes from faculty scholars’ work and connections to current research on faculty development.

*Supported by HHMI #52006924

PST2C18: 9:15-10 a.m. PER User's Guide Plus: PER-based Assessment Guide and Results Database

Poster – Adrian M. Madsen, American Association of Physics Teachers, 4210 Riley Drive, Longmont, CO 80503; adrian.m.madsen@gmail.com

Sarah B. McKagan, American Association of Physics Teachers

Eleanor C. Sayre, Kansas State University

As part of the PER User's Guide (http://perusersguide.org), we are developing an online database of PER-based assessment instrument scores and an accompanying data explorer. Here physics instructors can upload their students' assessment data and compare it to the larger data set. The system includes "ne-click analysis", enabling users to visualize their data, make comparisons and view statistics such as gain scores, effect sizes, and statistical significance. Users can compare their data in a variety of ways, such as to data from peer institutions, national data, or before and after a change in teaching method. We plan to conduct a large-scale comparison of assessment data from traditional and interactive-engagement classes as the database is populated. Additionally, we are developing guides to these PER-based assessments, including information about their background, research validation, and guidelines for administration. We solicit your feedback on our system and your assessment data to include in our database.

PST2C20: 9:15-10 a.m. Examining and Connecting Physics Teaching Assistants' Beliefs and Practices

Poster – Benjamin T. Spike, University of Colorado, Boulder, Department of Physics, UCB 390, Boulder, CO 80309-0390; spike@colorado.edu

Noah D. Finkelstein, University of Colorado, Boulder

As research-based course transformations become more widespread, increasing attention is being paid to physics Teaching Assistants (TAs) for their critical role in supporting transformed instructional environments, as well as for their own development as future faculty and scientists. We examine how physics TAs conceptualize physics teaching through both how they talk about and how they enact their roles in the classroom. In a previous work,[1] we reported on our efforts to develop a framework to characterize TAs' stated pedagogical beliefs and link them to their instructional practices. Here we present this framework in a validated and refined form, and apply it to interview and classroom video data. We also discuss how this framework may be used to examine variation in beliefs and practices, track the development of beliefs over time, and inform TA preparation.

1. B.T. Spike and N.D. Finkelstein, *PERC* 2012

PST2C21: 8:30-9:15 a.m. Core Courses: A Missed Learning Opportunity?*

Poster – Alexandru Maries, University of Pittsburgh, 5813 Bartlett St., Pittsburgh, PA 15217; alm195@pitt.edu

Chandralekha Singh, University of Pittsburgh

An important goal of graduate physics core courses is to help students develop expertise in problem solving and improve their reasoning and meta-cognitive skills. We explore the conceptual difficulties of physics graduate students by administering conceptual problems on topics covered in undergraduate physics courses before and after instruction in related first year core graduate courses. Here, we focus on physics graduate students' difficulties manifested by their performance on two qualitative problems involving diagrammatic representation of vector fields. Some graduate students had great difficulty in recognizing whether the diagrams of the vector fields had divergence and/or curl but they had no difficulty computing the divergence and curl of the vector fields mathematically. We also conducted individual discussions with various faculty members who regularly teach first year graduate physics core courses about the goals of these courses and the performance of graduate students on the conceptual problems after related instruction in core courses.

*This work is supported by the National Science Foundation.

PST2C22: 9:15-10 a.m. Developing Tutorials for Advanced Physics Students: Process and Lessons Learned

Poster – Charles Baily, University of Colorado, Department of Physics, Boulder, CO 80309-0390; Charles.Baily@Colorado.EDU

Steven J. Pollock, University of Colorado

When education researchers introduce new curricular materials to the physics community, we typically learn more about the efficacy of the end products than the actual process by which the materials came into being. We present details on our development of in-class tutorials for students in an advanced electrodynamics course at CU Boulder, in hopes of providing useful information for faculty engaged in similar projects. We discuss sources of inspiration for in-class activities, describe a validation process involving student focus groups, and consider some lessons learned following their initial classroom implementation.

PST2C23: 8:30-9:15 a.m. Developing and Evaluating Quantum Mechanics Formalism and Postulates Survey*

*Poster – Emily Marshman,** University of Pittsburgh, 3941 Ohara St., Pittsburgh, PA 15260; EMM101@pitt.edu*

Chandralekha Singh, University of Pittsburgh

Development of multiple-choice tests related to a particular physics topic is important for designing research-based learning tools to reduce the difficulties related to the topic. We explore the difficulties that the advanced undergraduate and graduate students have with quantum mechanics formalism and postulates. We developed a research-based multiple-choice survey that targets these issues to obtain information about the common difficulties and administered it to undergraduate and graduate students. We find that the advanced undergraduate and graduate students have many common difficulties with these topics. The survey can be administered to assess the effectiveness of various instructional strategies.

*Supported by the National Science Foundation

**Sponsored by Chandralekha Singh

PST2C24: 9:15-10 a.m. Large-scale Assessment for Upper-Division Electricity and Magnetism

Poster – Bethany R. Wilcox, University of Colorado, Boulder, 2510 Taft Drive, Unit 213, Boulder, CO 80302; Bethany.Wilcox@colorado.edu

Steven Pollock, Marcos Caballero, University of Colorado, Boulder

The Colorado Upper-division Electrostatics (CUE) diagnostic was designed as an open-ended assessment to capture elements of student reasoning in upper-division electrostatics. The diagnostic has been given for many semesters at multiple universities resulting in an extensive database of CUE responses. To increase the scalability of the assessment, we used this database along with research on students' difficulties to create a multiple-choice version. The new version explores the viability of a novel test format where students select multiple responses and can receive partial credit based on the accuracy and consistency of their selections. This format was selected with the goal of preserving insights afforded by the open-ended format while exploiting the logistical advantages of a multiple-choice assessment. Here, we present examples of the questions and scoring of the multiple-choice CUE as well as initial analysis of item difficulty, discrimination, and overall consistency with the open-ended version.

PST2C25: 8:30-9:15 a.m. Multiple Perspectives on Student Syntheses of Concepts in Thermal Physics*

Poster – Trevor I. Smith, Dickinson College, Carlisle, PA 17013; smithtre@dickinson.edu

John R. Thompson, Donald B. Mountcastle, University of Maine

We have previously reported examples of student failures to conceptually combine Boltzmann factors with the density of states appropriately in thermal physics. Our earlier analyses focused on specific student difficulties observed directly from the data; e.g., students successfully describe ideas related to either the Boltzmann factor or the density of states, but do not often articulate the simultaneous effects of both, as required by the physical context. We now extend our findings by analyzing student data through multiple theoretical lenses, such as a resources perspective and the framework of conceptual blending, among others. Employing these perspectives illuminates valuable features of the data previously unavailable to us.

*Portions of this work supported by NSF Grant DUE-0817282.

PST2C26: 9:15-10 a.m. Student Resource Use in Upper-Level Laboratories

Poster – Xian Wu, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506-2601; xian@phys.ksu.edu

Eleanor C. Sayre, Kansas State University

As part of an ongoing study into upper-level physics students' identity development, we present a case study of a group of three students working in a junior-level Advanced Lab course. The data collected for this analysis include video-based observations of students working together in the lab, working in different groups in a prior lab course (Modern Physics), and individual interviews with each student. We use discourse analysis and Tannen words to analyze the students' interactions with each other, the laboratory equipment, and the lab handout. We correlate their in-class discourse and behavior with their out-of-class interviews to paint a fuller picture of their resource use and identity development in laboratory contexts.

PST2C27: 8:30-9:15 a.m. Students' Use of Modeling in the Upper-Division Physics Laboratory

Poster – Benjamin Zwickl, University of Colorado, Boulder, Department of Physics, 390 UCB, Boulder, CO 80309; benjamin.zwickl@colorado.edu

Noah Finkelstein, H. J. Lewandowksi, University of Colorado, Boulder

Modeling, the practice of developing, testing, and refining models of physical systems, has gained support as a key scientific practice in the K-12 Next Generation Science Standards, and in curricula such as Modeling Instruction, RealTime Physics, ISLE, and Matter & Interaction. However, modeling has gained less traction at the upper-division undergraduate level. As part of a larger effort to transform upper-division physics labs to incorporate scientific practices, including modeling, we conducted a series of think-aloud experimental activities using simple electronic and optical components in order to investigate how students use modeling with minimal explicit prompting in a laboratory setting. We review general patterns in students' use of models, describe our coding scheme, and conclude with a discussion of implications for the design of modeling-focused lab activities and lab-appropriate assessments.

PST2C28: 9:15-10 a.m. Cognitive Tutors for Studio Physics

Poster – Jan Beks, The Petroleum Institute, PO Box 2533, Sas Al Nahl, Abu Dhabi 0000, United Arab Emirates; jbeks@pi.ac.ae*

Kofi Agyeman, Curtis C. Bradley, The Petroleum Institute, Abu Dhabi

We describe innovative cognitive tutor software that has been developed for Studio Physics coursework at the Petroleum Institute in Abu Dhabi. Cognitive tutors are sophisticated computer-based instructional programs that include a user-friendly interface with built-in tutoring, expert-domain, and student-progress modules. Cognitive tutors monitor student progress in order to provide timely guidance and feedback. The software is spreadsheet-based, using Visual Basic for Applications to provide powerful graphical tools and rapid prototyping. We will discuss (i) how cognitive tutors support a Studio Physics curriculum, (ii) our unique approach to building cognitive tutors, and (iii) evidence of their positive impact on student attitudes and learning outcomes. In addition, we will share our plans for refinements relating to quality control of student-generated data, improved and varied forms of tutor feedback, student decision-making and improved branching in tutor design, and some very early steps toward the use of text-based, natural language dialog.

*Sponsored by Vince Kuo

PST2C29: 8:30-9:15 a.m. To Use or Not to Use Diagrams: The Effect of Drawing a Diagram in Solving Introductory Physics Problems*

Poster – Alexandru Maries, University of Pittsburgh, 5813 Bartlett St., Pittsburgh, PA 15217; alm195@pitt.edu

Chandralekha Singh, University of Pittsburgh

Drawing appropriate diagrams is a useful problem-solving heuristic that can transform a given problem into a representation that is easier to exploit for solving it. A major focus while helping introductory physics students learn problem solving is to help them appreciate that drawing diagrams facilitates problem solution. We conducted an investigation in which 111 students in an algebra-based introductory physics course were subjected to two different interventions during recitation quizzes throughout the semester. They were either (1) asked to solve problems in which the diagrams were drawn for them or (2) explicitly told to draw a diagram. A comparison group was not given any instruction regarding diagrams. We developed a rubric to score the problem-solving performance of students in different intervention groups. We present results for two problems involving electric field and electric force. We also compare the performance of students in finding electric field to finding electric force in similar situations both immediately after instruction in a quiz and a while after instruction in a midterm exam.

*Work supported by the National Science Foundation

PST2C30: 9:15-10 a.m. John Francis Woodhull: An Early 20th Century Physics Education Visionary

Poster – Diana Murray, Stony Brook University, Center for Science and Mathematics Education, 092 Life Sciences Building, Stony Brook, NY 11794-5233; diana.murray@stonybrook.edu

Keith Sheppard, Stony Brook University

"We cannot teach the principles of physics except through an experience with their applications." (J.F. Woodhull, 1915.) This presentation provides an account of John Francis Woodhull, one of the most influential science education reformers during the early 20th century. As a professor of physical science, he was a founding member of Teachers College. Along with C.R. Mann, a physicist at the University of Chicago, and G.S. Hall, a pioneer in adolescent development, he strongly advocated child-centered education and condemned the highly quantitative high school physics course established by Harvard at the turn of the century. It is widely unrecognized that Woodhull conceived the project method of science teaching which was based on the exploration of real-world problems. Woodhull was instrumental in the development of General Science as an introductory, integrated science course for all students, and he stressed the importance of the "science of teaching" over the "teaching of science."

D – Technologies

PST2D01: 8:30-9:15 a.m. Designing a Model Rocket to Deliver Air Quality Sensors

Poster – Kathleen Melious, T Wingate Andrews High School, 1900 Cana Road, Mocksville, NC 27028; meliouk@gcsnc.com

James P. Healy, UNCG

Shan Faizi, Kyle Payton, Thomas Lyons, Blake Compton, T Wingate Andrews High School

In 2013 the EPA estimates that it will spend close to $1 billion on projects related to improving the air quality of the United States.[1] While the air quality across a community is easily monitored at ground level, crucial data about the health of an area's atmosphere can be obtained by monitoring conditions at low altitudes (100 - 800 meters) across a community.[2] The goal of our project is to construct a delivery system for air quality sensors from commonly available amateur rocketry supplies. The delivery system must be reliable in delivering the payload to a constant and reproducible altitude and allowing for safe and reliable recovery of the system after each flight.

1. FY 2013 - EPA Budget in Brief, www.epa.gov.
2. Campaign to diagnose air quality concludes in California, http://climate.nasa.gov/news/870.

PST2D02: 9:15-10 a.m. Fluid Simulations for Undergraduates*

Poster – Daniel V. Schroeder, Weber State University, 2508 University Circle, Ogden, UT 84408-2508; dschroeder@weber.edu

Modern computers and algorithms make it feasible to teach many aspects of fluid dynamics through interactive simulations. Two-dimensional simulations, on grids of 10,000 to 100,000 sites, now run fast enough on personal computers for students to immediately see the effects of viscosity, flow speed, and obstacle shapes and sizes. While low Reynolds numbers result in stable, laminar flow, it is also easy to observe instability and vortex shedding at somewhat higher Reynolds numbers. Using a simple lattice-Boltzmann algorithm, students in an introductory computational physics course can code their own fluid simulations in C, Java, JavaScript, or Python. This algorithm can be derived directly from the Boltzmann distribution of statistical mechanics, without reference to the Navier-Stokes equations. *http://physics.weber.edu/schroeder/

PST2D03: 8:30-9:15 a.m. High-Performance Computing System at Community and Liberal Arts Colleges

Poster – Tae Song Lee, Community College of Allegheny County-South Campus, 1750 Clairton Road, West Mifflin, PA 15122-3029; tlee@ccac.edu

Carlos D. Taylor, Aaron Anthony, Community College of Allegheny County

We investigate possibility of a high performance computing (HPC) system at Community and Liberal Arts College settings (Adams & Vos 2002; Adams & Brom 2008). HPC systems are used in many scientific, engineering, and even business related applications. As a teaching orientated institution, fairly low cost high-end computer servers might bring great attentions from school executives and students simultaneously. For our first attempt, a five-server cluster with 40 core xenon processors connected via a gigabit switch is constructed under a second-hand purchase to overcome financial obstacles at a community college. We test its performance with an adaptive mesh refinement (AMR), grid-based hybrid code known as ENZO from the University of California, San Diego.

PST2D04: 9:15-10 a.m. Implementation of an Introductory Physics MOOC with Video Lab Reports

Poster – Scott S. Douglas, Georgia Institute of Technology, 837 State St. Atlanta, GA 30332; scott.s.douglas@me.com

John M. Aiken, Georgia State University

Shih-Yin Lin, Michael F. Schatz, Georgia Institute of Technology

Marcos D. Caballero, University of Colorado, Boulder

In this talk, we describe the implementation of an introductory physics Massively Open Online Course (MOOC) through Coursera which incorporates computational modeling, peer review, and laboratory exercises. We place special emphasis on the laboratory exercises, in which students capture video of real-world objects with their smartphones, then analyze the motion of these objects with the open-source program Tracker. Following their video experiments, students create computational models in VPython of the phenomena they captured on video, then compare their models to their observations in a manner consistent with the way expert scientists use computational models. Finally, students create and submit video lab reports in which they describe their video-capture experiment, the physical model they are exploring, their computational implementation of that model, and how each of these things relates to the others. Students then rate their peers' video lab reports in terms of the quality of the physics content.

PST2D05: 8:30-9:15 a.m. Introducing PhET Simulations' New Teaching Portal*

Poster – Stephanie V. Chasteen, University of Colorado, Boulder, UCB 390, Boulder, CO 80309; stephanie.chasteen@colorado.edu

Sarah B. McKagan, McKagan Enterprises

Ariel Paul, Katherine K. Perkins, University of Colorado, Boulder

The PhET Interactive Simulations project at University of Colorado is embarking on development of an extensive new portal to the website, geared specifically at teachers. The new website will enable teachers to modify and share lesson plans, to connect with other PhET users, to explore different ways of using the simulations in the classroom, and to learn more about research-based strategies for simulation use. Stop by the poster to find out about progress on the website, share feedback, and maybe even test-drive a beta version!

*You can find our free interactive simulations at http://phet.colorado.edu.

PST2D06: 9:15-10 a.m. Progress in Easy-to-Use 3D Programming Environments

Poster – Bruce A. Sherwood, North Carolina State University, 515 E Coronado Road, Santa Fe, NM 87505-0346; Bruce_Sherwood@ncsu.edu

Steve Spicklemire, University of Indianapolis

VPython (vpython.org), a free open-source module for the popular Python programming language, lets even novice programmers write programs that model physical systems and generate navigable real-time 3D animations. VPython plays an important role in several recent computational physics textbooks. At matterandinteractions.org are many lecture demo programs written in VPython. There are about 50,000 downloads of VPython per year, including by thousands of students in intro physics courses. In January 2013 VPython 6 was released, based on the cross-platform GUI library wxPython, which has made it possible for VPython animations to share a window with standard widgets (buttons, sliders, scrolling text boxes, etc.). VPython is quite mature; GlowScript (glowscript.org) is a related but very new environment under development that executes programs written in JavaScript or CoffeeScript in a browser. There are converters that facilitate translation from VPython to GlowScript. VPython and GlowScript will be demonstrated at the poster session.

PST2D07: 8:30-9:15 a.m. Randomness and Structure 1: Introductory-level Conceptual Framework for Biological Materials

Poster – Edit Yerushalmi, Weizmann Institute of Science, 234 Herzl St., Rehovot, 76100 Israel; Edit.Yerushalmi@weizmann.ac.il

Elon Langbeheim, Shelly Livne, Samuel Safran, Weizmann Institute of Science

Explaining the spontaneous formation of molecules into mesoscopic (nanometric) or even micron-sized structures that are important in biological materials (i.e. membranes, polymers, colloids), requires an understanding of cooperative behavior in interacting multi-particle systems. We present a conceptual framework for treating these phenomena with introductory-level students, which was tested in a pilot interdisciplinary course entitled "Soft and messy matter." We first discuss the competition of configurational entropy (that promotes randomness) and interparticle interactions (that promote order) in terms of a lattice model in the context of binary mixtures. The lattice model, allowing for concrete visualization, is later used to model the phase behavior of fluid mixtures, wetting, and self-assembly of surfactants via free-energy minimization. This approach can be incorporated into restructured introductory physics courses for life sciences, allowing students to understand how the competition between interactions and entropy is resolved to determine how molecules self-organize to form mesoscopic structures.

PST2D08: 9:15-10 a.m. Randomness and Structure 2: Computational Modeling of Interacting Multiparticle Systems

Poster – Ruth Chabay, NC State University, 515 E. Coronado Road, Santa Fe, NM 87505; rwchabay@ncsu.edu

Nava Schulman, Edit Yerushalmi, Weizmann Institute of Science

The concepts of entropy and equilibrium are central to the understanding of the spontaneous formation of structure in soft matter systems such as membranes. We are developing a suite of computational modeling tools with a strong visual component to support the development of these concepts by students in an introductory level course on soft matter. In the context of the lattice gas model, which is commonly used in the analytical treatment of such systems, students can explore the consequences of random motion, observe the dynamics of the approach to equilibrium, monitor bulk properties of the system, and observe that interparticle interactions are required for the spontaneous formation of mesoscale structures. These tools can be extended to allow students to do significant computational modeling projects by the end of the course. They provide, as well, a stimulus for discussion about the nature of scientific models.

PST2D09: 8:30-9:15 a.m. Randomness and Structure 3: Explicating Nature's Choices with Computational Tools

Poster – Nava Schulmann, Weizmann Institute of Science, 234 Herzl St., Rehovot, 76100 Israel; Nava.Schulmann@weizmann.ac.il*

Ruth Chabay, North Carolina State University

Edit Yerushalmi, Weizmann Institute of Science

Understanding the balance between randomness and structure in multi-particle systems via statistical thermodynamics methods requires construction of a concrete mental model for the process of weighing between configurations. We present two computational tools intended to support introductory-level students in constructing such a representation. One tool allows students to explore the plausibility of the ergodic principle and the meaning of entropy by displaying systems evolving in time versus their corresponding sets of microstates; another tool provides insights into the crucial role of the Boltzmann factor in determining the behavior of multi particle systems by explicitly tracking the mechanism of the Metropolis algorithm. We integrate these tools in an introductory-level course on soft and biological materials, where the understanding of the spontaneous formation of structures such as polymers, colloidal dispersions and membranes, is grounded in statistical thermodynamics descriptions of matter.
*Sponsored by Edit Yerushalmi

D – PER: Technologies

PST2D10: 9:15-10 a.m. Creatively Engaged Online: Student-Generated Content in a Non-Majors Introductory Course

Poster – Simon P. Bates, University of British Columbia, 1961 East Mall, Vancouver, BC V6T 1Z1, Canada; simon.bates@ubc.ca*

Emily Altiere, Firas Moosvi, University of British Columbia

We have implemented a component of student-generated assessment in an introductory physics course comprising exclusively non-majors, using the PeerWise online system. This poster presents details of how we have extended the previous instructional designs for PeerWise, shown to be capable of yielding high-quality questions authored by students, via modification of the six tutorials held throughout the course. A significant fraction of the tutorial content is composed of either studen- generated questions as problems to work through and/or explicit guidance designed to enhance the quality of student contributions. We present details of the change in quality of student-authored questions and explanations over time, mapping the former onto Bloom's Taxonomy and the latter onto a five-point scale.
Sponsored by Ross Galloway

PST2D11: 8:30-9:15 a.m. Tablets in a Large-Enrollment Introductory Course

Poster – Todd G. Ruskell, Colorado School of Mines, Physics Department, 1523 Illinois St., Golden, CO 80401; truskell@mines.edu

Many large-enrollment introductory physics courses now use personal response devices (clickers) to engage students during class and collect data for real-time formative assessment. However, most systems only allow for multiple-choice or in some cases numeric or simple text answers. A program called inkSurvey allows faculty to ask more open-ended questions and students can submit both text and graphical responses from tablet computers. This provides faculty much greater insight into a student's problem-solving process. In our pilot project, standard clickers were used in the first half of a calculus-based physics I course, and in the second half of the semester, tablets and inkSurvey were used to collect formative assessment data. We will report on impressions of both the faculty and students regarding the relative utility and effectiveness of each tool in promoting higher-order thinking and improved class performance.

PST2D12: 9:15-10 a.m. The Effect of Online Lecture on Performance in a Physics Class

Poster – John Stewart, University of Arkansas, Physics Building, Fayetteville, AR 72701; johns@uark.edu

This poster will describe the difference in student performance between students attending lecture in person and students choosing to watch the lecture on video as part of an online class. The video part of the class was implemented mid-semester so that the performance of the same set of students could be compared. Video watching patterns will be presented. The difference in performance of students primarily watching video to those primarily attending lecture on in-semester examinations and the Conceptual Survey of Electricity and Magnetism will be presented. The effect of the access to video on student study behavior and time management will be analyzed. In general, while the students electing to primarily watch video were a measurably different population than the students electing to primarily attend lecture, the shift in performance from attending lecture to watching video was small.

E – Upper Division and Graduate

PST2E01: 8:30-9:15 a.m. Investigation on Combined Black-Body Radiation Facility and Related Experiment

Poster – SHIHONG MA, Department of Physics/Fudan University, 220 Handan Road Shanghai, Shanghai 200433, CHINA; shma@fudan.edu.cn

PINGJING YANG, Department of Physics/Fudan University

HFY-200BII Blackbody source, with thermal radiation detector and microvoltmeter, can be used to set up a combined black-body radiation experimental facility. The experimental facility with good scalability has been developed completely and the operation steps by the students are simple and direct. Therefore, students can fully understand the physical model of black-body radiation through the experiment. In this article, the author verified the basic law of black-body radiation, demonstrated the feasibility of the method and gave a future prospect of the experiment.

PST2E02: 9:15-10 a.m. Sources and Resources for Training Physics Students to Write

Poster – Jean-Francois, S. Van Huele, Brigham Young University, N151 ESC BYU, Provo, UT 84602-4681; vanhuele@byu.edu

Whether you assign term papers, require lab reports, supervise publishable student research, or teach an advanced writing class in physics, there are lots of resources for you out there. This poster collects and organizes available sources and provides expert resources, including some practical do's and don'ts for physics students, their teaching assistants, and their writing instructors.

PST2E03: 8:30-9:15 a.m. Using Low-cost Microwave Sensor to Teach Advanced Topics in STEM

Poster – Scott MacIntosh, Black Cat Science, Inc. 70 Dwinell St., Boston, MA 02132; scott.macintosh@blackcatscience.com

Erik Bodegom, Erik J. Sanchez, Portland State University

A low-cost microwave sensor is utilized to teach various advanced topics in STEM education. We will describe a range of experiments that can be performed using the same device that teach concepts in physics, signal processing, and computational methods. Experiments and topics to be discussed include doppler measurements, dielectric constant estimation using back-scattered measurements, uses of the FFT, and synthetic aperture imaging.

PST2E04: 9:15-10 a.m. Visualizing Differential Forms in Thermodynamics

Poster – Roberto B. Salgado, Lawrence University, 711 E Boldt Way, SPC 24 Appleton, WI 54911; roberto.b.salgado@lawrence.edu

Following Caratheodory's approach to thermodynamics, some geometrically oriented mathematical physics textbooks (e.g. Bamberg and Sternberg, Burke, Frankel, Schutz) formulate classical thermodynamics using the exterior calculus of differential forms. Work and heat are inexact differential forms. We present visualizations of differential forms by studying the Carnot cycle for an ideal gas in the entropy-volume diagram.

E – PER: Upper Division and Graduate

PST2E05: 8:30-9:15 a.m. Analysis of Faculty and Student Interviews on Undergraduate Quantum Mechanics

Poster – Christopher A. Oakley, Georgia State University, 29 Peachtree Center Ave., Atlanta, GA 30303; coakley2@student.gsu.edu

Brian D. Thoms, Georgia State University

Characterizing faculty expectations is important to produce a comprehensive understanding of what knowledge students should acquire before and during a quantum mechanics course (QMC). We analyzed interviews conducted with faculty and students entering a QMC in the Department of Physics & Astronomy at Georgia State University. The interviews examine expectations regarding preparation, course material, and instructor's goals for a QMC. The goals of the interviews are to locate conflicts in perspective and to provide students with a "map" for areas that will help strengthen the knowledge and skills to be obtained before they enter a QMC. We report on contradictions and similarities in perceptions from interview data determined by coding the interviews and through the use of Activity Theory.

PST2E06: 9:15-10 a.m. Assessing Student Learning in Middle-Division Classical Mechanics/Math Methods

Poster – Marcos D. Caballero, University of Colorado, Boulder, 2000 Colorado Ave., Boulder, CO 80309; marcos.caballero@colorado.edu

Steven J. Pollock, University of Colorado Boulder

Reliable and validated assessments of introductory physics have been instrumental in driving curricular and pedagogical reforms that lead to improved student learning. As part of an effort to systematically improve our sophomore-level Classical Mechanics and Math Methods course (CM) at CU-Boulder, we are developing a tool to assess student learning of CM concepts in the upper division. The Colorado Classical Mechanics/Math Methods Instrument (CCMI) builds on faculty-consensus learning goals and systematic observations of student difficulties. The result is a nine-question open-ended post-test (with two additional, optional questions) that probes student learning in the first half of a two-semester sequence that combines classical mechanics with mathematical methods. In this paper, we describe the design and development of this instrument, its validation, and measurements made in classes at CU Boulder and elsewhere.

PST2E07: 8:30-9:15 a.m. Faculty and Undergraduate Student Perspectives on Evaluation in Upper-Division Courses

Poster – Christopher A. Oakley, Georgia State University, 29 Peachtree Center Ave., Atlanta, GA 30303; coakley2@student.gsu.edu

Brian D. Thoms, Georgia State University

Physics education research has been making progress in providing research-based instructional techniques and tools to help assess the complex learning goals associated with a mature understanding of physics. We conducted semi-structured interviews with faculty members and students entering a quantum mechanics course in the Physics & Astronomy Department of Georgia State University. The interviews examine perspectives on what types of evaluation are most appropriate for an upper-division course. The types of evaluation discussed are multiple-choice questions, short-answer questions, traditional written problems, student presentations, and one-on-one oral exams. A post-course survey was offered to the students that took the QMC that semester and those who completed the course in recent history. We present the data associated with multiple-choice questions and oral exams.

PST2E08: 9:15-10 a.m. Impacting Learning Across Disciplines through Undergraduate Thesis Writing

Poster – Jason E. Dowd, Duke University, Box 90338, 130 Science Drive, Durham, NC 27707; jason.dowd@duke.edu

Julie A. Reynolds, Duke University

We present results from the first year of ongoing research to better understand how writing an undergraduate thesis improves critical thinking and writing skills through impacting metacognition, motivation, and beliefs. In previous work, we have demonstrated that students studying biology who participate in a thesis-writing course alongside independent research not only develop better writing skills "expected, perhaps" but also exhibit stronger scientific reasoning skills than students working one-on-one with faculty. Students enrolled in the writing course achieved highest honors at graduation at almost triple the rate of other thesis writers. These results are in keeping with the notion that writing can be an effective strategy for promoting positive learning outcomes, but here we strive to understand how writing actually affects learning. Data have been collected across multiple departments and institutions. Ultimately, our analysis will be used to motivate institution- and department-specific changes during subsequent years of this multi-year study.

F – Post-Deadline Posters

PST2F01: 8:30-9:15 a.m. Learn Widely from Others' Strong Points

Poster – He Yanlan, National University of Defense Technology, No.137, Yanwachi Road, Department of Physics, Changsha, China 410073; hylst@sina.com

Liang Linmei, Yu Xiaoyan, National University of Defense Technology

Two types of "circulation" teaching methods of experiment of college physics are compared in this essay. it is concluded that the second circulation method is more conducive to training students and achieving the goal of teaching. The involvement of teachers from different scientific research backgrounds, as well as distinguished teachers and professors, makes the second circulation method more effective. Moreover, it is the key to the success of the circulation method that supervising and managing the quality of teaching process rationally and effectively.

PST2F02: 9:15-10 a.m. ATE Workshop for Physics Faculty*

Poster – Thomas L. O'Kuma, Lee College, PO Box 818, Baytown, TX 77522-0818; tokuma@lee.edu

Dwain M. Desbien, Estrella Mountain Community College

The ATE Workshop for Physics Faculty project is into its third year and has finished its 13th workshop/conference. In this poster, we will display information about the project, information about these workshops/conferences, and information about future workshops/conferences. Information concerning development of laboratory activities will also be displayed.

*Funded in part by an ATE NSF DUE grant.

PST2F03: 8:30-9:15 a.m. Growing STEM Learning Experiences from a Physics-based Learning Community

Poster – Eugene Li, Montgomery College, 51 Mannakee St., Rockville, MD 20850; eugene.li@montgomerycollege.edu

How does a community of STEM learners grow in a physics-based STEM learning community? Developing and implementing a learning community pairing of courses in an interdisciplinary setting has effects that not only include achieving matched STEM outcomes for interdisciplinary courses, but also forms social bonds that encourages supportive learning in otherwise challenging STEM courses for Montgomery College engineering and science students. The supportive social structure of inquiry-led activities and projects that are designed to enhance physics-based critical-thinking components is examined as it relates to cognition in calculus-based mathematics. The effects of technology on collaborative active learning experiences through using pedagogically "theme-focused" activities, online discussion board, personal response system (clickers, or text polling), and iPad cooperative activities are examined. This presentation analyzes some of the outcomes and experiences in the learning community pairing of calculus-based Physics I (Mechanics and Heat) and Math (Calculus II), called a "A Journey Across Newton's Bridge: Connections between Physics and Math," which has been offered annually for several years at Montgomery College.

PST2F04: 9:15-10 a.m. Relativistic Rotation of Simple Objects

Poster – Kenneth M. Purcell, University of Southern Indiana, 86000 University Blvd., Evansville, IN 47712; kmpurcell@usi.edu

A typical modern physics course begins with a discussion of special relativity focusing on 1 and 2 dimensional rectilinear motion. Missing from the discussion is the effect of special relativity on an object rotating at high angular speeds. Here I will present a means to introduce the effects of relativistic rotation on real objects at a level that is approachable to undergraduate students that are in a sophomore-level modern physics course and allows for this section of the course to truly serve as a bridge between the introductory and upper-level mechanics courses.

PST2F05: 8:30-9:15 a.m. Energizing Physics: Results from a Two-year Pilot Project

Poster – Stephen Scannell, Gresham High School/Portland State University, 967 SE 9th St., Gresham, OR 97080; sgscannell@gmail.com

Energizing Physics is an introductory physics course for the high school level designed to incorporate several approaches shown to improve student understanding of physics. These include a modeling approach to develop conceptual and quantitative understanding, a focus on depth vs. breadth, the use of learning targets and formative assessment strategies, and project-based learning, including hands-on projects that utilize the engineering design process, and smaller research projects that develop students' understanding of today's energy issues. Preliminary results and thoughts from a two-year pilot project (concluding in August 2013) will be shared.

PST2F06: 9:15-10 a.m. Simulated Sinusitis, Phantoms and Near Infrared Radiation (NIR) Transillumination Imaging

Poster – Kevin C. Yang, Mission Viejo High School, 25702 Minoa Drive, Mission Viejo, CA 92691; candokevin@hotmail.com

Sinusitis affects 31 million people nationwide annually. A potential imaging tool for the diagnosis of maxillary sinusitis is NIR transillumination through the hard palate of the mouth. To study optimal techniques for detecting maxillary sinusitis with NIR, phantoms simulating the sinuses and hard palate of a human skull were constructed and tested with NIR systems. MatLab analysis of NIR images of the phantom indicated that the light intensity emitted from completely fluid-filled cavities was up to 50% less than that emitted from healthy, air-filled cavities. NIR transillumination was also able to detect partially fluid-filled cavities that mimic the disease condition of a large number of patients. NIR light intensity demonstrated a significant ($p<0.05$) negative correlation with volume of fluid inside the cavities. Hence, NIR transillumination can distinguish between aerated (healthy) and fluid-filled (diseased) cavities in this phantom, indicating that the phantoms provide a static model that closely mimics maxillary sinusitis.

PST2F07: 8:30-9:15 a.m. Incorporating the MITx into an Upper-Division Lab Course

Poster – Charles I. Bosse, MIT, 77 Massachusetts Ave., Cambridge, MA 02139-4307; bossec@mit.edu

Christopher J. Sarabalis, Gunther M. Roland, MIT

MIT has recently pioneered the MOOC platform MITx. While the application for distributing education outside of the university is obvious, part of the goal of this platform was to provide addition options for students at MIT. Our 8.13 staff and instructors embarked on an effort to use the MITx platform to provide better content delivery, further "flip" classroom time currently used for lecture/tutorials, and to provide students more prompt and relevant feedback on questions asked to ensure conceptual preparedness for lab time.

PST2F08: 9:15-10 a.m. Refine Elements and Emphasize the Process to Improve Efficiency

Poster – Yanlan He, National University of Defense Technology, Number 137 Yanwachi St., Changsha, Hunan 410073 China; hylst@sina.com

Linmei Liang, Xiaoyan Yu, Xucan Chen, Gang Peng, National University of Defense Technology

A physics experiment course in China independent of theory class with about 60 hours is a compulsory course for engineering college students. A wide range of college students benefit from the course. Each of the physical experimental projects contains elements of physical thinking, specific experimental methods, and experimental technology. A physics experiment course often consists of dozens, or even hundreds, of projects. All the assembled elements of the experiments will be overlapped, if not refined scientifically and concisely. In order to make these refined elements easy to be understand and realized by students, both the training methods and process must be redesigned to improve the experiment course efficiency.

PST2F09: 8:30-9:15 a.m. The Impact of College Faculty Involvement in AP Physics

Poster – Peggy A. Bertrand, University of Tennessee, 821 Volunteer Blvd., Greve Hall, Room 103, Knoxville, TN 37991; pbertran@utk.edu

Although Advanced Placement physics courses are taught to secondary students by high school teachers, college physics faculty are instrumental to the success and integrity of the AP Program. College and university professors who fill various roles in the program are engaged in essential outreach and support of the high school physics teacher community. This poster presents an overview of the ways college professors participate in the Advanced Placement program, in course and assessment design, exam scoring and analysis, and through delivery of high-quality professional development for high school faculty.

PST2F10: 9:15-10 a.m. An Investigation of Force Concept and Science Perception by Freshmen Who Participated in an Intensive Class to Teach Mechanics

Poster – Nayoung Lee, Kunsan National University, Department of Physics, 102-102 Sejong Grancia Apt., Yeongdeo-dong, Giheung-gu Yongin-si, Gyeonggi-do 446-788; prop31@kunsan.ac.kr

This study will execute an intensive class to teach mechanics for freshmen at university during vacation time and analyze the understanding about the force concept and a change in the science perception. For this, a force concept evaluation sheet and survey on physics expectations created by the physics education group of the University of Maryland were used to conduct examination before/after the class participation. As a research result, after an intensive class during the given period, the overall understanding of the students about the force concept was improved and there was a positive change in the perception for expectations such as attitude or faith towards physics. The results of this study may suggest similar development programs for freshmen to learn physics and improvement of basic learning abilities expected to aid the learning of related major courses during the semesters following class participation.

PST2F11: 8:30-9:15 a.m. Interactive Engagement in Thermodynamics Lectures: Successes and Failures

Poster – Helen Georgiou, The University of Sydney, School of Physics, Camperdown, NSW 2006, Australia; georgiou@physics.usyd.edu.au

Manjula D. Sharma, The University of Sydney

Research in physics education endorses the use of interactive Engagement (IE) techniques for improving student attitudes towards physics and achieving superior learning outcomes. This poster presents findings from an Australia university that was successful in achieving both of these outcomes by using one form of IE, the Interactive Lecture Demonstration in first-year thermodynamics. The study further examined issues surrounding the fidelity of implementation of IE through the use of the Lecture Activity and Student Engagement (LASE) tool. Results from LASE show that different lecturers interpret IE techniques differently, students are not necessarily engaged simply by virtue of "Interacting" with the lecturer and peers, and lecturers are most comfortable in conventional lecture dynamics (lecturing with the aid of PowerPoint). Such findings may help in illuminating the reasons why some IE might not work and signal issues around sustainable and successful IE implementation in first-year physics environments.

PST2F12: 9:15-10 a.m. Promote Students' Interactive Learning Based on Peer Instruction*

Poster – Helan Wu, Tongji University/Harvard University, 292 Pierce Hall, Oxford St., Cambridge, MA 02138; helanwu@126.com

Zuyuan Wang, Mu Gu ,Tongji University

Eric Mazur, Harvard University

Through exploring several possible ways to achieve promoting interactive teaching and learning, to increase the participation of the students in the classroom, to enhance the students' learning, this paper presents a technology pathway that carries out interactive teaching and learning by using a mobile phone. According to comparing using Classroom Response System Based on Mobile-Phone (CRSBM) for interactive teaching and learning with traditional teaching, we got some interesting data. The survey shows that just over 94% of students have an actively welcome attitude to CRSBM. More than 89% of students think CRSBM can better stimulate their interaction and discussion. More than 86% think CRSBM can better improve their learning.

*This research is sponsored by Education Program of Tongji University and the Education Ministry of China.

PST2F13: 8:30-09:15 a.m. Assessing Curriculum of a Physics in Biomedicine Course

Poster – Elizabeth A. Anderson, Portland State University, Physics Department, Portland OR 97201; andee@pdx.edu

James K. Johnson, Grace Van Nes Ralf Widenhorn, Portland State University

Warren Christensen, North Dakota State University

Portland State University's Physics in Biomedicine is an undergraduate upper-level physics course designed for biology or pre-health majors to address the need for medically relevant situations to enhance students' understanding of physics applications. To assess the effectiveness of the instruction, a modified backwards design was used to create learning goals for each individual module. Student understanding of the learning goals was assessed through open response pre- and post-quizzes. These students' quizzes were then summarized and categorized for emerging patterns of student understanding. The goal of understanding this data is to determine students' conceptual understanding of each module and overall interpretation of physical phenomenon such as light absorption and emission, atomic energy levels, and electromagnetism. This insight into student thought is to help improve the development of the course and optimize assessment questions.

PST2F14: 9:15-10 a.m. A Nontraditional Modern Physics Class for the Life Sciences

Poster – Bradley S. Moser, University of New England, 11 Hills Beach Road, Biddeford, ME 04005; bmoser@une.edu

Katherine Misaiko, University of New England

What would it be like to teach Modern Physics without a textbook? To read sources directly from leaders in each field? To strip mathematical rigor from the class in favor of challenging and exciting concepts? At the University of New England, a health sciences university, few students are interested in venturing beyond Physics I and II. To inspire our population to enroll in Modern Physics, the course underwent a major transformation to focus on the concepts and philosophies, rather than on solving equations. Once students were reading the words of Feynman, Gamow, Weinberg, and other leaders, and once class sessions were dedicated to discussing the evidence for our expanding universe and alternatives to the Copenhagen Interpretation, the release from old paradigms felt liberating. This poster will present the philosophy and mechanics behind the course as well as provide an opportunity for one student to share her experience.

PST2F15: 8:30-9:15 a.m. 'Scratch and Win' Tickets and Team-based Clickers in Introductory Physics

Poster – Adam Clark, Muhlenberg College, 2400 Chew St., Allentown, PA 18104; aclark@muhlenberg.edu

This poster will document an attempt to hybridize the non-physics specific technique of Team-based Learning with the physics-native methods of Peer Instruction and Cooperative Group Problem Solving. Team-based Learning begins each unit with a "Readiness Assessment Test" (RAT) that acts not only as a reading quiz but also to assess if students are ready to begin problem solving. The RATs are taken first as individuals, then again in teams. The team test is administered with a "scratch-and-win" ticket known as an Immediate Feedback Assessment Technique (IF-AT) form. In the hybrid approach, students work in those same teams for clicker question discussion and for Cooperative Group Problem Solving. We discuss the advantages and disadvantages of this approach and present pre-/post-test Force and Motion Conceptual Evaluation (FMCE) data for classes taught in consecutive years in a liberal arts setting, one with the addition of Team-based Learning, one without.

PST2F16: 9:15-10 a.m. Garage Physics: A Flexible Space for Innovative Student-Focused Undergraduate Research and Education

Poster – Duncan Carlsmith, University of Wisconsin-Madison 1150 University Ave., Madison, WI 53706; duncan@hep.wisc.edu

Garage Physics at the University of Wisconsin-Madison provides a new flexible space for innovative student-focused research and education. In the Garage, a student (undergraduate or graduate) is encouraged to explore his or her passions, to find new passions, to learn practical skills, to study in new ways, and to take an active role in their education. The Garage mode of learning compliments the structured learning environment of the regular curriculum. A wide variety of projects is possible in the Garage: basic scientific research, projects for entrepreneurs interested in developing or exploiting new gadgets, and "steAm" projects merging STEM and Arts fields. (www.physics.wisc.edu/garage)

PST2F17: 8:30-9:15 a.m. Non-uniform Concentration of Bubbles in Rising Dough

Poster – Michael B Partensky, Lechem Lab 21 Florence Rd. Waltham, MA 02453; partensky@gmail.com

The spatial distribution of bubble concentration in rising dough is discussed in two experimental settings: (a) large transparent cylindrical vessel; (b) shallow Petri plate. In the case (a) we observe strong height dependence of bubble concentration, with significantly depleted top layer. In the case (b) the dynamic of radial distribution of bubbles is loosely described in terms of "uniformly expanding universe." Possible mechanisms of strong height dependence of bubble concentration (case a) are proposed and the questions for further research are offered.

PST2F18: 9:15-10 a.m. Project Oklahoma Whiteboard

Poster – Steven J. Maier, Northwestern Oklahoma State University, 709 Oklahoma Blvd., Alva, OK 73717; sjmaier@nwosu.edu

In the summer of 2012, Project Oklahoma Whiteboard[1] was launched as an initiative to provide teachers with an additional tool for classroom instruction. With a remaining budget of $5,000, the task was to have as great an impact on physics education in the state as possible.[2] The budget prohibited electronic technology, so a more grassroots effort was put into action. Every active high school physics teacher in Oklahoma (totaling 190) received a classroom set of 25 whiteboards (cut 10' x 12') with supplemental materials, including: AAPT membership application, AAPT/PTRA brochure, ToPPS[3] brochure, "whiteboarding" resources and information about online resources. This presentation will highlight the motivations for the project and its future.

1. www.nwosu.edu/whiteboard
2. Funded by Improving Teacher Quality funds through the Oklahoma State Regents for Higher Education.
3. www.nwosu.edu/ToPPS

PST2F19: 8:30-9:15 a.m. Equipotential Color Coding from Fields to Circuits

Poster – John Avallone, Stuyvesant High School, 9707 Fourth Ave., Brooklyn, NY 11209; john.avallone@gmail.com

When presenting the concept of equipotential surfaces in the Electric field unit, it is useful to use colored chalk to show the set of points at a given potential. With this established, it can be useful again to color the portions of circuit diagrams that are all at equal potential. With this illustration, students can easily distinguish parallel paths between equipotential "zones" and thus see the simplification of complicated circuits easily.

PST2F20: 9:15-10 a.m. Investigating Students' Difficulties in Charging by Induction: Analysis of Student Data

Poster – Lynda Klein, California State University, Chico, Department of Physics, Chico, CA 95929; lklein@csuchico.edu

Steven Sun, Chico High School

Yibo Zhang, Benjamin Catching, Xueli Zou, California State University, Chico

In this paper we will present the results of data recently gathered using videos made to collect and analyze student?s difficulties in charging by induction in the introductory calculus-based EM course. Not only do students have difficulty learning but also their instructors have difficulty teaching charging by induction (ref). Ref: "Charging an electroscope by induction." Vol. **3**, pp. 29, *TPT* Jan. 1965.

PST2F21: 8:30-9:15 a.m. Addressing Students' Difficulties in Charging by Induction: Creation of Experimental Videos

Poster – Steven Sun, Chico High School, 901 Esplanade, Chico, CA 95929; allknowscience@gmail.com

Yibo Zhang, Benjamin Catching, Lynda Klein, Chris Gaffney, California State University, Chico

As part of the efforts in addressing student difficulties of charging by induction, we made a series of instructional videos in which an electroscope is charged by charged rods. Students are prompted to explain with conceptual reasoning and models, predict using words, and sketch the phenomena they see, including a testing experiment to convince them of the outcome. This paper will show how we used the videos with our introductory students and discuss subtlety of physics beyond the phenomena.

PST2F22: 9:15-10 a.m. A New Spinning Coil for Measuring the Earth's Magnetic Field

Poster – Chris Kaneshiro, California State University, Chico, Department of Physics, Chico, CA 95926 ;ckaneshiro@mail.csuchico.edu

Daniel Lund, Xueli Zou, Eric Dietz, California State University, Chico

Steven Sun, Chico High School

A common way of measuring Earth's magnetic field in an introductory physics lab is by spinning a coil, and using an oscilloscope to analyze the induced emf. The coil is typically rotated by a motor, but we have constructed a device that uses a falling mass instead. Our device includes an angular velocity sensor and leads for a voltage sensor, so the frequency of rotation can be analyzed in addition to the induced emf. Problems that arise with motorized spinning coils include noise from the generator and large repair costs, but by replacing these motorized models with out apparatus, we are able to not only develop a more efficient way of measuring Earth's magnetic field, but also richer data for students to analyze.

PST2F23: 8:30-10 a.m. Curvature of the Universe CMB Lab for Non-Science Majors*

Poster – Daniel M. Smith Jr., South Carolina State University, PO Box 7709, Orangeburg, SC 29115; dsmith@scsu.edu

Measurements of fluctuations in the Cosmic Microwave Background (CMB) by the WMAP and Planck satellites have resulted in increasingly precise determinations of cosmological parameters that characterize the curvature, matter fraction, and dark energy fraction of the universe. But the colorful map of temperature fluctuations and the graph of the power spectrum have little physical meaning for the non-expert. To surmount the barrier to understanding the physics represented by these data products, a lab has been developed to enable students to determine the curvature of the universe by comparing actual WMAP data to theoretical maps and power spectra that students themselves calculate using the CAMB web interface.

*Funded by the South Carolina Space Grant Consortium/NASA EPSCoR

PST2F24: 9:15-10 a.m. Fresnel Equations with Complex Index of Refraction, Theory and Experiment

Poster – Scott A. Gimbal, California State University, Chico, Department of Physics, Chico, CA 95926; sgimbal5@gmail.com

Anna Petrova-Mayor, California State University, Chico

The Fresnel equations describe the amplitude and phase shift of light when reflected and/or refracted at the boundary between two media with different index of refraction. If the medium is conductive, such as gold for example, the index of refraction is complex. We will discuss how to evaluate the Fresnel equations for metallic coatings. We will present experimental data for the performance of a gold coated mirror for 45o incidence and linearly polarized laser beam. The experimental results will be compared with the theoretical prediction.

PST2F25: 8:30-9:15 a.m. Using Tablets to Augment and Standardize Teaching of Introductory Labs

Poster – Larry Bortner, University of Cincinnati, PO Box 210011, Cincinnati, OH 45221-0011; bortnlej@ucmail.uc.edu

Instructor preparation is very important in the student retention of knowledge in the physics laboratory. In the traditional physics laboratory setting, graduate teaching assistants and undergraduate learning assistants serve passably well because of their familiarity with the material. However, in the transition from traditional labs to labs that are more student-directed rather than cookbookish, instructors can become lost and may revert to the more comfortable habit of giving students all the answers, thus subverting the process. The use of a Kindle tablet loaded with TA instructions, hints, warnings, and suggested questions to ask students at targeted points in the student investigation offers stress reduction for the TA and promotes a more uniform instruction level.

PST2F26: 9:15–10 a.m. Locating Introductory Mechanics Problems Along the Well-structured – Ill-structured Continuum

Poster – Jeffrey A. Phillips, Loyola Marymount University, One LMU Drive, MS 8227, Los Angeles, CA 90045; jphillips@lmu.edu

Dante Sblendorio, Loyola Marymount University

Problems, across all disciplines, are typically described as either being well-structured or ill-structured. Simplistically, well-structured problems are defined as those where the goals and parameters are clearly stated and ill-structured as those that lack necessary information, which often leads to multiple solutions. We have found that those definitions do not completely capture the range of complexities that can be found in problems. Instead of this binary description, we prefer to view problems as lying along a continuum where their complexity and difficulty depend on, among other things, the fraction of conditions that are unstated in the problem. This fraction can take on any value, with larger ones implying that a solver to make the more decisions when creating a plan. We will present our coding scheme, which includes many other factors such as reading comprehension level and number of relevant physics concepts, and several example problems.

Ceremonial Session: Melba Newell Phillips Medal, 2013 – Lillian Christie McDermott

Location: Grand Ballroom I
Date: Wednesday, July 17
Time: 10-11 a.m.

Presider: Jill Marshall

Lillian C. McDermott
University of Washington
Professor of Physics,
Seattle, WA

DBER – A View from Physics

Discipline-based education research (DBER) on student learning in undergraduate science and engineering courses is a relatively new field. The history in physics is longer than in other disciplines. The Physics Education Group in the Physics Department at the University of Washington began conducting research in physics education (PER) in the early 1970s in courses designed to prepare preservice teachers to teach physics and physical science by inquiry. The scope of our research soon expanded to include undergraduates in the standard introductory courses and inservice teachers. We wanted to determine the degree to which all of these populations develop a functional understanding of physical concepts, interpret their formal representations, distinguish related concepts from one another, and do the reasoning required for their application. Later, we extended our investigations to more advanced courses, in which mathematical abstractions play an increasingly prominent role. Our research has not only been discipline-based but also discipline-specific. Examples will illustrate the nature of our investigations and their application to the development of our two research-based and research-validated curricula: *Physics by Inquiry* and *Tutorials in Introductory Physics*. Our experience has led to a few ideas about future directions for PER that we believe can help improve student learning from the elementary grades to the graduate level.

CKRL09: Crackerbarrel: The State of the Instructional Lab

Location: Pavilion East
Sponsor: Committee on Laboratories
Date: Wednesday, July 17
Time: 11 a.m.–12:30 p.m.

Presider: Timothy Grove

This will be an open discussion where current issues affecting the instructional lab will be discussed. The floor is open to lab goals, workload issues, equipment costs vs. funding, etc.

CKRL10: Crackerbarrel: Next Generation Science Education Standards

Location: Pavilion West
Sponsor: Committee on Laboratories
Date: Wednesday, July 17
Time: 11 a.m.–12:30 p.m.

Presider: Cathy Ezrailson

Participate in the discussion of the Next Generation Science Standards. Discussion includes development of the NGSS, two draft releases in 2012 and the final version to be released in spring of 2014. Participation is especially encouraged by those aware of efforts to inform teachers, administrators, and students about how students will be tested and teachers evaluated.

CKRL11: Crackerbarrel: For Solo PER

Location: Galleria II
Sponsor: Committee on Professional Concerns
Co-Sponsor: Committee on Research in Physics Education
Date: Wednesday, July 17
Time: 11 a.m.–12:30 p.m.

Presider: Steve Maier

Are you the only professional active in PER within your department? Are there only one or two colleagues in close proximity you can talk “PER shop” with? The membership of Solo PER is larger than you may think, and more diverse than most suspect. Join us for this crackerbarrel to connect with other Solo PER professionals and learn what is being done to help our/your endeavors. As in the past, bring questions, ideas, and professional concerns to share.

Session FA: Affective Issues and How They Impact Equity in the Classroom

Location: Paror A/B
Sponsor: Committee on Women in Physics
Co-Sponsor: Committee on Minorities in Physics
Date: Wednesday, July 17
Time: 12:30–2:20 p.m.

Presider: Dedra Demaree

FA01: 12:30-1 p.m. When Feist and Frustration Spark Substantive Engagement

Invited – Jennifer Richards, University of Maryland, College Park, 2311 Benjamin Building, College Park, MD 20742; jrich@umd.edu

Luke D. Conlin, Stanford University

Accounts from practicing scientists indicate that a variety of affectively charged experiences are common in the course of scientific practice and may spur continued pursuit and the development of new ideas. Yet we tend to shy away from certain affectively charged experiences in the classroom, such as extended argumentation for fear of students acting up and extended frustration for fear of students shutting down. In this talk, we focus on classroom examples in which teachers support students in engaging in feisty debate over competing ideas and in experiencing frustration as part of the process of and motivation for discovery. We consider how these affectively charged experiences may actually turn some students on to science, and we stress the need to assess the potential productivity of such experiences for student engagement and learning on a case-by-case basis. We conclude by discussing implications for classroom practice.

FA02: 1-1:30 p.m. Humor in the Classroom: More than Just Fun

Invited – Sissi L. Li, California State University, Fullerton, 800 N. State College Blvd., Fullerton, CA 92831; sili@fullerton.edu

Michael E. Loverude, California State University Fullerton

Humor is often used to foster a positive learning community by making the classroom fun. However, humor can have subtle side-effects that support participation, shape social dynamics, and communicate attitudes about science and scientists. In this study, we have examined humor use in a classroom and how it supports student learning and classroom social dynamics. Because humor is highly individualistic, we cannot tell you best practices for humor use in the classroom. Instead, we propose some ways to attend to how humor is used and how it can impact classroom learning in nuanced and unexpected ways. Using observations of an upper-division thermal physics course over a semester, we have identified some practices with elements of humor. We will provide examples of how these practices lower the stakes for participation, invite learners to be valued/legitimate members of the classroom community, and support identity development as scientists.

FA03: 1:30-1:40 p.m. Attitudes and Beliefs About Physics from a UK Academics' Perspective

Contributed – Robyn C.A. Donnelly, University of Edinburgh, School of Physics and Astronomy, James Clerk Maxwell Building, Mayfield Road, Edinburgh, Scotland EH4 8DA, United Kingdom; R.C.A.Donnelly@sms.ed.ac.uk

Cait MacPhee, Judy Hardy, University of Edinburgh

Simon Bates, University of British Columbia

The Colorado Learning Attitudes about Science Survey (CLASS), predominantly used to compare student attitudes towards physics, was distributed to members of the Institute of Physics (IOP) to gain a measure of "expert" views from UK physics graduates. We present a comparison of attitudes and beliefs of male and female academics, industry members, and people at different levels of academia. Data collected indicates a statistically significant gender difference between academics' responses to statements probing attitudes towards studying physics. Results show that female academics have a significantly higher agreement with the "expert" response to some survey statements than male academics. Considering statement categories, female academics show consistently different responses to males in each category. Furthermore, preliminary results suggest that the "expert" view for some statements, measured by UK academics' responses, may not be in complete agreement with those of US faculty members used to establish the "expert" responses to the CLASS survey.

FA04: 1:40-1:50 p.m. Inductive Reasoning: Equalizing Opportunities for Linguistically Diverse Students

Contributed – Shelly N. Belleau, University of Colorado, Boulder, 3888 Beasley Drive, Erie, CO 80516; shelly.belleau@gmail.com

Students learning English as a second language tend to underperform their English-speaking peers on traditional assessments, contributing to the issue of underrepresentation in STEM fields. This research investigates the extent to which curricula designed around evidence-based inductive reasoning, such as Physics and Everyday Thinking, can equalize opportunities for linguistically diverse students. Specifically, we evaluate how linguistically diverse learners and native English speakers perform in four categories: (i) asking questions and defining problems; (ii) developing and using models; (iii) constructing explanations and designing solutions; and (iv) engaging in evidence-based argumentation. Preliminary results indicate that students from linguistically diverse and English-speaking backgrounds demonstrated comparable growth in these scientific practices within the inductive reasoning environment. Links between this growth and the particularities of this learning environment are considered. These include maintaining space for making sense of natural phenomena by integrating everyday language with the technical language and practices of the discipline.

FA05: 1:50-2 p.m. Physics as a Mechanism for Engaging English Language Learners

Contributed – Enrique Suarez, University of Colorado, Boulder, School of Education, Boulder, CO 80309-0249; enrique.suarez@colorado.edu

Valerie Otero, University of Colorado, Boulder

English Language Learners (ELLs) are frequently left on the periphery of classroom interactions. Due to limited reading and/or spoken language skills, teachers and peers communicate with these students less often, decreasing the number of opportunities to engage. We argue that basic scientific practice provides a ready-made environment for increasing engagement among students marginalized from classroom discourse. Environments that privilege scientific inductive reasoning invite students who are learning English to participate. This study investigated first-grade students' discussions about factors that affect how an object floats. Students came from a variety of language backgrounds; all were considered beginner/intermediate ELLs. Results show that the goal of inducing principles from actual phenomena encouraged students to communicate their ideas and mechanistic reasoning, eventually increasing students' confidence in expressing themselves. Following the hybrid space argument of Vygotsky's theory of concept formation, external expression leads to students' conceptual development, as well as to English language skills.

FA06: 2-2:10 p.m. Rethinking the Locus of Evaluation to Promote Classroom Scientific Induction

Contributed – Mike Ross, University of Colorado, Boulder, 1907 Lotus Court Longmont, CO 80504; michael.j.ross@colorado.edu

Valerie Otero, University of Colorado, Boulder

For over a century, physicists and physics educators have attempted to transform physics education to engage students in scientific induction. These efforts have largely failed to bring about evidence-based, inductive reasoning on a broad scale. This study investigates the role of nontraditional evaluative structures in promoting authentic scientific reasoning among students, as contrasted with more commonly observed failure-avoidance behaviors, in two physics classes. Prominent evaluative structures in this context consisted of (1) individual and small group reconciliation of students' ideas and explanations with available laboratory evidence and (2) whole class consensus building of explanations that can best explain the evidence collected. Findings suggest that the relocation of evaluative authority over students' ideas and explanations to laboratory evidence and social consensus, rather than with teacher and text, can promote more authentic engagement, enjoyment, and a sense of identification with physics.

FA07: 2:10-2:20 p.m. Using Intersectionality to Investigate Students' Affective Reactions to College Mathematics

Contributed – Hilary A. Dwyer, University of California, Santa Barbara, Gevirtz School, Santa Barbara, CA 93106-9490; hdwyer@education.ucsb.edu*

Danielle Harlow, University of California, Santa Barbara

Many women and students of color leave STEM fields because they do not feel an affective connection to the culture of these disciplines. These individuals do not lack cognitive ability; rather they choose not to persist based on personal responses to factors such as sense of community, interactions with professors and peers, and stereotypes among professionals in the field. We used one-on-one interviews and focus groups to provide a safe space for students to discuss sensitive topics such as being a woman or man of color among mostly European American students and faculty. Applying an intersectionality lens to the testimonies of 24 math majors, we analyzed how gender and ethnicity together could illuminate students' affective responses to college mathematics. This project provides important implications for physics educators as undergraduate physics or engineering majors may hold similar views as the math students in this study.

*Sponsored by Danielle Harlow

Session FB: PER: Upper-Division Courses

Location: Pavilion East
Date: Wednesday, July 17
Time: 12:30–2:20 p.m.

Presider: Mila Kryjevskaia

FB01: 12:30-12:40 p.m. Examining Student Understanding of Diode Circuits*

Contributed – MacKenzie R. Stetzer, University of Maine, 5709 Bennett Hall, Room 120, Orono, ME 04469-5709; mackenzie.stetzer@maine.edu

Christos P. Papanikolaou, University of Athens

David P. Smith, University of North Carolina at Chapel Hill

As part of an ongoing investigation of student understanding of analog electronics, we have been examining student learning of canonical topics in upper-division electronics courses. A major goal of this multi-institutional investigation has been to probe student thinking in sufficient detail to guide the development of instructional materials that can help address underlying conceptual and reasoning difficulties. In this talk, I will focus on our efforts to probe student understanding of basic diode circuits using free-response questions and interviews. Specific examples from our work with both introductory and upper-division students will be used to highlight some of the implications for instruction that continue to emerge from this investigation.

*This work has been supported in part by the National Science Foundation under Grant Nos. DUE-0618185, DUE-0962805, and DUE-1022449.

FB02: 12:40-12:50 p.m. Investigating Student Understanding of Transistor Circuits

Contributed – Kevin L. Van De Bogart, University of Maine, 111 Bosworth St., Old Town, ME 04468; kevin.vandebogart@maine.edu

MacKenzie R. Stetzer, University of Maine

An upper-division laboratory course on analog electronics is a required component of many undergraduate physics programs and often serves as a gateway to other advanced laboratory courses and undergraduate research experiences. Ongoing research in such upper-division electronics courses has revealed persistent student difficulties with foundational circuits concepts (e.g., Kirchhoff's junction rule) as well as canonical topics in analog electronics (e.g., op-amp circuits). We have recently extended our investigation to examine student understanding of fundamental bipolar-junction transistor circuits. Specific examples will be used to highlight our findings and to provide insight into student reasoning about such circuits. In addition, implications for instruction will be discussed.

FB03: 12:50-1 p.m. Student Understanding of Electric Circuit Theory as a Tool for Modeling Physical Networks

Contributed – Christian H. Kautz, Hamburg University of Technology (TUHH), Schwarzenbergstr. 95, Hamburg, XX 21073 Germany; kautz@tu-harburg.de

Dion Timmermann, Hamburg University of Technology

Courses on circuit analysis for students in electrical or mechanical engineering often focus on algorithms for solving circuit problems that are presented in the form of standard circuit diagrams. Research has shown that many students have difficulty developing a conceptual understanding of basic concepts such as current and voltage. At Hamburg University of Technology, we have begun to investigate to what extent students are able to recognize the model aspects of (linear) circuit theory. In particular, we probe student understanding of (1) the connection between graphical and mathematical representations of circuits, (2) the connection between the elements of circuit theory and their real-world correspondents, (3) the "syntax" (i.e., set of rules) underlying circuit diagrams, and (4) the limitations of the linear circuit model and its idealized elements. We will present some initial results, indicate how these relate to previously identified conceptual difficulties, and show their relevance for instruction.

FB04: 1-1:10 p.m. Assessing Student Learning in Middle-Division Classical Mechanics/Math Methods

Contributed – Marcos D. Caballero, University of Colorado, Boulder, 2000 Colorado Ave., Boulder, CO 80309; marcos.caballero@colorado.edu

Steven J. Pollock, University of Colorado, Boulder

Reliable and validated assessments of introductory physics have been instrumental in driving curricular and pedagogical reforms that lead to improved student learning. As part of an effort to systematically improve our sophomore-level Classical Mechanics and Math Methods course (CM) at CU-Boulder, we are developing a tool to assess student learning of CM concepts in the upper-division. The Colorado Classical Mechanics/Math Methods Instrument (CCMI) builds on faculty-consensus learning goals and systematic observations of student difficulties. The result is a nine-question open-ended post-test (with two additional, optional questions) that probes student learning in the first half of a two-semester sequence that combines classical mechanics with mathematical methods. In this paper, we describe the design and development of this instrument, its validation, and measurements made in classes at CU Boulder and elsewhere.

FB05: 1:10-1:20 p.m. In between Multiple Choice and Open Ended: Large-scale Assessment for Upper-Division Physics?

Contributed – Bethany R. Wilcox, University of Colorado, Boulder, 2510 Taft Drive, Unit 213, Boulder, CO 80302; Bethany.Wilcox@colorado.edu

Steven Pollock, Marcos Caballero, University of Colorado at Boulder

Multiple-choice assessments are a standard tool for achieving reliable measures of certain aspects of students' conceptual learning in large introductory physics courses. However, upper-division physics involves greater emphasis on assessing students' reasoning in addition to their conceptual knowledge. In order to capture elements of student reasoning, the Colorado Upper-division Electrostatics (CUE) diagnostic was designed as an open-ended assessment. Unfortunately, the training required to score the CUE accurately limits its scalability. Using our extensive database of CUE responses to construct distractors, we created a multiple-choice version of the diagnostic. Our principal goal was preserving insights afforded by the open-ended format while exploiting the logistical advantages of a multiple-choice assessment. This new version explores the viability of a novel test format where students select multiple responses and receive partial credit based on the accuracy and consistency of their selections. Here, we present the development, scoring, and preliminary analysis of the multiple-choice CUE.

FB06: 1:20-1:30 p.m. Students' Dynamic Geometric Reasoning About Quantum Spin-1/2 States

Contributed – Hunter G. Close, Texas State University-San Marcos, 601 University Drive, San Marcos, TX 78666; hgclose@txstate.edu

Catherine C. Schiber, David Donnelly, Eleanor W. Close, Texas State University-San Marcos

Quantum states are traditionally cognitively managed exclusively with algebra rather than geometry. One reason for emphasizing algebra is the high dimensionality of quantum mathematical systems; even spin-1/2 systems require a 2-d complex number space for describing their quantum states, which can be hard to visualize. Using "nested phasor diagrams," which use nesting to increase the dimensionality of graphic space, we taught undergraduate students to represent spin-1/2 states graphically as well as algebraically. In oral exams, students were asked to identify which spin-1/2 states, expressed numerically, would generate the same set of probabilities as each other (i.e., they are the same except for a different overall phase factor). Video records of oral exams show that no students (N=13) performed this task successfully using an algebraic method; instead, all students solved the problem graphically. Furthermore, every student who succeeded used a certain gesture to solve the problem.

FB07: 1:30-1:40 p.m. Effects of a Wave Function Manipulative on Subsequent Student Gesturing

Contributed – Catherine C. Schiber, Texas State University-San Marcos, 601 University Drive, San Marcos, TX 78666; ccschiber@gmail.com

Hunter G. Close, Eleanor W. Close, David Donnelly, Texas State University-San Marcos

We compare student gestures from oral exams in an undergraduate quantum mechanics course for two academic years, 2012 and 2013. In both years, students were asked to show with their hands the quantum wave function for various one-dimensional potentials by assigning the three available spatial dimensions to the real part of the function, the imaginary part of the function, and the scenario's single spatial coordinate. In 2012, the students' instructor encouraged visualization of the wave function in these terms by gesturing frequently and by explaining 2-d quantum simulations in 3-d. In 2013, instruction included several in-class activities involving building a 3-d representation of the quantum wave function for several potentials using pipe cleaners. The oral exam in 2013 did not, however, include the pipe cleaners. We present evidence of the influence of the pipe cleaners on students' cognitive management, including embodied action, of the wave function.

FB08: 1:40-1:50 p.m. Teaching Undergraduate Quantum Mechanics Courses: Contents, Textbooks, and Teaching Methods

Contributed – Homeyra R. Sadaghiani, Cal Poly Pomona, 3801 W. Temple Ave., Pomona, CA 91768; hrsadaghiani@csupomona.edu

Quantum mechanics suggests a new picture of physical systems that often is in conflict with students' classical views. For example, the underlying principle of orthonormality of state vectors is not necessarily aligned with student mental models of three- dimensional space vectors. Researchers have found that these classical views can create barriers in student learning of quantum concepts. Some researchers have postulated that introducing quantum ideas in an unfamiliar context such as spin (that does not have a classical counter part) might reduce the likelihoods of activating students' classical resources. To test this, we have experimented with teaching quantum mechanics using two different textbook approaches: (1) traditional approach (starting with continuous basis); (2) spin first approach (starting with discrete basis). We have investigated student learning of the core concepts using classroom concept questions and end of quarter diagnostic tests. We will discuss the implications of this study for choices of initial context, the order and emphasis of content being taught, as well as how Physics Education Research-based curriculum could be utilized to increase student engagement and learning in these courses.

FB09: 1:50-2 p.m. Investigating Student Difficulties with Measurements in Quantum Mechanics

Contributed – Gina Passante, University of Washington, Department of Physics, Seattle, WA 98195; passante@uw.edu

Paul Emigh, Peter S. Shaffer, University of Washington

The concept of measurement is a fundamental idea in quantum mechanics. Ideas pertaining to quantum measurement have been shown to be difficult for both introductory and advanced students. This is understandable, since in learning quantum mechanics, students must successfully interpret a new mathematical and conceptual formalism and recognize how this new model differs from classical physics. We discuss some of the conceptual and reasoning difficulties that we have identified related to measurement in quantum mechanics, using illustrative examples from written and online pretests and from post-tests administered on course examinations.

FB10: 2-2:10 p.m. Analysis of Faculty and Student Interviews on Undergraduate Quantum Mechanics

Contributed – Christopher A. Oakley, Georgia State University, 400 Science Annex, Atlanta, GA 30303; coakley2@student.gsu.edu

Brian D. Thoms, Georgia State University

Characterizing faculty expectations is important to produce a comprehensive understanding of what knowledge students should acquire before and during a quantum mechanics course (QMC). We analyzed interviews conducted with faculty and students entering a QMC in the Department of Physics & Astronomy at Georgia State University. The interviews examine expectations regarding preparation, course material, and instructor's goals for a QMC. The goals of the interviews are to locate conflicts in perspective and to provide students with a "map" for areas that will help strengthen the knowledge and skills to be obtained before they enter a QMC. We report on contradictions and similarities in perceptions from interview data determined by coding the interviews and through the use of Activity Theory.

FB11: 2:10-2:20 p.m. Qualitative Understanding of Entropy Changes in Upper-division Thermal Physics*

Contributed – Michael E. Loverude, California State University, Fullerton, Department of Physics, MH-611, Fullerton, CA 92834; mloverude@fullerton.edu

Sissi L. Li, California State University, Fullerton

As part of an ongoing project involving research and curriculum development in upper-division thermal physics, we have investigated student understanding of the concept of entropy and the approach to thermal equilibrium. Previous talks from this project have described student interview responses concerning models of entropy in the approach to thermal equilibrium and the quantitative connections between mathematical models of entropy that are macroscopic and particulate in nature. In the current talk, we present data from written problems in which students are asked to reason qualitatively about changes in entropy as well as about reversibility.

*Supported in part by NSF grants DUE 0817335 and 0817282.

Session FC: Pre-college PER

Location: Salon Ballroom I/II
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Physics in High Schools
Date: Wednesday, July 17
Time: 12:30–2:30 p.m.

Presider: Dan Crowe

FC01: 12:30-1 p.m. Teaching and Learning of Physics in Grades 5-8*

Invited – David E. Meltzer, Arizona State University, 7271 E. Sonoran Arroyo Mall, Mesa, AZ 85212; david.meltzer@asu.edu

For the past five years I have taught regular weekly science classes to students in grades 5-8. This has allowed me to follow the development of many students over periods of years. I have used modified versions of various research-based college-level curricula, and have developed my own materials. Assessment materials included items from state-mandated tests, from standard instruments such as the CSEM, and from other sources. I will focus discussion on several themes: (1) there is great potential for significant physics learning at the middle-school level, but (2) the time and effort required to achieve such outcomes are enormous and perhaps underappreciated; at the same time (3) there are grounds for skepticism regarding the appropriateness of many common grade-level standards and expectations, and (4) assessment of learning by middle-school students must take into account a very substantial decay rate in student learning gains over time, a point emphasized by Piaget.

*Supported in part by a grant from Mary Lou Fulton Teachers College, Arizona State University.

FC02: 1-1:30 p.m. Middle School Student Achievement Correlates with Teachers' Knowledge of Energy*

Invited – Michael C. Wittmann, University of Maine, 5709 Bennett Hall, Orono, ME 04469-5709; mwittmann@maine.edu

Levi Lucy, University of Maine

In the Maine Physical Sciences Partnership we are studying teachers' thinking about energy as well as what teachers know about their students' ideas about energy. Before and after all instruction on energy, students answered a validated survey constructed primarily of questions from the AAAS Assessment database. Teachers took the same survey, answering the questions and predicting the answers their students would give. In two instances, differences in teacher responses are correlated with student achievement on those questions. Teachers with the most detailed content responses on one question as well teachers with the most complete understanding of common incorrect answers on another question had students with the highest gains on each of those questions. We discuss the design or our survey, our data, and how we analyzed the results.

*This material is based upon work supported by the National Science Foundation under Grant #0962805.

FC03: 1:30-1:40 p.m. Adapting a Novel Curriculum in a Traditional High School Environment

Contributed – Emily A. Knapp, University of Colorado, Boulder, 1435 Willowbrook Drive, Longmont, CO 80504; knapp_emily@svvsd.org

Valerie K. Otero, University of Colorado, Boulder

Adopting novel curricula is difficult in high schools that have strict pacing criteria and standards set forth by the district for general physics classes. In order to adapt a PER-based approach to teaching physics, we alternated novel and traditional classroom structures to capture the essence and pedagogy of an innovative curriculum while still maintaining compliance with district policies. This study investigates how students responded to the alternating implementations of Physics and Everyday Thinking; an innovative curriculum based on the inductive method. The curriculum involves student-centered investigation, group discussions, collecting and interpreting evidence, and generating inferences and principles from observations. Findings include students' trust in their own investigations and data, students' views on working in research groups, and the impact of decentralized authority in the classroom. These findings and lessons learned from adapting a novel curricular approach in a traditional environment will be discussed.

FC04: 1:40-1:50 p.m. Effects of Flexibility on Homework Completion and Student Performance

Contributed – Alisa P. Grimes, University of Colorado, Boulder, 249 UCB, Boulder, CO 80309; alisapaulinegrimes@yahoo.com

Research has shown that student choice and flexibility in the learning environment are linked to motivation and agency. This education research investigates the effect of choice and flexibility in impacting homework completion rate. Two different classroom treatments were applied over two terms of an urban high school chemistry course. The first treatment involved flexible, supportive classroom structures that theoretically would lead to a greater homework completion rate. The second treatment (or control) involved the traditional, authoritative structures that had been in place--students were penalized for not completing homework within the designated timeframe. Initial results suggest that the flexible supportive structures led to greater homework completion rates and to higher performances on the district assessment over the non-flexible homework condition. These results will be discussed along with instructional implications, explanatory conjectures, and lessons learned.

FC05: 1:50-2 p.m. Effective Ways of Using Interactive Whiteboards in a Physics Classroom

Contributed – Bor Gregorcic, Univeristy of Ljubljana, Faculty for Mathematics and Physics, Ljubljana, 1000 Slovenia; bor.gregorcic@fmf.uni-lj.si

Eugenia Etkina, Rutgers University

Gorazd Planinsic, Univeristy of Ljubljana

This talk will discus how Interactive Whiteboards are used in a high school physics class. While IWB use has already been studied from a general perspective, few studies have addressed the specifics of their use for teaching physics. We investigate effective ways of using IWB in instruction and in curriculum design. The framework for our study is based on the Design Based Research approach. A unit is designed, implemented, evaluated, redesigned and used in class again. As the cycle is repeated, the result is an improved unit and emergence of principles for IWB use and curriculum material design. We put special emphasis on using the interactive surface of the board, as this is one of the main advantages of the IWB over a standard computer-projector setup. The surface, when used in combination with dynamic interaction software (Algodoo, for example) makes possible a creative graphical and kinesthetic input from the students.

FC06: 2-2:10 p.m. Mechanistic Reasoning in an Informal Physics Program

Contributed – Rosemary Wulf, University of Colorado, Boulder, 440 UCB, Boulder, CO 80309; rosemary.wulf@colorado.edu

Kathleen Hinko, Noah Finkelstein, University of Colorado, Boulder

Informal science education has the potential to help students engage in active learning in physics. Providing students with the chance to experiment and to have students externalize their reasoning to explain their experiments, rather than being told a correct answer, will help students to take on the role of an active learner in science. Building on prior efforts in studying and promoting mechanistic reasoning,[1] we apply a modified coding scheme to examine mechanistic reasoning in middle school students' scientific notebooks in an informal setting. We compare students' mechanistic reasoning in two inquiry physics curricula, one that is very guided and the other that is more open inquiry. We find that students in the more open inquiry-oriented curriculum use more varied types of mechanistic reasoning. We discuss the role that such active expert learning and reasoning may play in the promotion of children's positive scientific identities.

1. R.S. Russ, R.E. Scherr, D. Hammer, D. and J. Mikeska, Recognizing mechanistic reasoning in student scientific inquiry: A framework for discourse analysis developed from philosophy of science. *Sci. Ed.* **92**, 499-525. (2008).

FC07: 2:10-2:20 p.m. Student Understanding of Newton's Second Law with Computational Modeling

Contributed – John M. Aiken, Georgia State University, 3736 Gloucester Drive, Tucker, GA 30084; johnm.aiken@gmail.com

Shih-Yin Lin, Scott S. Douglas, Michael F. Schatz, Georgia Institute of Technology

Marcos D. Caballero, University of Colorado, Boulder

John B. Burk, St. Andrews' School

Brian D. Thoms, Georgia State University

With any representation of a physical model (e.g., graphs, diagrams, computation), students must learn to connect the model to the individual representation. This paper follows previous work where computational modeling (using VPython) was integrated into a high school Modeling Instruction physics course. To characterize student understanding of Newton's second law, five representative students were recruited in a think-aloud session with a follow-up interview. During the think-aloud session, students wrote a program modeling the motion of a baseball. Students' understanding of the physics concepts behind the computational model will be reported. In particular, we will focus on students' ability to relate Newton's second law to the velocity update in a computational model of force and motion.

FC08: 2:20-2:30 p.m. Spatial Skills and High School Physics and Math Performance

Contributed – Alfonso J. Hinojosa, United High School, 2811 United Ave., Laredo, TX 78045; ajhinojosa@unitedisd.org

Ramon E. Lopez, University of Texas at Arlington

We are investigating the effect that student spatial skills have on student success on statewide Texas Physics and Math assessment exams and STEM course grades. Previous work indicates an increase in a student's cognitive load when mentally manipulating three-dimensional images. To investigate if there is a broader academic impact, we conducted a study (nine sections) of student spatial intelligence and the relationship to academic performance during the fall 2012 semester using the introductory Pre-AP and AP Physics courses. All students were administered the Mental Rotation Test (MRT) which consists of 20 spatial intelligence problems. The scores were then statistically correlated with the corresponding student state physics and math assessment scores, as well as physics and math class grades. We will contrast those correlations with the correlations between student exam performance and high school courses taken.

Session FD: The AIP Career Pathways Project

Location: Broadway III/IV
Sponsor: Committee on Physics in Undergraduate Education
Co-Sponsor: Committee on Professional Concerns
Date: Wednesday, July 17
Time: 12:30–2:30 p.m.

Presider: Toni Sauncy

FD01: 12:30-1 p.m. AIP Career Pathways Project: An Overview

Invited – Roman Czujko, American Institute of Physics, One Physics Ellipse, College Park, MD 20740; rczujko@aip.org

This talk describes the Career Pathways Project (CPP) which was supported by the National Science Foundation beginning in October of 2010. The number of physics bachelor's degrees awarded to the class of 2011 set an all-time high in the U.S. at around 6300. If departments want to continue to grow the number of bachelor's, they will need to prepare students to successfully enter the STEM workforce. The CPP team identified a set of physics departments that have a strong record of placing their bachelor's recipients into the STEM workforce and we have completed nine site visits to such departments in various size universities and in different parts of the country. This talk describes the set of features that all these departments share and the features that may reflect the characteristics of the universities, strengths of the departments or the opportunities in the local economy.

FD02: 1-1:30 p.m. Career Preparation for Physics Majors at UW-Eau Claire

Invited – Lyle A. Ford, University of Wisconsin-Eau Claire, Department of Physics and Astronomy, Eau Claire, WI 54702; fordla@uwec.edu

Heidtke L. Staci, University of Wisconsin-Eau Claire

A bachelor's degree in physics can prepare an individual for a wide range of careers but many students are not aware of the full range of employment options available to them. The faculty in the Department of Physics and Astronomy at the University of Wisconsin-Eau Claire recognizes the challenges faced by graduates who want to apply what they have learned in college to careers that they begin after obtaining their bachelor's degrees. We have found that a pair of short courses that focus on career exploration and the internship/job search significantly help our students find employment after graduation. In this talk, we will describe these courses, our LabVIEW certificate program, and the STEM recruiter position in our Admissions Office. We will also give details on how our Career Services office interacts with the Department of Physics and Astronomy to maximize the benefit the office provides to our students.

FD03: 1:30-2 p.m. Physics Career Pathways Illustrated in the Liberal Arts

Invited – Timothy N. Good, Gettysburg College, Physics Department, Gettysburg, PA 17325; goodt@gettysburg.edu

A recent analysis of data collected by the AIP SRC reveals that Gettysburg College has both a strong record of granting physics bachelor's degrees compared to other liberal arts institutions and is among the national leaders in terms of the percent of their recent physics bachelor's recipients who entered the STEM workforce within one year of earning the bachelor's degree. The college collaborated with the AIP Career Pathways team in a study to learn, and then disseminate, effective practices. Herein we report our findings; the significant factors are curriculum, climate, and community. We will describe a flexible curriculum rich in one-to-one instruction and advising, an energetic physics faculty devoted to "hands-on" laboratory instruction across the major, the availability of independent research opportunities, and a departmental climate that nurtures community, fostering a strong, positive relationship among physics majors at all levels and with alumni participating in a vibrant colloquium series.

FD04: 2-2:30 p.m. Undergraduate Physics at UC Davis

Invited – Patricia C. Boeshaar, University of California, Davis, One Shields Ave., Davis, CA 95616; boeshaar@physics.ucdavis.edu

The physics program at UC Davis has seen our number of graduating physics majors more than double in five years and the number of women increase to approximately 25%. This success is due in part to incorporating students' suggestions throughout our program. On the pedagogical side, three senior capstone courses offer an opportunity to try out a research area in nuclear, particle, condensed matter physics, or cosmology. Our Astrophysics Specialization plus five Applied Physics majors, as well as a five-year BS in Physical Electronics with MS in Electrical Engineering have attracted more multidisciplinary students. Scientific writing is emphasized in our advanced labs and through the use of research wikis. A fall seminar in career preparation is followed by spring seminar presentations by former graduates. We offer undergraduate teaching assistant positions, both in observational astronomy as well as pre-professional classes. Faculty along with a staff coordinator are actively involved in advising students. An AIP site visit report in 2011 cited many of the achievements of our program.

Session FE: Panel – A Modern Approach to Teaching Quantum Mechanics

Location: Broadway I/II
Sponsor: Committee on Physics in Undergraduate Education
Date: Wednesday, July 17
Time: 12:30–2:30 p.m.

Presider: Noah Finkelstein

Quantum mechanics is arguably one of the most difficult subjects students encounter in their study of physics. However, substantial progress has been made in elucidating student difficulties and tailoring activities to student needs. Single photon detectors are becoming more affordable, making single photon interference experiments viable for undergraduate labs. Simulations have the potential to enhance student exploration and conceptual understanding and to contrast classical and quantum behavior. There has been substantial work on quantum mechanics curriculum development both at the introductory and advanced undergraduate level. This panel aims to give attendees an overview of relevant work in the areas of research-based activity, lab, and curriculum development for student learning of quantum mechanics. A discussion will be held after the presentations, considering how to best share expertise and to form closer links between these different areas of development.

FE01: 12:30-2:30 p.m. Physics or Philosophy: Quantum Interpretations in the Undergraduate Curriculum

Panel – Charles Baily, University of Colorado, Boulder, Department of Physics, UCB 390, Boulder, CO 80309-0390; Charles.Baily@Colorado.EDU

The ongoing controversy surrounding the physical interpretation of quantum mechanics has naturally influenced the ways in which interpretive themes are (or are not) discussed in the classroom. Interpretative agnosticism, and the tendency for instructors to favor mathematical proficiency over sense making ("shut up and calculate"), has been shown to negatively impact student thinking, and the unintended consequences of these kinds of instructional choices deserves greater consideration from teachers and education researchers. I argue that de-emphasizing interpretation and discouraging students from visualizing quantum processes denies them opportunities to develop important modeling skills, and deprives them of critical tools for deriving physical meaning from mathematical equations and algorithms. Moreover, our perspectives on the measurement problem have evolved significantly since the onset of the "second quantum revolution"— the manipulation of single-particle systems and tests of local realism provide a context for students to learn about exciting developments in experimental science, not philosophy.

FE02: 12:30-2:30 p.m. A New Introductory Quantum Mechanics Curriculum

Panel – Antje Kohnle, University of St Andrews, North Haugh, St Andrews, KY16 9SS, United Kingdom; ak81@st-andrews.ac.uk

Dan Browne, University College London

Mark Everitt, Loughborough University

Pieter Kok, University of Sheffield

Derek Raine, University of Leicester

Elizabeth Swinbank, University of York

The Institute of Physics New Quantum Curriculum consists of learning and teaching materials for a first course in university quantum mechanics starting from two-level systems. This approach immediately immerses students in inherently quantum mechanical aspects by focusing on experiments that have no classical explanation. It allows from the start a discussion of interpretative aspects of quantum mechanics and quantum information theory. Texts, interactive animations and activities are freely available at http://quantumphysics.iop.org/ with multiple paths through the material.Texts have been written by researchers in quantum information theory and foundations of quantum mechanics. St Andrews has developed the interactive animations, building on the expertise of the QuVis project. The linear algebra needed for this approach is part of the resource. This presentation will describe the online materials and initial evaluation outcomes trialling animations in a St Andrews Modern Physics course.

FE03: 12:30-2:30 p.m. Teaching Quantum Mechanics with Photon Labs

Panel – Enrique J. Galvez, Colgate University, Department of Physics and Astronomy, 13 Oak Drive, Hamilton, NY 13346; egalvez@colgate.edu

Photon labs provide a way for students to see the connection between the algebra of unitary operations of quantum mechanics and physical systems. While spins and Stern-Gerlach apparatuses provide a good setting to learn the algebra, it is quite abstract. Photon labs' optical elements provide laboratory-based examples of quantum-mechanical operators, such as polarizers (projection operators), waveplates (basis rotation and transformation), mirrors (exchange operation), and polarization interferometers (tensor product of spaces). In addition, the labs address fundamental concepts, such as superposition and entanglement, which can be used to discuss the more challenging conceptual aspects of quantum mechanics.

FE04: 12:30-2:30 p.m. Modern Quantum Mechanics in the Paradigms in Physics Curriculum*

Panel – David H. McIntyre, Oregon State University, Department of Physics, Corvallis, OR 97331; mcintyre@ucs.orst.edu

Our approach to modernizing the teaching of quantum mechanics in the Paradigms in Physics program includes adopting a "spins-first" approach and incorporating modern pedagogical strategies. We introduce quantum mechanics through the analysis of sequential Stern-Gerlach spin measurements. The aims of the spins-first approach are: (1) To immerse students in the inherently quantum mechanical aspects of physics, and (2) To give students experience with the mechanics of quantum mechanics in the forms of Dirac and matrix notation. To facilitate our spins-first approach, we use Stern-Gerlach simulation software to study measurements, interferometers, spin precession in a magnetic field, and "which-path" detection. We build upon the spins-first approach by using the spin-1/2 example to introduce perturbation theory, the addition of angular momentum, and identical particles. We also use other methods of encouraging student engagement in the classroom, such as small group activities, white board activities, kinesthetic activities, and computer visualization.

*This material is based on work supported by the National Science Foundation under Grant Nos. 9653250, 0231194, and 0618877. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.

FE05: 12:30-2:30 p.m. Improving Students' Understanding of Upper-Level Quantum Mechanics*

Panel – Chandralekha Singh, University of Pittsburgh, 3941 Ohara St., Pittsburgh, PA 15213, clsingh@pitt.edu

Guangtian Zhu, University of Pittsburgh

Learning quantum mechanics is especially challenging, in part due to the abstract nature of the subject. We have been conducting investigations of the difficulties that students have in learning quantum mechanics. To help improve student understanding of quantum concepts, we are developing quantum interactive learning tutorials (QuILTs) as well as tools for peer-instruction. The goal of QuILTs and peer-instruction tools is to actively engage students in the learning process and to help them build links between the formalism and the conceptual aspects of quantum physics without compromising the technical content. They focus on helping students integrate qualitative and quantitative understanding, and discriminate between concepts that are often confused. In this talk, I will give examples from my research.

*Supported by the National Science Foundation.

Session FG: ALPhA Labs in the Classroom

Location: Galleria I
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Laboratories
Date: Wednesday, July 17
Time: 12:30–2:10 p.m.

Presider: Joss Ives

FG01: 12:30-1 p.m. Can Instructional Lab Resemble Science Lab? What and How

Invited – Eugenia Etkina, Rutgers University, 10 Seminary Place, New Brunswick, NJ 08901; eugenia.etkina@gse.rutgers.edu

In this talk I will describe how one can use physics instructional laboratory to create the spirit of a science lab. To achieve this we need to a) rethink the goals of the labs; b) have a clear vision of what the achievement of these goals looks like; c) create experiences for the students that will help them reach the desired achievement level. In my talk I will describe a 10-year long journey of Rutgers ISLE [1] labs that allowed us not only to answer the above questions but to collect robust data that show what activities students can be engaged in a lab to learn to approach experimental problems like scientists and how we can help them be successful in this endeavor.[2, 3]

1. E. Etkina & A. Van Heuvelen, (2007) in E. F. Redish and P. Cooney, (Eds.), *Research Based Reform of University Physics* (AAPT, 2007).
2. E. Etkina, S. Murthy, & X. Zou, *Am J. Phys.* **74**, 979-982. (2006).
3. E. Etkina, A. Karelina, M. Ruibal-Villasenor, R. Jordan, D. Rosengrant, & C. Hmelo-Silver, *JLS,* **19**, 1, 54-98. (2010).

FG02: 1-1:30 p.m. Doing Research in the Advanced Lab: A Hybrid Approach

Invited – Martin J. Madsen, Wabash College, 301 W Wabash Ave., Crawfordsville, IN 47933; madsenm@wabash.edu

We have adopted a hybrid approach to our junior/senior physics major laboratory classes that integrates components from a more traditional advanced lab-like course and a full undergraduate research experience in a research lab. We have limited resources both in terms of faculty and budget which make it difficult to give our students research experience in faculty labs. I will describe our alternative approach which is to integrate the process of doing science in our advanced lab. Since we moved to this format, we have found better engagement from the students, positive feedback on the class from alumni, and have even published several papers in the *American Journal of Physics.*

FG03: 1:30-1:40 p.m. A National Assessment of Undergraduate Physics Labs: First Results

Contributed – H. J. Lewandowski, University of Colorado, Boulder, Department of Physics, 390 UCB, Boulder, CO 80309; benjamin.zwickl@colorado.edu

Benjamin Zwickl, Takako Hirokawa, Noah Finkelstein, University of Colorado, Boulder

The Colorado Learning Attitudes about Science Survey for Experimental Physics (E-CLASS) is a short multiple choice survey that assesses students' attitudes about conducting physics experiments in an instructional setting and in professional research. The survey is given at the beginning and at the end of a course, whereupon students are also asked about what helped to earn a good grade in the course. A variety of aspects of experimentation are explored, including students' sense-making, affect, self-confidence, and the value of collaboration. Over 4000 E-CLASS responses have been gathered from over 30 courses at 17 colleges and universities. We will present a broad overview of our findings, including which student views are the least expert-like, which views shift most over the course of a semester, and which have largest differences between introductory and upper-division courses.

FG04: 1:40-1:50 p.m. Students' Use of Modeling in the Upper-Division Physics Laboratory

Contributed – Benjamin Zwickl, University of Colorado, Boulder, Department of Physics, 390 UCB Boulder, CO 80309; benjamin.zwickl@colorado.edu

Noah Finkelstein, H. J. Lewandowksi, University of Colorado, Boulder

Modeling, the practice of developing, testing, and refining models of physical systems, has gained support as a key scientific practice in the K-12 Next Generation Science Standards, and in curricula such as Modeling Instruction, RealTime Physics, ISLE, and Matter & Interaction. However, modeling has gained less traction at the upper-division undergraduate level. As part of a larger effort to transform upper-division physics labs to incorporate scientific practices, including modeling, we conducted a series of think-aloud experimental activities using simple electronic and optical components in order to investigate how students use modeling with minimal explicit prompting in a laboratory setting. We review general patterns in students' use of models, describe our coding scheme, and conclude with a discussion of implications for the design of modeling-focused lab activities and lab-appropriate assessments.

FG05: 1:50-2 p.m. Reflecting and Evaluation In Physics Labs: Can It Be Done?

Contributed – Natasha G. Holmes, University of British Columbia, 6224 Agricultural Road, Vancouver, BC V6T 1Z1, Canada; nholmes@phas.ubc.ca

James Day, Ido Roll, Doug A. Bonn, University of British Columbia

Sense making behaviours during experiments, such as reflection and evaluation, often require a mastery of subject matter, as well as considerable technical understanding of equipment being used. Students are novices in both of these areas and so require assistance in developing these important behaviours. We have recently studied if, when, and how students reflect during physics labs. Our work showed that while many students were able to reflect on their results and correct systematic errors when two nominally equivalent measurements differed from one another by about 30%, very few would make corrections when the difference was only about 5%. Rather than confront the discrepancy, students often would simply increase their stated uncertainties to reflect the inaccuracy, so that 5% was not a significant difference. During this talk, I will present our study and discuss some of the approaches we are taking to target these behaviours in an introductory physics lab.

FG06: 2-2:10 p.m. Evaluating Scientific Learning Community Labs at The University of Toledo

Contributed – Adam C. Lark, University of Toledo, McMaster Hall, Rm 2017, 2801 W. Bancroft, Toledo, OH 43606-3390; adam.lark@rockets.utoledo.edu

For three years The University of Toledo has been piloting our version of The University of Maryland's Scientific Community Labs (SCL) with the intent of replacing our traditional Real Time Physics Labs. This semester (fall 2013) we are running a full study comparing the SCL to the Traditional Labs. Using standard measures such as the Force Concept Inventory (FCI) and Colorado Learning Attitudes about Science Survey for Experimental Physics (E-CLASS) surveys as well as interviews meant to gauge a student's procedural learning, we can compare both classes for changes in each throughout the semester.

Session FH: PER: The Birth of a Subdivision of Physics

Location: Pavilion West
Sponsor: Committee on History and Philosophy in Physics
Date: Wednesday, July 17
Time: 12:30–2:30 p.m.

Presider: Ruth Howes

FH01: 12:30-1 p.m. Are We There Yet?

Invited – Dewey I. Dykstra, Jr., Boise State University, Physics Department, MS 1570, Boise, ID 83725-1570; ddykstra@boisestate.edu

The story from participation in what we now call Physics Education Research (PER) reveals challenges faced by the field since its beginnings in the late 1960s, early 1970s. PER is not from a bifurcation of an existing field of physics. Instead, it is a brand new field in physics. As such, PER has faced, and still faces, challenges of a different sort than one would expect in a bifurcation. Some of these challenges will be described from the perspective of a member of the field since near its beginning.

FH02: 1-1:30 p.m. Physics Education Research in Tecnologico de Monterrey: A Case Study

Invited – Genaro Zavala, Tecnologico de Monterrey, E. Garza Sada, 2501 Monterrey, NL 64849 Mexico; genaro.zavala@itesm.mx

The history of Physics Education Research (PER) in other countries is shorter than that in the United States. In some countries the activity is non-existent and/or PER is not recognized as a research subdivision of physics by physics communities. In this talk I will present the case of Mexico focusing in a city, Monterrey, and in an Institution, Tecnologico de Monterrey. Although the emphasis will be on only one institution, however, the history of PER in Tecnologico de Monterrey is strongly linked to the history of PER in Mexico since PER, unlike Physics Education which has a long tradition, is present in a small number of institutions in the country.

FH03: 1:30-2 p.m. A Community-based Report of the Developmental History of PER

Invited – Karen Cummings, 501 Crescent St., New Haven, CT 06511; cummingsk2@southernct.edu

In the fall of 2010 I was asked to put together a report on the developmental history of the field of Physics Education Research which I presented to the National Research Council of the National Academies of Sciences, Committee on the Status, Contributions, and Future Directions of Disciplined-Based Education Research (DBER). A goal of the committee (with funding from the NSF) was to gain a broad view of the historical development, current status, and future directions of the various DBER fields. The history that I compiled and reported is information I gathered from more than 20 people who are, or were, active in the development of the PER community. In this talk I will summarize this work and compare the development of PER with other DBER fields. Unique developmental aspects of PER that I believe have been crucial in the relative success of the field will be highlighted.

FH04: 2-2:30 p.m. Establishing a PER Group in a Physics Department: An Example

Invited – Lillian C. McDermott, University of Washington-Seattle, Department of Physics, Seattle, WA 98195; lcmcd@phys,washington,edu

From the early 1970s onward, the Physics Education Group in the Physics Department at the University of Washington (UW) has worked toward establishing physics education research (PER) as an appropriate field for scientific inquiry in physics departments. In 1999 APS and AAPT issued a joint resolution in strong support of PER by physics faculty, post-docs, and graduate students. Since then, the field has grown rapidly. It is still difficult, however, to establish a viable group in PER, especially at research-intensive universities. The experience at UW may provide some helpful insights to others who may want to establish a PER group.

Session FI: Physics & Society

Location: Galleria III
Sponsor: Committee on Science Education for the Public
Co-sponsor: Committee on Space Science and Astronomy
Date: Wednesday, July 17
Time: 12:30–2:30 p.m.

Presider: Art Hobson

FI01: 12:30-1 p.m. The Internet, the Information Age, and Climate Science

Invited – Andrew L. Rice, Portland State University, Department of Physics, Portland, OR 97207-0751; arice@pdx.edu*

The Internet has led to an unprecedented availability of information and, with the emergence of “smart” phones, this information is literally at our fingertips at all times. This accessibility of information facilitates an open exchange of ideas and opinions through online dialogs between like-minded citizens who share similar core values and world views. Yet this is not without repercussions. Much of the information available online is without filter, subject to author bias and, at worst, intentionally misinformative. There are few scientific fields today more subject to this than climate science. In this talk we examine the origins of information on climate science on the Internet and how it is disseminated. We also discuss different pedagogical approaches for addressing questions on climate science stimulated from online material. Finally, we examine widely circulated statements as case studies of the challenges educators face in addressing the spread of online misinformation about climate science.

*Sponsored by Art Hobson

FI02: 1-1:30 p.m. Wacky or Real: What Are YOU Doing About It?

Invited – Erik Bodegom, Portland State University, Department of Physics, Portland, OR 97201; bodegom@pdx.edu

There are 7 billion people on Earth, most with crazy ideas, beliefs, and superstitions that spread quickly far and wide by e-means. Prior to the Pony Express, ideas spread slowly, haphazardly. Because of today’s flood of misinformation, junk science, and woo-woo, it is necessary that people are vaccinated against moronity. It is the mission of the sciences and philosophy to inoculate the masses, but are we failing? Even many notable scientists have shown a shocking lack of understanding, e.g., Josephson, Pauling, Shockley, Mullis, Lenard, Mullis, Watson, Giaever, P. Curie, and Collins. Why? We live under the pretense that we are more than “Cro-Magnon.” But are we?

FI03: 1:30-2 p.m. Another Look at Surprising Facts About Earth’s Current Population

Invited – A. James Mallmann, Milwaukee School of Engineering, 1025 North Broadway, Milwaukee, WI 53202-3109; mallmann@msoe.edu

Simple arithmetic can be used to present what would seem to be convincing evidence that Earth’s current population should not be viewed with any concerns that would inspire us to worry. But equally simple arithmetic can be used to show that that seemingly convincing evidence should be questioned. Which of these examples of contradictory evidence should be used as a guide to think about the current and future population of Earth?

FI04: 2-2:10 p.m. Using NYTimes Environmental Articles to Teach Physics

Contributed – John P. Cise, Austin Community College, 1212 Rio Grande St., Austin, TX 78701; jpcise@aol.com

For five years I have been using NYTimes articles on the environment to assist in teaching physics concepts. NYTimes articles are: pasted into word, edited to fit on one page, graphics added. Introduction, questions, hints, and answers are then added to the standard printable word page. All pages are available and printable at: http://CisePhysics.homestead.com/files/NYT.

htm. I use these NYTimes Physics concept applications for: introducing new contepts in class, quizzes, extra credit material for students to be done on own and submitted to me. Many other (than environment) NYTimes physics concept applications exist at this site. The site is listed as a resource for physics teachers at ComPADRE. http://CisePhysics.homestead.com/files/NYT.htm

FI05: 2:10-2:20 p.m. Using da Vinci's Machines to Demonstrate Physics at a Planetarium

Contributed – Pamela A. Maher, University of Nevada, Las Vegas, 4505 South Maryland Parkway, Las Vegas, NV 89154; maherp@unlv.nevada.edu

Janelle M. Bailey, University of Nevada, Las Vegas

Allan M. Tucka, College of Southern Nevada

This study seeks to address the nation's science, technology, engineering, and math (STEM) education needs by providing undergraduate students an opportunity to present physics concepts to patrons at a planetarium. Thirty (N=30) students taking a program of pre-engineering and calculus-based physics self-selected to participate in a grant-funded study at a two-year college in the Southwest. These student participants built a model of a da Vinci machine from a kit, designed an informational flyer aligned to state K-12 physical science standards, and presented informally to the general public attending a planetarium. Data were collected and qualitative analysis performed to assess students' perceptions toward speaking about physics concepts. Data were also collected from the general public to determine effectiveness of the presentations in communicating physics concepts. Results reveal the extent to which an opportunity to engage in scaffolded informal public speaking enhances participants' confidence and creates links between theory and practice.

FI06: 2:20-2:30 p.m. Teaching About the Electrical Grid in a First-Year Seminar

Contributed – Jack Dostal, Wake Forest University, PO Box 7507, Winston Salem, NC 27109; dostalja@wfu.edu

The First-Year Seminar program at Wake Forest University consists of small classes (15-19 students) for students of all disciplines. An emphasis is placed upon critical thinking, developing and deconstructing arguments, and considering different points of view through group discussions, presentations, writing, etc. I created the seminar "Power and the U.S. Electrical Grid" for this program. Students learn about the grid's history, nature, and underlying physics, including mechanisms of power generation (green and otherwise). Alternative power distribution systems in other countries are also investigated. Political and ethical issues are robust and far-reaching; we discuss historic issues ("War of the Currents") as well as current and future ones. In this talk I will describe the course structure, activities, and some lessons learned from teaching the course to a combination of prospective science and non-science majors.

Session FJ: Teacher Recruitment

Location: Galleria II
Sponsor: Committee on Teacher Preparation
Date: Wednesday, July 17
Time: 12:30–2 p.m.

Presider: David Rosengrant

FJ01: 12:30-1 p.m. Recruiting Without Recruiting – Leading by Example

Invited – Gay B. Stewart, University of Arkansas, Department of Physics, Fayetteville, AR 72701; gstewart@uark.edu

John C. Stewart, University of Arkansas

At University of Arkansas, Fayetteville, we have experienced an order of magnitude growth in the number of physics graduates, and a much larger growth in the number of teachers, from one per decade to five to eight per year. Until fall 2012, we did not have a recruitment program. Our philosophy has always been "If there is a reason we want teachers to teach that way, why don't we?" We revised the introductory sequence, and added a third class, based on a successful revision of the second-semester course for scientists and engineers. Students report their choice of teaching as a career to be something they considered since their faculty obviously considered the quality of education they received to be important. The strongest correlation with recruitment of majors appears to be agreement with the belief "I can teach science." Program details and results of the recent effort at recruiting will be presented.

FJ02: 1-1:30 p.m. Getting Physics Majors to Consider Teaching and Teacher Preparation Program

Invited – Chuhee Kwon, California State University, Long Beach, 1250 Bellflower Blvd., Long Beach, CA 90840; chuhee.kwon@csulb.edu

Galen Pickett, Laura Henriques, California State University Long Beach

We are using the outreach events established through the PhysTEC project, early teaching experience, and clear pathway to recruit majors to a teacher preparation program. Social mixers and open houses are held every semester for university students and faculty to interact with high school students and teachers. Demo-sharing is another monthly opportunity for students to get exposed to enthusiastic physics teachers. These events are fully embraced by the faculty, and physics majors are encouraged to consider teaching as a profession. PHYS 390 is an early teaching experience course for majors, and it is required to qualify for the Learning Assistant (LA) job opportunity. PHYS 390 and LA track allows physics majors a chance to learn how to teach, a special glimpse of what it is like to interact with students from an authoritative point of view, and a meaningful teaching experience before committing to a credential program.

FJ03: 1:30-2 p.m. When They Walk Into Your Office, Are You Ready?

Invited – Duane B. Merrell, Brigham Young University, n-143 ESC, Provo, UT 84602; duane_merrell@byu.edu

In 2004 the physics teacher preparation program was moved to the physics department at Brigham Young University. During this last school year the move to preparing physics teachers in the physics department has led to the mentoring of our 100th physics teacher in eight years. It seems that the way the students find us is varied but the one important piece is that they find us. This presentation will visit the the variety of different ways we help students to believe that they can complete and receive a physics teaching credentials.

Session GA: PER: Problem Solving

Location: Pavilion West
Sponsor: AAPT
Date: Wednesday, July 17
Time: 2:40–4:20 p.m.

Presider: Geraldine Cochran

GA01: 2:40-2:50 p.m. Influence of Visual Cueing and Feedback on Physics Problem Solving*

Contributed – Amy Rouinfar, Kansas State University, Department of Physics, 116 Cardwell Hall, Manhattan, KS 66506; rouinfar@phys.ksu.edu

Jeffrey Murray, Adam M. Larson, Lester C. Loschky, N. Sanjay Rebello, Kansas State University

Research has demonstrated that using visual cues to focus students' attention on relevant areas in diagrams and animations can increase comprehension and facilitate problem solving. In this study we investigate the effectiveness of visual cues and correctness feedback in conceptual physics problems containing a diagram with respect to comprehension and transfer of physics concepts. Students enrolled in an introductory physics course were individually interviewed. During each interview students worked through sets of problems containing a diagram. Each problem set contained an initial problem, six isomorphic training problems, and a transfer problem. Answers and explanations were given verbally. Students in the cued conditions saw visual cues on the training problems, and those in the feedback conditions were told if their responses were correct or incorrect. We discuss the influence of both cueing and feedback on students' answers and attention.

*This work is supported by the National Science Foundation under grant 1138697 as well as the KSU NSF GK-12 Program under grant NSF DGE-0841414.

GA02: 2:50-3 p.m. Tracking Eye Movements While Viewing Motion Graphs

Contributed – Jennifer L. Docktor, University of Wisconsin-La Crosse, Department of Physics, 1725 State St., La Crosse, WI 54601; jdocktor@uwlax.edu

Jose Mestre, University of Illinois at Urbana-Champaign

Elizabeth Gire, University of Memphis

N. Sanjay Rebello, Adrian Madsen, Kansas State University

Multiple representations are important for learning physics concepts and solving problems (e.g. interpreting text, equations, pictures, diagrams, and/or graphs), yet students often struggle to make sense of these representations. This study investigates how introductory students and graduate students view and interpret motion graphs. Participants viewed several graphs of position, velocity, or acceleration on a computer screen and were asked to match a region of the graph with a description of the object's motion. We compare performance on the questions with audio-recorded explanations and eye movements recorded using an eye tracker.

GA03: 3-3:10 p.m. A Meta-analysis of Brain-Behavior Correlations in Problem Solving

Contributed – Jessica E. Bartley, Florida International University, 11200 SW 8th St., CP 204, Miami, FL 33199; jbart047@fiu.edu

Angela R. Laird, Eric Brewe, Florida International University

Human brain mapping methods offer the opportunity to provide biological evidence of student engagement in physics conceptual reasoning and problem solving tasks. We identified brain networks associated with physics problem solving via a quantitative meta-analysis of component cognitive processes such as deductive reasoning, spatial skills, and mathematical calculations. This study assembled functional magnetic resonance imaging (fMRI) data from the BrainMap database [1] and used computational data mining techniques to identify the neural correlates associated with these cognitive processes. The present results were designed to provide groundwork for larger fMRI work in the domain of PER. Ultimately, we aim to use this work as the first phase of a study seeking to identify biological evidence to operationalize engagement, embodied experience, and conceptual metaphor in physics problem solving.

1.A.R. Laird ,J.L. Lancaster, P.T. Fox, "BrainMap: The social evolution of a human brain mapping database," *Neuroinformatics* 2005, 3:65-78

GA04: 3:10-3:20 p.m. Emphasis on 'Basic' Skills in Problem Solving Sessions

Contributed – Brianne N. Gutmann, University of Illinois-Urbana Champaign, 307 W Elm St., #2, Urbana, IL 61801; bgutman2@illinois.edu

Gary Gladding, University of Illinois-Urbana Champaign

In a supplementary class that aims to help struggling students with problem solving, I have replaced some of the problem practice with basic skill practice, instead. Most of the students are potentially high risk to fail our introductory mechanics class, as flagged by a diagnostic test given to incoming freshmen. They have completed a preparatory class prior to this course, and take this extra class concurrently with mechanics. It is usually focused on problem-solving strategies and lots of practice solving problems. This time, I am treating half of the sections traditionally, while the other half spend some of their time working "easier" problems: old exam problems that most students did really well on, but failing students did poorly on. This work includes a short quiz and a packet of related problems. I will discuss how this affected their performance in their mechanics course.

GA05: 3:20-3:30 p.m. The Role of Participation in Experimental Design and Problem Solving

Contributed – Binod Nainabasti, Florida International University, 11200 SW 8 St., VH 173, Miami, FL 33199; bnain001@fiu.edu

David T. Brookes, Florida International University

The context of this study is a calculus-based introductory college physics course that is a studio-format course implementing the Investigative Science Learning Environment (ISLE). Our study analyzes students' interactions as they work together in groups, engaging in experimental design and how their interactions are related to their problem-solving performance in exams. Students are first given an experimental design problem. They must solve the design problem and learn new physics by working together in groups of three and collaborating together as a whole class. A day later they take an individual exam in which one of the problems is related to the experimental design problem they encountered previously. Using video data, we identify different ways in which students participate in group discussions when they engage in the experimental design problem. We then see if there are patterns in their participation that are connected to their performance on the related exam question.

GA06: 3:30-3:40 p.m. Team-based and Project-based Learning in a Flipped Introductory Physics Class

Contributed – Carolann Koleci, Harvard University, 29 Oxford St., Cambridge, MA 02138; ckoleci@seas.harvard.edu

Eric Mazur, Kelly Miller, Harvard University

Yoo Junehee, Seoul National University/Harvard University

Have you ever considered doing away with lectures and traditional exams? Imagine a class in which there are no formal lectures and no exams. Envision students coming prepared for class. Instead of memorizing strands of equations or regurgitating concepts, students take ownership of their learning. They become passionate about learning physics because month-long projects provide the motivation for the learning. What if conceptual learning gains in such a class were more than double that of a traditional class? Welcome to Applied Physics 50, our introductory applied physics course that is team-based and project-based.

GA07: 3:40-3:50 p.m. Lens to Learning: Class-wide Video Analysis of Peer Instruction Dscussions

Contributed – Laura Tucker, Harvard University, 29 Oxford St., Pierce Hall 293, Cambridge, MA 02138; ltucker@seas.harvard.edu

Rachel Scherr, Seattle Pacific University

Eric Mazur, Harvard University

Numerous studies show courses taught using Peer Instruction have higher learning gains than traditional courses on standardized assessments. Yet we have very few measurements of what actually happens during the peer discussion component of this pedagogy. To address this need, we recorded every student discussion in nearly every lecture of an introductory physics course at a major research university. We will present results from analysis of these student conversations, providing insight on discussion behavior over different questions. In addition, we will illustrate the interesting case of "discovery conversations," in which all students in a group answer incorrectly in the initial poll and discuss only among their group, but one or more group members answer correctly after discussion.

GA08: 3:50-4 p.m. Investigating the Construction and Effectiveness of Student Notecards

Contributed – Timothy L. McCaskey, Columbia College, Chicago, Department of Science and Mathematics, 600 S. Michigan Ave., Chicago, IL 60605; tmccaskey@colum.edu

In a previous study, I allowed introductory physics students to create a notecard for their midterm and final exams in an attempt to remove equation memorizing as a focus of the course. I hoped to use the study of these cards as an epistemological lens that would uncover their perceptions and attitudes about the course. Without follow-up questions, though, epistemology remained unclear. I have continued the study by adding anonymous survey questions that probe why students chose to include what they did, how (if at all) the card was helpful, and how their card preparation changed throughout the semester.

GA09: 4-4:10 p.m. A Zero Transfer Worked Example Experiment

Contributed – Noah Schroeder, University of Illinois, 1110 W. Green St., Urbana, IL 61801; noschroeder@gmail.com

Tim Stelzer, University of Illinois

Worked example research often measures effectiveness by assessing student understanding through a near transfer problem. Failure has been attributed to many things, among them student overconfidence in understanding a given worked example. This experiment directly measured this overconfidence by assessing students with a "zero transfer" task. In this experiment, students were shown a worked example to a homework problem, and then asked later on to reproduce the worked example. Results, including student performance and confidence ratings, will be shown.

GA10: 4:10-4:20 p.m. Exploring Different Course Formats Via AP Scores and Epistemic Games

Contributed – Jonathan V. Mahadeo, Florida International University, 1433 Banyan Way, Weston, FL 33327; jmaha001@fiu.edu

Adrienne L. Traxler, Eric Brewe Florida, International University

For this project we used the advanced placement (AP) grading system to evaluate university student responses for an AP Physics problem on a common final exam given to six separate introductory course sections. The sections were grouped into Inquiry based (IQB), lecture/lab/recitation (LLR), and lecture/lab (LL) course formats. Via the AP grading rubric, we found that each of the course types scored statistically differently with IQB highest, lecture/lab second, and lecture/lab/recitation third. To extend the interpretation of these differences, student work was subjected to a secondary analysis using the framework of epistemic forms and epistemic games.[1] In this secondary analysis, we interpret written student responses as evidence of student moves in six types of knowledge-constructing games. We code differences between student problem solutions to identify different epistemic games being played. These data are interpreted in conjunction with scores on the AP problem to identify trends by course format.

1. J. Tuminaro and E.F. Redish "Elements of a cognitive model of physics problem solving: Epistemic games." *Physical Review Special Topics-Physics Education Research* **3**.2 (2007): 020101. DOI: 10.1103/PhysRevSTPER.3.020101 Florida International University Physics Education Group NSF Award 0802184 HHMI Award 52006924

Session GB: Quantum & Condensed Matter Labs Beyond the First Year

Location: Broadway I/II
Sponsor: Committee on Laboratories
Co-Sponsor: Committee on Physics in Undergraduate Education
Date: Wednesday, July 17
Time: 2:40–4:20 p.m.

Presider: Gabe Spalding

GB01: 2:40-3:10 p.m. Measuring the Phonon Spectrum of Silicon Using a Tunnel Diode

Invited – Kurt Vandervoort, California State Polytechnic University, Pomona, Physics and Astronomy, 3801 W. Temple, Pomona, CA 91768; kvandervoort@csupomona.edu

An experiment was developed for our senior-level laboratory to examine the properties of a tunnel diode. Tunnel diodes were invented in the late 1950s and represented the first way to produce a junction that allowed reproducible measurements of the tunneling current. The students perform two experiments to examine the properties of this unique device. They measure the room temperature current vs. voltage curve which reveals a region of negative dynamic resistance (where increasing voltage leads to decreasing current). They also measure the first and second derivatives of the I-V curve for a diode immersed in liquid nitrogen, revealing peaks at voltages associated with energies of phonons assisting in the tunneling process. As a primary goal of the course, students are introduced to precision circuits and instrumentation, namely, a dual-phase lock-in amplifier, and precision multimeters interfaced through the LabVIEW programming language.

GB02: 3:10-3:40 p.m. Diode Laser-based Experiments in Rubidium Vapor for the Advanced Laboratory

Invited – Shannon Mayer, University of Portland, 5000 N Williamette Blvd., Portland, OR 97203; mayers@up.edu

Saturated absorption spectroscopy, performed on the 5S1/2 - 5P3/2 transition in rubidium vapor (wavelength = 780.24 nm), has become a common experiment in the advanced laboratory. We describe three additional experiments that can be performed in rubidium using grating-feedback diode lasers. The first experiment uses a single laser operating at 778.1 nm to investigate the 5S1/2 - 5D5/2 two-photon transition in rubidium. The experiment yields Doppler-free spectral features and provides students with an opportunity to investigate electric dipole selection rules. The second experiment uses two lasers (wavelength = 780.24 nm and wavelength = 776.0 nm) to coherently control photons via electromagnetically induced transparency (EIT). In the third experiment two lasers are used to generate a collimated beam of blue light with high temporal and spatial coherence. This collection of experiments introduces students to contemporary topics in nonlinear optics and quantum coherence while utilizing equipment from the absorption spectroscopy laboratory.

GB03: 3:40-3:50 p.m. Numerical Experiments for Statistical Physics: Adjuncts to the Laboratory

Contributed – Norman Chonacky, Yale University, Department of Applied Physics, Becton Center, New Haven, CT 06520-8284; norman.chonacky@yale.edu

Marie Lopez del Puerto, University of St. Thomas

Based upon a national survey[1] of the use of computation in undergraduate physics departments, there is clear evidence that computational methodology is not an integral part of courses as are theory and experiment. This is most marked at the upper-division level where experiments are also underrepresented and theory dominates. I ask, does this service our undergraduate majors well? I present computational statistical physics exercises[2] as examples appropriate for both lecture and laboratory, and that aspire to bridge that gap between theory and experiment while better serving the needs[3] of all undergraduate physics majors.

1. R.G. Fuller, "Numerical computations in U.S. undergraduate physics courses," *Comput. Sci. Eng*. **8** (5), 16-21 (2006).
2. N.J. Chonacky and M. Lopez del Puerto, "Statistical Physics:" Partnership for Integration of Computation into Undergraduate Physics (PICUP) http://www.compphysicsed.org/statistical_physics.php (2012).
3. R. Ivie and K. Stowe "The Early Careers of Physics Bachelors", American Institute of Physics, College Park, MD 20740-3843, (2002).

GB04: 3:50-4 p.m. Two-Dimensional Advanced Laboratory Thermodynamics Experiment

Contributed – Patrick G. McDougall, California State University, Chico, 400 W 1st St., Chico, CA 95929; p.mcdougall1988@gmail.com*

Eric Ayars, California State University, Chico

We present a novel apparatus for two-dimensional heat flow measurements in an undergraduate Advanced Lab or thermodynamics course. The apparatus uses an Arduino microcontroller to measure temperatures to high precision at 100 points on a square metal plate in real time. This temperature and time data can then be compared with computational solutions to the heat equation for the metal plate. The combination of thermodynamics, computational modeling, and experimental measurement provides an interesting (and challenging!) Advanced Lab experiment.

*Sponsored by Eric Ayars

GB05: 4-4:10 p.m. The Rich Physics of the Semiconductor Diode I-V Characteristics

Contributed – Herbert Jaeger, Miami University, Department of Physics, Oxford, OH 45056; jaegerh@MiamiOH.edu

Recording the I-V characteristics of a semiconductor diode sounds like a simple enough task, yet it is rich in physics and provides a multitude of learning opportunities for students at every level. At the basic level, the measurement can be performed at room temperature with a battery and a multimeter. A more sophisticated approach could involve an electronic current-to-voltage converter with variable gain and automated data acquisition. Data analysis ranges from simple observation of the turn-on voltage to a complex non-linear fitting procedure. This talk will present variations on the theme and show how this simple experiment can be used at the introductory level as well as make appearances at the more advanced level.

GB06: 4:10-4:20 p.m. 2-D and 3-D Random Walk Simulations of Stochastic Diffusion

Contributed – Bob Brazzle, Rockwood Summit High School, 1780 Hawkins Road, Fenton, MO 63026; brazzlerobert@rockwood.k12.mo.us

I will describe a physical Monte Carlo simulation using a number cube and a lattice of concentric rings of tiled hexagons. At the basic level, it gives students a concrete connection to the Statistical Mechanics concept of stochastic diffusion. I will also present a simple algorithm that can be used to set up a spreadsheet to track the evolving concentration of simulated "particles" (in contrast with the physical simulation, which tracks a single particle's motion). Although setting up the spreadsheet involves only elementary mathematics, it is robust enough to allow one to demonstrate or "discover" Fick's first law, and a discretized version of the stochastic diffusion equation. Upper-level undergraduates could thus use the spreadsheet to independently explore relevant advanced concepts (e.g. flux and diffusion gradient). A paper to be published in AJP describes this simulation as well as several extensions: lattices with different geometries in two and three dimensions.

Session GC: Facilitating Faculty Change Through Research

Location: Broadway III/IV
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Physics in Undergraduate Education
Date: Wednesday, July 17
Time: 2:40–4:40 p.m.

Presider: Eric Brewe

GC01: 2:40-3:10 p.m. Developing a Research-based Model for Educational Transformation

Invited – Melissa Dancy, University of Colorado, Boulder, CO 80305; melissa.dancy@gmail.com

Charles Henderson, Western Michigan University

Through multiple projects over many years, we have investigated why physics education-based reforms have had limited impact on mainstream faculty. Our research highlights limitations of the typical development and dissemination model of reform and offers insights into a research-based model for achieving effective and sustained reform. In this talk we summarize our findings, including reasons for the limited impact of reforms. We then offer suggestions, based on our findings, for a more effective change model.

GC02: 3:10-3:40 p.m. Physics Faculty Expectations for Undergraduate Physics Majors

Invited – Renee Michelle Goertzen, Florida International University, 11200 SW 8th St., VH 169, Miami, FL 33199; rgoertze@fiu.edu

As part of a project to investigate the goals that physics faculty hold for majors, 17 physics faculty were interviewed about what attitudes and abilities they expect students to have developed by the time they graduate with a Bachelor's degree. The various expectations that these professors have for their physics undergraduates fall into three groups: core knowledge and skills, broadly applicable skills, and culture of physics. The expectations that professors discuss in interviews contrast with the skills and knowledge typically assessed during an undergraduate physics degree, suggesting a need for more explicit dialogue among physics instructors about the expectations. The analysis suggests that some goals are both implicit and constructed in-the-moment in response to interview prompts. Understanding the nature of physics faculty expectations will allow us to better assess whether students meet these expectations, as well as whether physics programs' standards adequately capture faculty goals.

GC03: 3:40-4:10 p.m. Moving Beyond Telling Individual Faculty About Educational Innovations

Invited – Chandra A. Turpen, University of Maryland, College Park, MD 20740; turpen@umd.edu

Charles Henderson, Western Michigan University

Melissa Dancy, University of Colorado, Boulder

Educational researchers who are trying to change the way other people teach usually do so through the following strategy: They develop new ways to teach and share their innovations through journal articles and talks. Using these one-way communication mechanisms, they focus on telling other educators why lectures don't work, explaining their new methods, giving data on effectiveness of their new method, and sharing materials that others can use. Four findings from interviews with 35 faculty members from across the country suggest needed changes to this strategy: 1) Innovations often spread through informal interactions, 2) Adopters and educational researchers don't share a common understanding about innovations, 3) Faculty adopting innovations sometimes modify them without understanding the underlying motivation and structure, and 4) Depending on where faculty are in either adopting or adapting a new way of teaching, educators may see aspects of the innovation as either a barrier or a motivator.

GC04: 4:10-4:40 p.m. Complexity of Faculty Change in the FIU Science Collaborative*

Invited – Adrienne L. Traxler, Florida International University, 11200 SW 8th St., Miami, FL 33136; altraxle@fiu.edu

The FIU Science Collaborative is a four-year project to reform undergraduate science education across three departments at Florida International University. It drives institutional change through community building and faculty development. Interested professors and instructors apply to be "faculty scholars," undertaking major transformation of a class they teach to incorporate active learning. They also become involved in regular discipline-based education research (DBER) meetings with a wider community of STEM faculty. This project affords exciting opportunities and challenges in research on faculty change. I will discuss emerging themes from faculty scholars' work and how they tie in with current research on faculty development.

*Supported by HHMI #52006924

Session GD: PER: Student Reasoning and Topical Understanding

Location: Pavilion East
Sponsor: AAPT
Date: Wednesday, July 17
Time: 2:40–4:20 p.m.

Presider: MacKenzie Stetzer

GD01: 2:40-2:50 p.m. Probing Inconsistencies in Student Reasoning: Formal vs. Intuitive Thinking

Contributed – Nathaniel Grosz, North Dakota State University, Department of Physics, Fargo, ND 58108-6050; Nathaniel.C.Grosz@my.ndsu.edu

Mila Kryjevskaia, North Dakota State University

MacKenzie R. Stetzer, University of Maine

Even after targeted instruction, many students still struggle to productively and consistently analyze unfamiliar situations. We have been designing sequences of questions that allow for an in-depth examination of inconsistencies in student reasoning approaches. Our results indicate that even those students who do possess the knowledge and skills necessary to analyze many challenging situations correctly often fail to utilize relevant ideas and skills productively; students tend to "abandon" their correct formal reasoning approaches in favor of more intuitive solutions (perhaps more appealing to them at that moment). We will present results from sequences of questions administered in introductory calculus-based physics courses.

GD02: 2:50-3 p.m. Physics Reasoning: Biases Toward the Most Available Variable

Contributed – Andrew F. Heckler, Ohio State University, 181 W Woodruff Ave., Columbus, OH 43210; heckler.6@osu.edu

Abigail M. Bogdan, Ohio State University

It has been demonstrated in a number of everyday contexts that when reasoning about causes of simple phenomena, people tend to only consider explanations that are the most available in their memory. Thus, even if people know that two factors can influence an outcome, they often only consider the one that is most available. We demonstrate this phenomenon in the physics education context. Specifically, when students are asked to determine explanations for the variation of some quantity, such as the tipping of a balance scale, or the mass density of a material, they tend to only consider the most available variable that causes the variation, even in cases when that variable is physically non-causal. However, when interviewed further, students are often able to reason about alternative explanations and other potential variables. We discuss a range of known student difficulties in physics in terms of this reasoning bias phenomenon.

GD03: 3-3:10 p.m. Effects of Belief Bias on Causal Reasoning from Data Tables

Contributed – Abigail M. Bogdan, The Ohio State University, 191 West Woodruff Ave., Columbus, OH 43210; bogdan.22@osu.edu*

Andrew F. Heckler, The Ohio State University

Students often fail to draw valid conclusions from simple tables of experimental data. Our research suggests that part of their struggle might be caused by the influence of prior beliefs. In this study, students were asked to either verify or construct a claim about a causal relationship between several variables based on information presented in data tables. We found that students demonstrated belief bias in the ways they chose to cite data, frequently treating their own theories as a source of evidence to be supplemented by or illustrated with examples from data. Because of this tendency to hunt piecemeal through the tables for supporting examples, contradictory data was often simply overlooked. However, even when noticed, data that contradicted their theories was often ignored, misinterpreted to conform, or discounted in some way.

*Sponsored by Andrew F. Heckler

GD04: 3:10-3:20 p.m. Effects of Training Examples on Understanding of Force and Motion

Contributed – Daniel R. White, The Ohio State University, 191 W Woodruff Ave., Columbus, OH 43210; drwhite@mps.ohio-state.edu

Andrew F. Heckler, The Ohio State University

We examined the effects of various kinds of training tasks on student responses to questions about the relationship between the directions of net force and velocity, and between acceleration and velocity in one dimension. The four training conditions were constructed in a 2x2 design (abstract vs. concrete contexts) x (acceleration-velocity vs. force-velocity question types), and a control (no training) was also included. We found that all training conditions significantly improved performance on all question types compared to control, however acceleration-velocity training resulted in higher performance on all question types compared to force-velocity training. Additionally we found that the degree of abstraction of the training (that is, the number of concrete details included in the example) has no significant effects on student scores. These results are consistent with hierarchies of student understanding of force and motion in previous works, which we also discuss.

GD05: 3:20-3:30 p.m. Effectiveness of Computer-based Training on Vector Products

Contributed – Brendon D. Mikula, The Ohio State University, 191 W. Woodruff Ave., Columbus, OH 43210; bdmikula@gmail.com

Andrew F. Heckler, The Ohio State University

Computer-based training on dot products and cross products was given to N=223 students in an introductory level, calculus-based electromagnetism course at The Ohio State University. The level of feedback in training was varied as follows: no training (control), correctness feedback, correctness and correct answer feedback, correctness and explanation feedback. Training lasted for approximately 10 minutes, and a paper assessment was given immediately afterwards. This assessment consisted of both arrow format questions, similar to those in the training, and conceptual/transfer questions related to vector products selected from the Vector Concept Test (Zavala & Barniol). All training conditions significantly outperformed control on both question types ($d > 0.46$). Consistent with VanLehn's interaction plateau hypothesis, high-level feedback was significantly more effective than low-level feedback for arrow notation questions ($d = 0.35$) and no significant difference was observed between the high-level feedback conditions for either question type.

GD06: 3:30-3:40 p.m. Student Reasoning on Gravitational and Electrostatic Potential Energy

Contributed – Beth A. Lindsey, Penn State, Greater Allegheny, 4000 University Drive, McKeesport, PA; 15132 bal23@psu.edu

Potential energy is a conceptually rich topic presenting many difficulties for students. Recent research has identified many difficulties relating to work, energy, and systems. Failure to reason correctly about potential energy may underlie many of these difficulties. I will describe an investigation into student understanding of potential energy as typically presented in the context of universal gravitation or electrostatics. I will discuss the connections between student understanding of potential energy in mechanics and their subsequent performance in electricity and magnetism. I will present data from written questions and from one-on-one student interviews, and discuss the implications these data have for instruction on energy in introductory courses.

GD07: 3:40-3:50 p.m. Students' Initial Representations of Light in College Physics

Contributed – Craig C. Wiegert, University of Georgia, Department of Physics and Astronomy, Athens, GA 30602-2451; wiegert@physast.uga.edu

Cameron Zahedi, University of Georgia

We report on college physics students' prior diagrammatic knowledge about light propagation and optics. At the beginning of the second semester of introductory college physics, students were asked to draw a diagram of light being emitted in all directions from a small source. An analysis of these initial diagrams demonstrates the diversity of students' prior knowledge as well as the relative prevalence of some initial misconceptions in geometric and physical optics.

GD08: 3:50-4 p.m. How Students Combine Resources to Understand Solar Cells

Contributed – AJ Richards, Rutgers University, 136 Frelinghuysen Road, Piscataway, NJ 08854; richard6@physics.rutgers.edu

Darrick C. Jones, Eugenia Etkina, Rutgers University

We use the framework of resources to investigate how students construct understanding of a complex modern physics topic that requires mastery of several concepts. Specifically, we are interested in how students combine multiple resources as they reason about a solar cell. We video recorded preservice physics teachers learning about solar cells, analyzed their interactions, and studied how they activated and combined resources. Our findings show that certain combinations of resources can dramatically improve students' understanding and insight. This presentation will reveal these combinations and discuss possible implications for instruction.

GD09: 4-4:10 p.m. Cognitive Resources and Varied Expertise

Contributed – Darrick C. Jones, Rutgers, The State University of New Jersey, Department of Physics and Astronomy, 136 Frelinghuysen Road, Piscataway, NJ 08854-8019; dcjones@physics.rutgers.edu

AJ Richards, Eugenia Etkina, Rutgers

We compare the reasoning of individuals from different backgrounds with varying levels of physics expertise as they attempt to solve novel physics problems about solar cells, which incorporate advanced physics topics including complex circuits and semiconductor physics. By performing a fine grained analysis on the video recordings of the problem-solving sessions, we determine what resources individuals used when reasoning about solar cells. We analyze how resource activation differed between individuals and how this influenced overall reasoning strategies. We present the results of the study and discuss implications they have for instructional design.

GD10: 4:10-4:20 p.m. Transfer of Physics Learning to Various Disciplinary Contexts

Contributed – Bijaya Aryal, University of Minnesota-Rochester, 300 University Square, 111 S. Broadway, Rochester, MN 55904; baryal@umn.edu

Robert Dunbar, Rajeev Muthyala, Aminul Huq, Starr Sage, University of Minnesota-Rochester

This study reports on the utility of using various disciplines as vehicles to deliver concepts within physics classes. Specifically we explore the degree to which students' transfer concepts from physics into various disciplinary contexts such as anatomy/physiology, chemistry, mathematics, and public health. The research design includes three phases of learning activities: concept learning, context introduction, and transfer of physics learning task incorporated into multidisciplinary integrated learning modules. Qualitative and quantitative data will be presented to describe the impacts of the various strategies employed at one or more stages of the learning activities used. We report on the impact of altering the level of concreteness of activities at concept learning stage and real world vs abstract example in the context stage on student transfer of physics learning. We also discuss our finding that the extent to which students use or transfer physics concepts varies with disciplinary contexts.

Session GE: Upper Division and Graduate

Location: Salon Ballroom II/III
Date: Wednesday, July 17
Time: 2:40–4 p.m.

Presider: Steve Turley

GE01: 2:40-2:50 p.m. A Revised and Improved Junior 'Careers' Course for Physics Majors

Contributed – Richard W. Robinett, Penn State University, Department of Physics, 104 Davey Lab, University Park, PA 16802; rick@phys.psu.edu

We describe the revised format and structure of a junior "careers" course required of all physics majors at Penn State University. The course is designed to provide "background on career choices available with an undergraduate physics degree, including employment opportunities, planning for graduate study, and tailoring the physics curriculum to meet career goals." Additional topics include scientific literacy and communication skills (including technical word processing) and the ethical conduct of research. We describe the variety of classroom activities and homework assignments used to address the course goals. We note how the class also provides an opportunity for assessment of larger curricular goals within the physics degree program.

GE02: 2:50-3 p.m. A Structured Approach to Special Relativity: Simultaneity, and Four Vectors

Contributed – Deepthi Amarasuriya, Northwest College, 231 W.6th S., Bldg. 24, Powell, WY 82435-1887; deepthi.amarasuriya@northwestcollege.edu

Within the first few weeks of a Modern Physics course students are assigned a variety of exercises on Special Relativity. In addition to dealing with counter-intuitive concepts, students are expected to first use the appropriate mathematical formalism to convert given data into simple equations. At this introductory stage, their natural tendency is to fall back upon Newtonian notions of space and time, together with the equations of classical mechanics. In the absence of appeals to intuition, it is crucial that instructors properly guide students' thinking along unfamiliar lines by providing systematic approaches to problems on Special Relativity. In this talk, I present some approaches that I have successfully used in my Modern Physics course to do problems involving simultaneity, and the energy-momentum four vector.

GE03: 3-3:10 p.m. Capstone Course: Physics of Sustainability

Contributed – Mary M. Brewer, William Jewell College, 500 College Hill, Liberty, MO 64068; brewerm@william.jewell.edu

As part of a curriculum revision of the physics major at William Jewell College, the department developed a capstone course for the major, The Physics of Sustainability, which was taught for the first time during the spring 2013 semester. The purpose of this course is to synthesize many facets of physics, including mechanics, fluids, optics, electronics, material science and nuclear physics, within the context of sustainable energy. The course integrates material from earlier in the curriculum with new topics and more in-depth theory, as well as practical applications. The students plan, construct, and monitor both solar and wind systems. This talk will focus on the content and structure of the course and the student response to this first offering.

GE04: 3:10-3:20 p.m. Learning through Computation in Upper-Division Physics

Contributed – David Roundy, Oregon State University, 301 Weniger Hall, Corvallis, OR 97331; roundyd@physics.oregonstate.edu

I will describe a computational laboratory course that I have developed to help students in learning upper-division courses. The course runs in parallel to their junior year courses, covering the same physics topics and many of the same mathematical methods. Students work in pairs, and write their programs with little guidance from the instructor. Results from less than two years of teaching this course suggest that students find it helpful, including students who join our program with no computer programming experience.

GE05: 3:20-3:30 p.m. Of Cats and Students: Discovering Quantum Information with Undergraduates

Contributed – Jean-Francois S. Van Huele, Brigham Young University, N151 ESC, BYU, Provo, UT 84602-4681; vanhuele@byu.edu

Can you violate the Heisenberg uncertainty relation? How do quantum operations work? What new insight does weak measurement provide? What restrictions exactly apply to cloning? When does entanglement come in handy? And what's a quantum Cheshire cat? Quantum theory has evolved significantly beyond its traditional coverage in the physics curriculum. About all that we need to constrain quantum mysteries are linear algebra and creative thinking. This turns quantum information into fertile ground for undergraduate research projects and teaching. I review my experience with students and their projects and give examples on how to ask questions of current relevance in quantum theory and get the students to answer them.

GE06: 3:30-3:40 p.m. Thermally Induced Structural Change Measured by Holographic Non-Destructive Testing

Contributed – Ralph E. Oberly, Marshall University, One John Marshall Drive, Huntington, WV 25755; oberly@marshall.edu

Anthony Hernandez, Marshall University

This project is to observe the structural change of a rigid body using holographic non-destructive testing. Through the application of a specific voltage to a Peltier heating and cooling device, it is possible to produce a controlled temperature change on the surface of the object. Using the technique of double-exposure, a hologram can be generated that shows an interference pattern between the shape of the original object at rest and its shape after some sort of physical deformation. The goal is to view the way that heat propagates through a three-dimensional object using this technique, and the object's physical deformation over time with respect to controlled temperature change.

GE07: 3:40-3:50 p.m. On-Ramp: Improving Students' Understanding of Lock-In Amplifiers*

*Contributed – Seth T. DeVore,** University of Pittsburgh, Department of Physics and Astronomy, Pittsburgh, PA 15213; std23@pitt.edu*

Chandralekha Singh, Jeremy Levy, University of Pittsburgh

A lock-in amplifier is a powerful and versatile instrument frequently used in condensed matter physics research. However, many students struggle with the basics of a lock-in amplifier and they have difficulty in interpreting the data obtained with this device in diverse applications. To improve students' understanding, we are developing an "On-Ramp" tutorial based on physics education research which makes use of a computer simulation of a lock-in amplifier. During the tutorial's development we interviewed several faculty members and graduate students. The tutorial is based on a field-tested approach in which students realize their difficulties after predicting the outcome of experiments that use a lock-in amplifier; students can check their predictions using simulations. The tutorial then guides students towards a coherent understanding of the basics of a lock-in amplifier. In this talk the development and assessment process will be discussed.

*Supported by the National Science Foundation.

**Sponsored by Chandralekha Singh

GE08: 3:50-4 p.m. The Demographics and Experiences of Graduate Students in PER

Contributed – Ramon Barthelemy, Western Michigan University, 1903 W. Michigan Ave., Kalamazoo, MI 49009; ramon.s.barthelemy@wmich.edu

Charles Henderson, Western Michigan University

Ben Van Dusen, University of Colorado Boulder

Statistical data on the numbers, demographics, and experiences of graduate students in physics are well documented. However, in these assessments one sub-field is often left out, physics education research (PER). Currently no data exists on the composition of students in PER. This includes the number of graduate students, the departments they are housed in, their gender, their race, their experiences and more. This talk will present the first empirical study focusing on the experiences and demographics of students in PER.

Session GF: Lessons from Successful Professional Development for Successful Teacher Preparation

Location: Parlor A/B
Sponsor: Committee on Teacher Preparation
Date: Wednesday, July 17
Time: 2:40–4:10 p.m.

Presider: Karen Jo Matsler

GF01: 2:40-3:10 p.m. AAPT/PTRA Professional Development for 4th-8th Grade Teachers*

Invited – Steven L. Shropshire, Idaho State University, Department of Physics, Pocatello, ID 83209; shrostev@isu.edu

Jan Mader, Great Falls High School

Karen Jo Matsler, Educational Assessment and Training, Inc.

The Physics Teaching Resource Agents (PTRA) program developed by the AAPT has served as a successful professional development (PD) model for high school physics teachers since 1985. In Idaho, this model has been applied to PD for middle school teachers in physical science from 2008 to 2011, and to PD for elementary teachers in physical science and mathematics since 2011. Support from both programs has been provided by the Idaho Math Science Partnership. An overview of the AAPT/PTRA model for PD and how it was adjusted in Idaho to serve the needs of 4th-8th grade teachers will be presented. The impact of the program on teacher content knowledge and confidence, and on the academic performance of students of teachers who participated will be summarized.

*This program is supported by the Idaho State Board of Education Math and Science Partnership program.

GF02: 3:10-3:40 p.m. Lessons from GaDOE MSP and Improving Teacher Quality Professional Development

Invited – Bob Powell, University of West Georgia, Department of Physics, Carrollton, GA 30118; bpowell@westga.edu

Ann Robinson, David Todd, University of West Georgia

Sharon Kirby, Cherokee County Schools (retired)

The University of West Georgia has been successful during the last six years in receiving grants to provide professional development for area teachers from both improving teacher quality and the Georgia Department of Education MSP programs. The key characteristics of the proposal preparation are strong partnerships, justification for the need of professional development, letters of support, and meaningful content emphasizing hands-on activities. The AAPT/PTRA units on Kinematics and Dynamics, Energy and Momentum, Electricity and Magnetism, and Waves and Geometric Optics have been used for the curriculum and have been well received. Evaluations indicate improvement of both content knowledge and pedagogy skills.

GF03: 3:40-4:10 p.m. The AAPT/PTRA ToPPS Program at NWOSU

Invited – Steven J. Maier, Northwestern Oklahoma State University, 709 Oklahoma Blvd., Alva, OK 73717; sjmaier@nwosu.edu

Saeed Sarani, Oklahoma State Regents for Higher Education

In 2011, Northwestern Oklahoma State University began hosting AAPT/PTRA [1] summer institutes for Teachers of Physics and Physical Science (ToPPS).[2] Aligned with the state's STEM vision, ToPPS seeks to better prepare Oklahoma's future workforce through relevant professional development and to serve as a source of support for rural districts. While most participants are middle school teachers, others include teachers from elementary and secondary schools. For many participants, the NWOSU ToPPS program serves as the only physics teacher preparation they have had access to. The challenge of striking a balance among participants' varied expectations, prior knowledge, and teaching experiences has turned out to be the greatest asset of this program. In this talk, data on the effectiveness of the program will be presented followed by discussion of long-term goals (such as sustainability) and the implications/impact this program has already had on HS physics teaching in Oklahoma. [3]

1. www.aapt.org/Programs/projects/PTRA/
2. www.nwosu.edu/ToPPS
3. www.nwosu.edu/whiteboard

Session GG: Best Practices in Educational Technology II

Location: Galleria II
Sponsor: Committee on Educational Technologies
Date: Wednesday, July 17
Time: 2:40–4:30 p.m.

Presider: Frances Mateycik

GG01: 2:40-2:50 p.m. Clickers in Small Classrooms: A Help or Hindrance?

Contributed – Bradley S. Moser, University of New England, Department of Chemistry and Physics, Biddeford, ME 04005; bmoser@une.edu

Clickers are often viewed as beneficial to student learning, especially in large classes, where they help create an interactive environment. Are clickers unfailingly fruitful, or do they sometimes stymie successful instruction? At the University of New England, small Studio Physics classrooms and modeling instruction methods offer a highly engaging learning experience to students. In a classroom that already offers a compelling learning environment, are clickers a useful pedagogical tool or a redundancy? Drawing heavily upon Peer Instruction and PhET simulations, four instructors used a bank of questions aimed at ascertaining clicker effectiveness. Two instructors used clickers, while two others presented questions without the use of such technology. Style, implementation, and enthusiasm were varied. Gathering evidence in the form of clicker responses, assessment gains, student feedback, and instructor feedback, we scrutinized the relative contribution of clickers to student learning and offer our advice on best practices.

GG02: 2:50-3 p.m. Creating a Community of Nerds with Facebook Groups

Contributed – Eugene Torigoe, Thiel College, Greenville, PA 16125; etorigoe@thiel.edu

In 2011 I was the second member of a Facebook group created for people in the Allegheny College Physics Department. The group has grown to over 50 members and has become a forum to discuss physics news, to share jokes, and to ask questions. It has lowered the barrier of communication between faculty, students and alumni. This year I started another Facebook group for the Thiel College Physics Department, and it has been a very important tool we use to recruit students and connect with others in the community. I'll discuss how to set up a group, the benefits of having a Facebook group, and some of the challenges I've faced building a community.

GG03: 3-3:10 p.m. Improving Formative Assessment in High School Physics with Learning Catalytics

Contributed – Lisa Lamont, Windward School, 11350 Palms Blvd., Los Angeles, CA 90066; llamont@windwardschool.org

Simon Huss, Windward School

Brian Lukoff, Harvard University

The Windward Science and Technology Department has implemented Learning Catalytics* in its introductory physics classroom, utilizing this cloud-based audience-response platform to take formative assessment to the next level. Developed by Harvard researchers, Learning Catalytics greatly expands on existing clicker technology, offering additional means of assessing student comprehension. Windward faculty has integrated this tool into their existing student-centered, inquiry-based curriculum. The curriculum combines hands-on laboratory activities and demonstrations with formative assessments delivered via the Learning Catalytics platform. The program utilizes proven teaching strategies such as Physics Ranking Tasks and Interactive Lecture Demonstrations that are quickly delivered and evaluated using this unique system. The discussion will include Windward's experience with implementation, observed outcomes, and directions for future study, described in the context of two academic units.

*Please visit the Learning Catalyics website at: LearningCatalytics.com

GG04: 3:10-3:20 p.m. Does Electronic Homework Impact Students' Performance in College Physics?

Contributed – Emily S. Roth, Bradley University, 1501 W. Bradley Ave., Peoria, IL 61625; eroth@mail.bradley.edu*

Kevin R. Kimberlin, Jose Lozano, Bradley University

The purpose of this study is to get a better understanding of the impact that online homework versus hard-copy homework assignments have on performance in introductory algebra-based physics at Bradley University. An initial step in this study was to examine online homework effectiveness by analyzing factors such as homework completion time, homework scores, individual exam scores, average test scores, and initial Force Concepts Inventory (FCI) scores (N=29, Fall 2012), taught in the traditional format. In the spring of 2013 two sections of the course were conducted in a similar format; however one section used handwritten assignments, while the second used online assignments from Mastering Physics with the same problems (N~27). The results are presented in this work.

*Sponsored by Kevin Kimberlin

GG05: 3:20-3:30 p.m. Effective Use of LaTeX in High School Physics Assessment

Contributed – Joshua Gates, The Tatnall School, 5 E Brookland Ave., Wilmington, DE 19805; joshuagatesnc@yahoo.com

LaTeX markup language is used widely in academia and by college and university professors, but it isn't as widely known among high school teachers. The easily learned/easily Googleable syntax can make beautiful and flexible assessments. The author will present some basics, offer templates and libraries for use, and demonstrate how Python programming can be used to manage a database of problems—creating, displaying, and assembling them into assessments much more quickly than can be done with word-processing software (and with better results).

GG06: 3:30-3:40 p.m. Using Tablets in a Large-Enrollment Introductory Course

Contributed – Todd G. Ruskell, Colorado School of Mines, Physics Department, Golden, CO 80401; truskell@mines.edu

Many large-enrollment introductory physics courses now use personal response devices (clickers) to engage students during class and collect data for real-time formative assessment. However, most systems only allow for multiple-choice or in some cases numeric or simple text answers. A program called inkSurvey allows faculty to ask more open-ended questions and students can submit both text and graphical responses from tablet computers. This provides faculty much greater insight into a student's problem-solving process. In our pilot project standard clickers were used in the first half of a calculus-based physics I course, and in the second half of the semester, tablets and inkSurvey were used to collect formative assessment data. We will report on impressions of both the faculty and students regarding the relative utility and effectiveness of each tool in promoting higher-order thinking and improved class performance.

GG07: 3:40-3:50 p.m. Wireless Open Source Physics Laboratory Data Acquisition System

Contributed – Zengqiang Liu, Saint Cloud State University, 720 4th Ave. S WSB 311, Saint Cloud, MN 56301; zliu@stcloudstate.edu

A data acquisition system (DAQ) is critical to laboratory physics teaching but is often viewed as a black box and is expensive, which limits time and location for experiential learning to one to three hours of weekly scheduled session in lab rooms. With the AAPT award-wining open source physics laboratory (OSPL) DAQ, the cost is drastically reduced. OSPL promotes experiential learning beyond lab sessions and lab rooms, and provides students opportunities to learn "what's inside the box". The cost and labor of the newly designed OSPL 2.0 DAQ are $60 and one hour. OSPL 2.0 also features Bluetooth wireless data transfer and a polished new look. OSPL 2.0 includes a variety of accurate low-cost home-made sensors and an expanded list of compatible sensors from existing vendors. This provides huge opportunity for introductory physics laboratory curriculum development, cost effective lab equipment improvement and lab components in online education.

GG08: 3:50-4 p.m. Social Media in the Public H.S. Physics Classroom

Contributed – Fran Poodry, West Chester East HS, 450 Ellis Lane, West Chester, PA 19380; fpoodry@gmail.com

Issues abound when high school teachers communicate with high school students over social media. How can social media be used effectively at the high school level without violating school/district policies? What can be accomplished through social media that would not happen within the classroom? Why should a teacher use social media at all with one's students, given the issues involved? I use Facebook and Twitter with high school students in a public school setting and will share guidelines and tips. You can follow me on Twitter by searching for the username MsPoodry.

GG09: 4-4:10 p.m. Using Piazza in an Introductory Physics Class

Contributed – Andrew Duffy, Boston University, Physics Department, Boston, MA 02215; aduffy@bu.edu

Meredith Knight, Boston University

At Boston University, we have been using Piazza, a free social-media tool, in our large introductory physics classes. The idea is that, instead of sending course-related questions in individual e-mails to the instructors, the students post the questions on Piazza, where they can be answered by other students or by members of the course staff. All students have access to the information, and are able to take part in follow-up discussions. The result, over a semester, is a large collection of threaded (and searchable) discussions. The talk will give a brief introduction to Piazza, and discuss the benefits of using Piazza in a large-enrollment class.

GG10: 4:10-4:20 p.m. SkyDrive and Office Web Apps for Student Research Project Management

Contributed – Changgong Zhou, 21000 West Ten Mile Road, Southfiemd, MI 48075; czhou@ltu.edu

Undergraduate research projects provide students with valuable research experiences. However, for the young researchers, especially those first-timers, the lack of project management skills can make it difficult to remain motivated and organized. Meanwhile, simultaneously supervising several projects that are usually different in many aspects, such as project scopes, research methods, student readiness and etc., can pose a challenge to a professor who often has other academic and administrative duties. In this presentation, a project management practice centered on Microsoft SkyDrive and Office Web Apps is described. This practice, by integrating centralized management with shared responsibilities, can make project supervising less demanding for professors, and has the potential to foster project management skills for student researchers.

GG11: 4:20-4:30 p.m. Instructors Take Note: Course Structure Impacts Student Use of Etexts

Contributed – Daniel T. Seaton, MIT, 77 Massachusetts Ave., Cambridge, MA 02139; dseaton@mit.edu

Yoav Bergner, Saif Rayyan, David E. Pritchard, MIT

Gerd Kortemeyer Michigan State University

The overall amount, and the manner, in which students use e-texts depends strongly on course structure, but weakly on class size or on whether the online environment is blended, distance learning, or open. Analyzing tracking logs from the LON-CAPA and edX platforms, we determine the use of etexts in more than 16 introductory physics courses at Michigan State University and MIT, plus four non-physics courses from MITx. A two -parameter model of usage distributions reveals that traditional course structure (few exams, other learning resources besides the e-text) generally correlates with the average student viewing less that 20% of the text, whereas reformed structure (frequent exams, embedded assessment in the assigned e-text) correlates with students viewing over 70%. Our data-mining techniques also analyze the temporal pattern of e-text use, distinguishing weekly reading from review immediately before (or during open book) exams.

Session GH: Other

Location: Galleria I
Sponsor: AAPT
Date: Wednesday, July 17
Time: 2:40–3:30 p.m.

Presider: TBD

GH01: 2:40-2:50 p.m. Introducing Research Experiences in a Community College

Contributed – Chitra G. Solomonson, Green River Community College, Auburn, WA 98092; csolomonson@greenriver.edu

Andrew H. Rice, Christine K. Luscombe, Keith A. Clay, Green River Community College

As more students seek to gain admission to universities, fewer seats are becoming available to them due to increasing budget cuts. Thus admission is becoming increasingly competitive. At the same time, more and more students are relying on community colleges to serve as a stepping stone to college. Experience in research is becoming an important component of STEM undergraduate programs in four-year schools. Research experiences have been shown to deepen students' resolve in persisting in STEM fields especially for underrepresented populations.[1] In this project (funded by NSF DUE-1141339), faculty members at Green River Community College are collaborating with faculty members at the University of Washington to develop and implement lab modules in the cutting-edge fields of Organic Photovoltaics (OPVs) and Organic Light Emitting Devices (OLEDs). Results of a pilot study involving a small group of Green River in the calculus-based physics course will be discussed.

1. S.H. Russell, M.P. Hancock, and J. McCullough, "Benefits of undergraduate research experiences," *Sci.* **316**(5,824): 548-549 (2007).

GH02: 2:50-3 p.m. Acronym Usage 4 Physics Equations

Contributed – Shannon A. Schunicht, M&W inc @Texas A&M University, 6773 Bendwood, College Station, TX 77845.3005; sschunicht@gmail.com

Physics instruction using acronyms is always remembered. Examples include FOIL (First, Outside, Inside & Last). Another: My (Multiplication)- Dear (division)- Aunt (Addition) & Sally (subtraction). Others, forgotten soon thereafter, if not continually used. This author was in a plane crash, rendered unconscious for three weeks culminating with BA & BS. Pragmatic discoveries were made to compensate for memory deficits. The most valuable was having each vowel: mathematical operation, i.e. a:@ =>multiplication, o:over =>division, i:minus =>subtraction, u:plus => addition, and e:equals. Most consonants and variables are indeed consonants, e.g. c: speed of light & z: altitude. Using this technique, any formula may be manipulated into a word/series of. ADDITION LETTERS may be added to enhance letter combinations intelligibility, but need be CONSONANTS. An acronym for The Quadratic Equation: exCePT i buiLD rabbiTS 4 caTS oN 2HaTS. Everyone remembers Dr. Seuss? The possibilities of this mnemonic technique are limitless as ?X=> 0

The application of this mnemonic technique to Eastern characters has yet to be explored

GH03: 3-3:10 p.m. Incompatibility of Relativistic Definition of Force

Contributed – Bharat Lal Chaudhary, All India Radio, Apricot703, Sahara Garden City, Adityapur Jamshedpur, Jharkhand 831014; India; bl_chaudhary@rediffmail.com

The relativistic definition of force is incompatible with the Newtonian definition of force and doesn't conform to the physical condition. In Newtonian mechanics, force is mass times acceleration. If the force is zero, the acceleration becomes zero. That is, there is no effect without cause. But in relativistic mechanics, force is defined as the rate of change of momentum. In this case both mass and speed are variables. Therefore, the force equation in this case contains two terms on the right side. If the force is made zero, left side becomes zero. Right side also becomes zero. Since there are two terms on the right side, acceleration doesn't become zero when force is made zero. That is, the effect is there without the cause. Thus the relativistic definition of force doesn't fulfill the physical condition. Therefore relativistic definition of force is untenable.

GH04: 3:10-3:20 p.m. Ransacking the Physics Lab for Astro101 Classroom Demos

Contributed – Louise OV Edwards, Yale University, 260 Whitney Ave., New Haven, CT 06511, louise.edwards@yale.edu

Demonstrations can help to increase the level of learner-centered teaching in the classroom in many ways. They break up the lecture, allow for peer interactions, and give the students a chance to grapple with physics concepts using their hands. Non-science majors especially, may not otherwise have a chance to take a physics lab, or experiment with many of the classic hands-on physics activities to which the science major has access. In this talk, I outline 10 demonstrations I have taken from our campus planetarium as well as from the physics laboratory. Covering topics from the nature of light, to the solar wind and Earth's magnetic field, these demonstrations are all highly portable, and applicable specifically to the common concepts covered in an Astro 101 class for non-science majors.

GH05: 3:20-3:30 p.m. 'Hobab Theory' Theory of Everything, Including Social Aspects

Contributed – Shahrad Faghihi, Winzerer str. 178, Munich, Bavaria 80797, Germany; sharadf@hotmail.com

The Universe started with Big Explosion-Jump. It started from a certain point of extremely contracted space holding energy. If one contracts space, then space gets folded, like a three-dimensional spring. Space resists contraction and contracted space tends to expand. Space reaction to contraction is becoming denser and starting to roll and make curls right from the middle, where it bears the maximum pressure. Almost like coil. It starts boiling and rotating. If contracting continues it starts to split itself in two, four, eight and so on—the same way a cell divides itself. Space Balls look like a bubble full of space. One could see these Bubbles as spherical space surfaces or space membranes near each other and fully touching and pushing each other, as we know from geometry. The boiling of Space Bubbles and the folds give its membranes a vibrating motion. It has a wavy form. All particles and phenomena in physics can be explained as different form and interaction of these contracted Space Bubbles.

Session GI: Post-Deadline Papers

Location: Galleria III
Sponsor: AAPT
Date: Wednesday, July 17
Time: 2:40–4:40 p.m.

Presider: TBD

GI01: 2:40-2:50 p.m. Developing Self-Learning Ability in a Bilingual College Physics Course

Contributed – Hou Jixuan, Southeast University, Department of Physics, Southeast University, Nanjing, Jiangsu 211189 P. R. China; jixuanhou@hotmail.com

Zhong Hui, Yun Ying, Zhou Zhiyong, Southeast University

When freshmen students enter the universities from high school, they immediately encounter many changes and challenges, especially in the ways of teaching and learning. They are not used to the learning styles in the university, which are more flexible and very different from what they have experienced in high schools. It's important for the teachers to help students develop the ability to conducted self-motivated and controlled learning. We have been working on this goal in our physics courses for the past 10 years. We introduce the new development in a Bilingual Physics course that used both Chinese and English to teach physics. We describe the teaching methods designed to foster students' self-learning ability and discuss the results and implications of this new course format.

GI02: 2:50-3 p.m. Experiences in Teaching Sport Science

Contributed – Blane Baker, William Jewell College, Campus Box 1130, Liberty, MO 64068; bakerb@william.jewell.edu

My experiences in teaching a course based on the science of sport over the past decade are presented. A general overview of the topics covered, along with examples of how athletic performance can be analyzed by physics and other scientific disciplines, are discussed. In addition, classroom assignments, laboratory work, and readings are summarized to show what is expected of students. Finally, writing goals and rubrics for grading are described.

GI03: 3-3:10 p.m. Growing a Major from Scratch: The CSUSM Experience*

Contributed – Charles J. De Leone, California State University, San Marcos, 333 S. Twin Oaks Valley Road, San Marcos, CA 92096-0001; cdeleone@csusm.edu

Edward Price, California State University, San Marcos

Six years ago the Physics Major at California State University, San Marcos was nothing but a plan. Today the program has more than 80 majors and has already graduated 10 students, bucking the trend of low enrollments in physics majors at small and mid-sized institutions. This talk will attempt to analyze the successful and less successful elements of this program, including curriculum choices, student-faculty interactions, and student recruitment, via data from student interviews and survey responses. The talk will also report on how elements of the major align with successful strategies identified in the Strategic Programs for Innovations in Undergraduate Physics (SPIN-UP) report. Lastly, we will report on current and future challenges to the program in an age of budgetary constraint.

*Supported in part by NSF Grant DUE-1068477

GI04: 3:10-3:20 p.m. Assessing the Developing Curriculum of an Upper-Level Physics in Biomedicine Course

Contributed – Elizabeth A. Anderson, Portland State University, 1762 SE Ironwood Way, Gresham, OR 97080, andee@pdx.edu

James K. Johnson, Grace Van Ness, Ralf Widenhorn, Portland State University

Warren Christensen, North Dakota State University

Portland State University's Physics in Biomedicine is an undergraduate upper-level physic course designed for a biology or pre-health major to address the need for medically relevant situations to enhance students' understanding of the physics application. To assess the effectiveness of the instruction, a modified backwards design was used to create learning goals for each individual module. Student understanding of the learning goals was assessed through open response pre and post quizzes. These students' quizzes were then summarized and categorized for emerging patterns of student understanding. The goal of understanding this data is to determine a student's conceptual understanding of each module and overall interpretation of physical phenomenon such as light absorption and emission, atomic energy levels, and electromagnetism. This insight into student thought is to help improve the development of the course and optimize assessment questions.

GI05: 3:20-3:30 p.m. Learning How to Listen: The Interview Project in LA Pedagogy*

Contributed– Eleanor W. Close, Texas State University-San Marcos, Department of Physics, San Marcos, TX 78666; eclose@txstate.edu

Hunter G. Close, David Donnelly, Texas State University-San Marcos

Texas State University-San Marcos has recently begun implementation of a Learning Assistant (LA) program in our introductory calculus-based physics sequence. In addition to their teaching responsibilities, LAs enroll in a course on Physics Cognition and Pedagogy (for upper-division physics elective credit). A central theme of this course is learning both the nature and the value of students' existing ideas in physics. This is accomplished in part through the Interview Project assignment, for which LAs conduct a clinical interview of a non-physics student with the goal of listening to the interviewee' ideas about physics without attempting to change them - that is, to ask questions to learn, without attempting to teach. We will present evidence of the effect of this experience on LAs perceptions of the nature of teaching and learning, the challenge of developing skills of listening for alternative ideas, and the intellectual value of "incorrect" thinking.

*Supported in part by NSF DUE-1240036

GI06: 3:30-3:40 p.m. Embodied Physics Learning: Grasping the Center of Gravity

Contributed – Daniel J. Lyons, University of Chicago, 5848 S. Univeristy Ave., Green Hall 317, Chicago, IL 60637; danjlyons@gmail.com

Jason Sattizahn, Carly Kontra Sian Beilock, University of Chicago

Susan Fischer, DePaul University

Introductory physics students utilize the concept of "center of gravity" when constructing free-body style diagrams. However, a formal definition of center of gravity is typically introduced much later in the course than Newton's laws. In both instances, students regularly have difficulty abstracting an extended (non-discrete) object to an equivalent discrete, or point-like, representation. This study explores performance on a computer-based center of gravity finding task. College students not enrolled in a physics course located the centers of gravity of a series of two-dimensional shapes that varied by symmetry and extension. Participants struggled when applying the center of gravity concept to extended objects in general and asymmetric extended objects in particular. The distribution of responses for extended-asymmetric objects closely resembles many of the errors made by algebra-based physics students. An embodied learning intervention is being piloted to facilitate the abstraction strategy of representing extended objects using discrete points.

GI07: 3:40-3:50 p.m. Learning Outcomes in an Experimental Course

Contributed – Deepak Iyer, Rutgers University, 136 Frelinghuysen Road, Piscataway, NJ 08854; deepaki@physics.rutgers.edu

Mary Emenike, Simon Knapen, Michael Manhart, Aatish Bhatia, Rutgers University

We report on two surveys carried out at the end of a large enrollment (120 students) course, "Physics for Humanities." The first survey is the Colorado Learning Attitudes about Science Survey (CLASS-Phys), and the second is a course specific survey designed by the authors. The surveys are intended to study to what extent the learning goals of the course were achieved and to measure the efficacy of the different pedagogical strategies implemented in the course. Furthermore, CLASS-Phys data from this course will be compared to previously published CLASS-Phys data from other institutions.

GI08: 3:50-4 p.m. Team-based Assessment in a Flipped Introductory Physics Class

Contributed – Junehee Yoo, Seoul National University, Kwanak ro 1, Kwanak gu Seoul, MA 151742 Korea, Republic of; yoo@snu.ac.kr

Eric Mazur, Carolann Koleci, Brian Lukoff, Harvard University

In a flipped introductory physics class, teamwork is regarded as a core competency and even reflected to assessment method. Reading Assurance Assessments, the high stakes component of the course are performed by team based rather than individually isolated. Three research questions; is the team-based assessment methods fair, especially for the high achievers, can team-based assessments measure teamwork as it intended and how can improve a teamwork are approached by analyzing 34 students' individual and team scores longitudinally during one semester. As a result, team-based assessments seemed to measure teamwork as it intended and to be fair when we accept that teamwork is important as well as conceptual mastery, even though the portions are not the same. Team composition for effective teamwork will be discussed.

GI09: 4-4:10 p.m. Forced Vibration of Nonlinear Oscillator System

Contributed – Zeyang Shen, Southeast University, No .2 Southeast University Road, Nanjing, Jiangsu 211189 P. R. China; 213120972@seu.edu.cn

Linear harmonic oscillator is a classical model for simple harmonic vibration. When applied by an external force with a stabilized frequency, the closer the frequency of the external force comes to natural frequency of the oscillator, the larger amplitude can be observed. For non-linear harmonic oscillator system, numerical results show something distinguishing. The ball, which is set between two springs, moves in a frequency identical to the frequency of the external force applied to the system. By increasing the frequency of the external force from very small, the ball vibrates with an increasing magnitude of amplitude. When the frequency reaches a certain level, a jump can be clearly seen on the amplitude of the ball. A realistic experiment is being conducted to verify the results.

GI10: 4:10-4:20 p.m. Theoretical Calculation of a New Type Superconductor

Contributed – Jingrong Ji, No.2 Southeast University Road, Nanjing, Jiangsu; 211189 jjr6699@126.com

Human beings have been exploring the superconductors with critical temperature at room temperature since the discovery of the super-conduction phenomenon about one hundred years ago. Although the superconductors have some profound and lasting significance in many fields, there are still various factors that will limit the superconductors from being widely used in our daily life in each period of the research process. This thesis is based on the pre-existing superconductivity theories and improves the calculation formula about the transition temperature about the superconductors and puts forward a new type superconductor: metal-copper-based-iron-based superconductor material and calculates the formula and simulates the molecular structure of this kind of superconductor material with these theories so that we can get a special kind of the superconductor with the critical temperature at the even higher temperature. We hope this research can broaden our train of thought of discovering this potential material and help us find the superconductors that can be widely used in our daily life.

GI11: 4:20-4:30 p.m. Introduction and Research on Touch Screen Technology

Contributed – Yupeng Wang, Southeast Universit,y No. 2 Southeast University Road, Nanjing, Jiangsu 211189 P. R. China[wyp940712@163.com

Recently, touch screen technology has been more and more widely used in production and living. With the improvement of people's living standard, there will be a continuing increase in demand for electronic products, so touch screen technology has good development prospects. Our paper is based on the principles of different types of touch screen and we focus on the projected capacitive touch screen. We design a principal experiment to have a better understanding of the projected capacitive touch screen and do the preliminary search on it. Introduction about three newest touch screen technologies, "sol" , "on-cell", and "in-cell", is presented in this paper. Ideas about how to make the touch screen thinner, more sensitive and user-friendly are discussed, which is based on "in-cell" technology. We hope this paper will have a positive effect on the research of optimizing the structure of future touch screens.

GI12: 4:30-4:40 p.m. Mpemba Effect in Water

Contributed – Yuxin Wang, Southeast University, No. 2, Southeast University Road, Nanjing, Jiangsu 211189 P. R. China; wyxkx55@163.com

Mpemba effect, referring to a phenomenon that hot water freezes faster than cold under certain conditions, has been under discussion for a long period of time. Based on the freezing mechanism, we first figure out that the Mpemba effect is scientific by deducing the Newton's law of cooling, and then discuss the mechanism of Mpemba effect in theory. Experiments about Mpemba effect were done on our own specific and certain conditions. Via the experimental phenomena and data, we make further analysis of the mechanism of the mMpemba effect. In addition, we make assumptions of a type of phenomenon about high energy level back to ground state, and imply the applications from both microscopic view and macroscopic view.

Session GJ: Post-Deadline Papers II

Location: Skyline III
Sponsor: AAPT
Date: Wednesday, July 17
Time: 2:40–4:30 p.m.

Presider: TBD

GJ01: 2:40-2:50 p.m. Garage Physics: Flexible Space for Innovative Student-Focused Research and Education

Contributed – Duncan Carlsmith, University of Wisconsin, Madison, 1150 University Ave., Madison, WI 53706; duncan@hep.wisc.edu

Garage Physics at the University of Wisconsin, Madison provides a new flexible space for innovative student-focused research and education. In the Garage, a student (undergraduate or graduate) is encouraged to explore his or her passions, to find new passions, to learn practical skills, to study in new ways, and to take an active role in their education. The Garage mode of learning compliments the structured learning environment of the regular curriculum. A wide variety of projects are possible in the Garage: basic scientific research, projects for entrepreneurs interested in developing or exploiting new gadgets, and "steAm" projects merging STEM and Arts fields. (www.physics.wisc.edu/garage)

GJ02: 2:50-3 p.m. Supporting Middle School Teachers with Standards-Aligned Formative Assessments

Contributed – Andrew W. Dougherty, The Ohio State University, 191 West Woodruff Ave., Columbus, OH 43210; andrew@physics.osu.edu

Bruce R. Patton, The Ohio State University

The state-led revision of the National Science Standards aims to increase student achievement by shifting focus towards a deep understanding of scientific concepts. Changes in expectations have created a need for new standards-aligned assessments. School Year Based Inquiry Learning (SYBIL), a professional development partnership between The Ohio State University and a large district in central Ohio, created a year-long program to aid K-8 teachers in developing common formative assessments (CFAs). The program is designed to equip a committee of teachers to produce high-quality assessments. SYBIL has also helped assess test items, using IRT, in order to improve the assessments. The design of the program is presented, as well as data showing the improvements made to formative assessments. Evidence is also presented that shows the program has improved the teachers' abilities to create and analyze formative assessments, as well as to watch for bias against minorities and gender.

GJ03: 3-3:10 p.m. Penetration of Electrostatic Field into Metals: Theoretical Conundrums and Their Resolution

Contributed – Michael B. Partensky, Brandeis University 415 South St., Waltham, MA 02453-2728; partensky@gmail.com

One of the most distinctive characteristics of the metals is the strong screening of the electrostatic field F by the conduction electrons, limiting the penetration of F into the metal to the first few atomic layers. This property is exaggerated by the perfect conductor model of the classical electrostatics with vanishing "field penetration length" L=0. The penetration of electrostatic field into metals was first discussed at a microscopic level by Rice (1928) using Thomas-Fermi approach. The predicted effect increased the effective gap of thin film capacitors and electric double layers, leading to drastic contradiction with experiment. Paradoxically, in order to comply with the experimental data, the penetration length L should have become negative! We describe the solution of this conundrum, address the fundamental discrepancies of Thomas- Fermi-type theories, and briefly review modern Density Functional studies of surface electron screening.

GJ04: 3:10-3:20 p.m. Investigative Study on the Correlation Between High School Student Mental Rotation Test (MRT) Scores and State Assessment Scores and Grades in STEM Classes

Contributed – Alfonso J. Hinojosa, 1620 Guerrero St., Laredo, TX 78043; ajhinojosa@unitedisd.org

Ramon Lopez, University of Texas at Arlington

We are investigating the effects that student spatial representations have on student success in state assessment exams and STEM courses. Previous work indicates an increase in a student?s cognitive load when mentally manipulating three-dimensional images. In physics, student difficulties with mentally manipulating 3-D images while retaining related material may be connected with spatial intelligence issues. To investigate this, we conducted a study (9 sections) on student spatial intelligence during the fall 2012 semester using the introductory physics and chemistry classes. All students were administered the MRT, which consists of 20 spatial intelligence problems. The scores were then statistically correlated with the corresponding student state assessment scores, as well as class grades. We will contrast those correlations with the correlations between student exam performance and high school courses taken.

GJ05: 3:20-3:30 p.m. STEM Skill Building in the Physical Sciences – 2Y College Prep

Contributed – Capitola D. Phillips, Northwest Arkansas Community College, Bentonville, AR 72712; dphillips@nwacc.edu

Non-science majors enrolled in the Introduction to Physical Science course at Northwest Arkansas Community College (NWACC) engage in skill building, and project-based activities (EMPACTS) in STEM disciplines, as they complete "Educational Outreach Teaching Projects." Teams of diverse learners (including preservice teachers) collaborate in teams of two to four as they create their own learning experiences. Each team uses skills developed within the framework of physical science course assignments and activities to create lesson plans, activities, and demonstrations, which they share as they teach and present in area schools. College and K-12 faculty mentors offer experience and advice as students adapt college-level concepts for the K-12 learner, using common core standards. The EMPACTS (Educationally Managed Projects Advancing Curriculum, Technology/Teamwork and Service) program at NWACC is a curriculum driven, project-based learning model, which creates a learning environment where college learners of all backgrounds collaborate to create their own learning experiences.

GJ06: 3:30-3:40 p.m. The Elitzur-Vaidman Bomb Paradox as a Fun Lab Exercise

Contributed – Patrick C. Hecking, Thiel College, 75 College Ave., Greenville, PA 16125; phecking@thiel.edu

The Elitzur-Vaidman bomb thought experiment involves a quality test for a bomb, which is triggered by the absorption of a photon. Classically it is impossible to test a "good" bomb and certify that it will work without exploding it and therefore making it useless. Quantum Mechanics makes such a test possible by shifting from the wave to the particle picture. A lab exercise using dice and a score sheet has been developed to simulate a fun-filled game with "good" and "bad" bombs and a study of probabilities.

GJ07: 3:40-3:50 p.m. Building Modeling Skills and Developing Science Identity in Physics Freshmen

Contributed – Joel C. Corbo, University of California, Berkeley, 1930 Channing Way, #3C, Berkeley, CA 94704; jcorbo@berkeley.edu

Acquiring research skills and developing an identity as a scientist are critical to the development of young physicists but often neglected in undergraduate physics courses. While some students develop these traits "on the job" as undergraduate researchers, many leave the physics major before experiencing what being a scientist is all about. To counteract this trend, the Berkeley Compass Project offers a freshman course called "Introduction to Modeling" that emphasizes the actual practice of science. In it, students engage in model-building through guided activities related to the ray model of light. They then use the skills acquired to conduct research projects guided by graduate student advisors and culminating in papers and a poster session. The students also reflect on their "scientific identities" through a series of readings, discussions, and self-evaluations. In this presentation, we discuss the methods and activities used in this course and the positive outcomes experienced by our students.

GJ08: 3:50-4 p.m. Using Centripetal Forces to Model Ocean Tides

Contributed – John Fons, Universty of Wisconsin-Rock County, 2909 Kellogg Ave., Janesville, WI 53546; john.fons@uwc.edu

Using a very basic understanding of solving centripetal force problems, it is possible to accurately model the frequency and depths of oceanic tides throughout the day. The computer/calculator modeling is easily completed in simple software packages such as Excel and can be performed by students who have a solid fundamental grasp on centripetal forces and resolving vectors.

GJ09: 4-4:10 p.m. Asking Teachers: Utility of Expert-like Framework in High School Physics

Contributed – Andrew Mason, University of Central Arkansas, Department of Physics and Astronomy, Lewis Science Center, Conway, AR 72035; ajmason@uca.edu

Mishal Benson, University of Central Arkansas

One method of improving standards in K-12 education is to approach students with elements of college-level physics to better prepare them for higher levels of learning. One such element that may prove useful is the ability to practice an expert-like problem-solving framework for introductory-level physics problems. We chose a sample of computer coaching modules, initially developed for a university-level calculus-based curriculum,[1] and minimally changed them to suit an algebra-based curriculum. Four in-service high school physics teachers were consulted in a workshop setting for feedback as to the utility of these coaches in the classroom and the usefulness as to the intent of their design. We report on the participants? feedback. Topics of interest include potential use in a high school classroom, and also potential use for teacher training.

1. In collaboration with L. Hsu, Q. Xu, K. Heller at University of Minnesota

GJ10: 4:10-4:20 p.m. Flow Visualization of Vortex Dynamics

Contributed – John S. Allen, Department Mechanical Engineering, University of Hawaii-Manoa, Honolulu, HI 96822; alleniii@hawaii.edu

Examples of vortices in an undergraduate fluid dynamics course often include those that can occur in nature such as tornadoes and dust devils. Wakes of moving objects may contain vortices and they can play an important role in propulsion. The vortices in the wake generated by a fish engaged in undulatory motion alternate between the clockwise and counter-clockwise directions. The leg kick of a human swimmer performing the butterfly stroke also generates vortices such that bound vortex forms around each foot. The magnitude of the resulting merged vortex ring can be related to propulsion efficiency. Using a custom bubble injection and visualization system with an air compressor, ring vortices from butterfly kicks were investigated by undergraduate students at the swimming pool. Underwater cameras and motion analysis software were used to quantify the associated biomechanical parameters. The flux of vortex lines can discussed with Kelvin?s circulation theorem.

PERC: Bridging Session

Location: Grand Ballroom I
Sponsor: AAPT PER
Date: Wednesday, July 17
Time: 4:30–8:30 p.m.

Presider: Dedra Demaree

L0901: 4:30-6 p.m. Affect Not as an Afterthought: Coupling Content and Social-Psychological Aspects in Physics Learning

Invited – Noah D. Finkelstein, University of Colorado, Boulder, 2000 Colorado Ave., Boulder, CO 80309-0390; noah.finkelstein@colorado.edu

Learning is a matter of socialization. As such, we can build on efforts over the last couple of decades to further expand the goals of physics teaching and learning beyond the historic measures of content mastery. We are now poised to examine how social and psychological domains impact and are impacted by the traditional content we so dearly love. Drawing from a theoretical tradition that takes play seriously, I explore a few environments where play and "messing about" simultaneously develop student affect and content mastery. At CU we are involved in: research documenting the engagement of youth in science to promote identity and content mastery; studies linking psychological effects to student performance and retention in college physics; and, investigations of the impacts of advanced undergraduate and graduate experiences that encourage productive messing about as scientists. These studies challenge the historical divides between formal / informal, content/ form, and content/ affect.

PL0902: 4:30-6 p.m. Having the Journey: Physics Education and Transformative Experiences

Invited – Kevin J. Pugh, University of Northern Colorado, Campus Box 94, Greeley, CO 80639; kevin.pugh@unco.edu

John Dewey argued that the curriculum should be a guide and not a substitute for having our own journey with the content. I agree and believe the purpose of science education should be to transform the way we see and experience the world, an outcome I refer to as a transformative experience. In this talk, I explain the nature of transformative experiences and present a model of fostering transformative experiences in science. This model has roots in Dewey's theory of aesthetic experience and was refined through design-based research. Instructional principles central to the model include: 1) artistically selecting and crafting content, 2) scaffolding re-seeing, and 3) modeling transformative experiences.

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Walkiewicz, Thomas
Wallace, William
Wangler, Julie
Weatherford, Shawn
Webb Sr., Robert
West, Mary
West, Myra
Wetli, Denise
Whatley, William
Whittaker, Chris
Wiest, Joseph
Wiley, H. Scott
Williams, Paul
Witmer, Patrick
Wolfe, David
Wolfe, Robert
Wu PhD, Helan
Yeatts, F.
Yerian, Stephen
Yoo, Junehee
Yost, Scott
YourCause, LLC - IMO Robert G. Fuller
Young, Anne – IMO Larry Bader
Young, Kevin
Yudovina, Elena
Zhang, Weijia - IMO Robert G. Fuller
Zitzewitz, Paul
Zollman, Dean
Zwart, John
Anonymous, 12
Anonymous – IMO Tucker Ryan Chan
Anonymous - IMO Paul Zitzewitz
Anonymous – IMO Tucker Ryan Chan

Index of Participants

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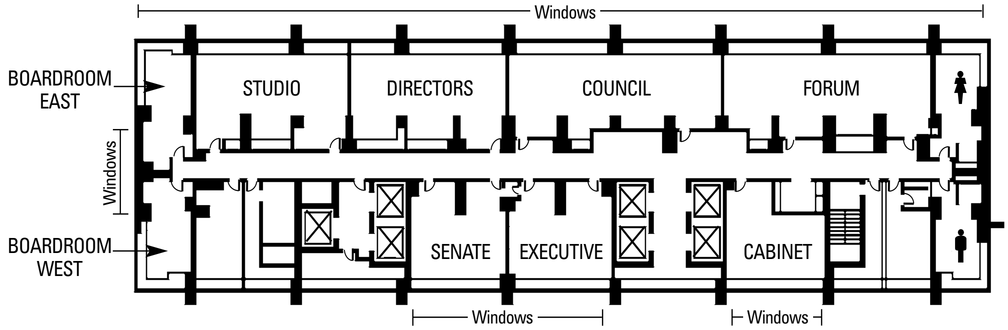
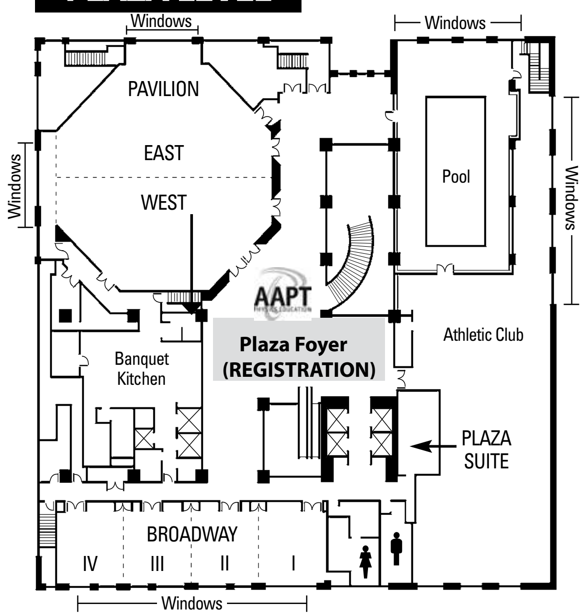
Hilton Portland Map

(Skyline rooms on 23rd floor)

THIRD FLOOR



PLAZA LEVEL



BALLROOM LEVEL

(below Plaza level)

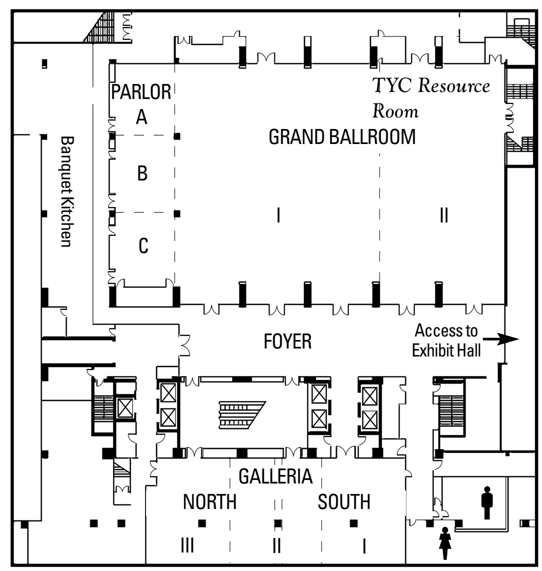
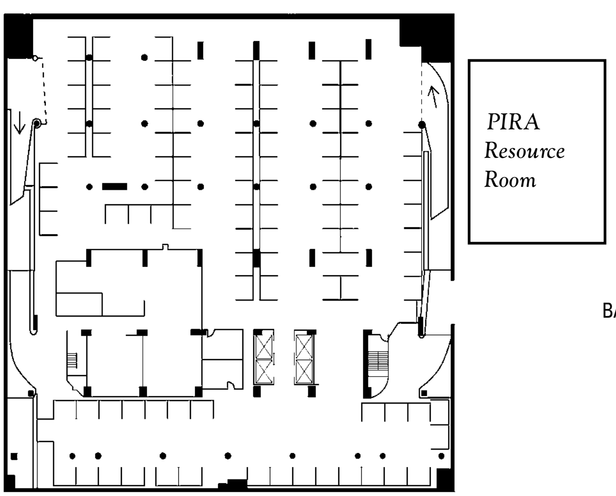


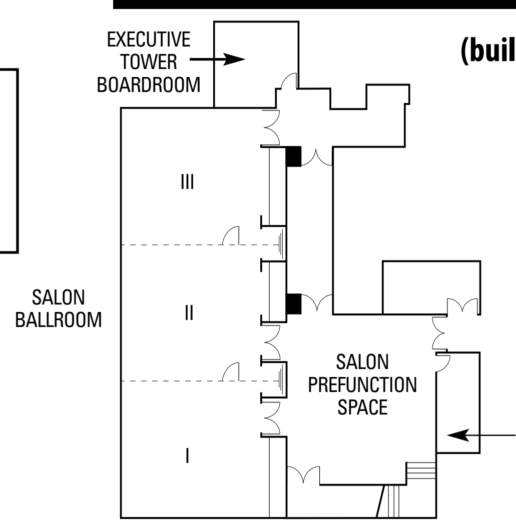
EXHIBIT HALL

(below Ballroom level)



HILTON PORTLAND EXECUTIVE TOWER

(building across street)



Portland State University Map

Academic & Student Recreation Center (ASRC) F8
Art Building (AB) I9
The Broadway (BHB) I7
Business Administration (BA) F7
Campus Public Safety (CPSO) H6
Cramer Hall (CH) E6
East Hall (EH) H7
Education, Graduate School of (ED) F7
Engineering Building (EB) H10
Engineering & Computer Science Annex (CECS) H8
Extended Studies Building (XSB) D4
Fifth Avenue Cinema (CIN) H8
Fifth Avenue Parking Lot F9
Fourth Avenue Building (FAB) G10
Harder House (HH) C4

Harrison Street Building (HSB) F3
Helen Gordon Child Development Center (HGCDC) C1
Hoffmann Hall (HOFF) F2
Honors Building, University (UHP) D2
Koinonia House (KHSE) E7
Lincoln Hall (LH) C6
Market Center Building (MCB) C10
Market Square Building (MSB) B8
Millar Library, Branford P (ML, LIB) 4G
Native American Student and Community Center (NASCC) J6
Neuberger Hall (NH) G6
Parking 1 (P1) G7
Parking 2 (P2) D7
Parking 3 (P3) D1
Peter W Stott Center (PSC) H4

Peter W Stott Community Field G3
PSU Bookstore (BOOK) E8
Research Greenhouses I4
Science and Education Center (SEC) J9
Science Building 1 (SB1) D3
Science Research and Teaching Center (SRTC) E3
Shattuck Hall (SH) H6
Simon Benson House (SBH) E4
Smith Memorial Student Union (SMSU) F6
University Center Building (UCB) G8
University Place (UP) J10
University Services (USB) E7
University Technology Services (UTS) J9
Urban Center (URBN) D8
West Heating Plant (WHP) H3

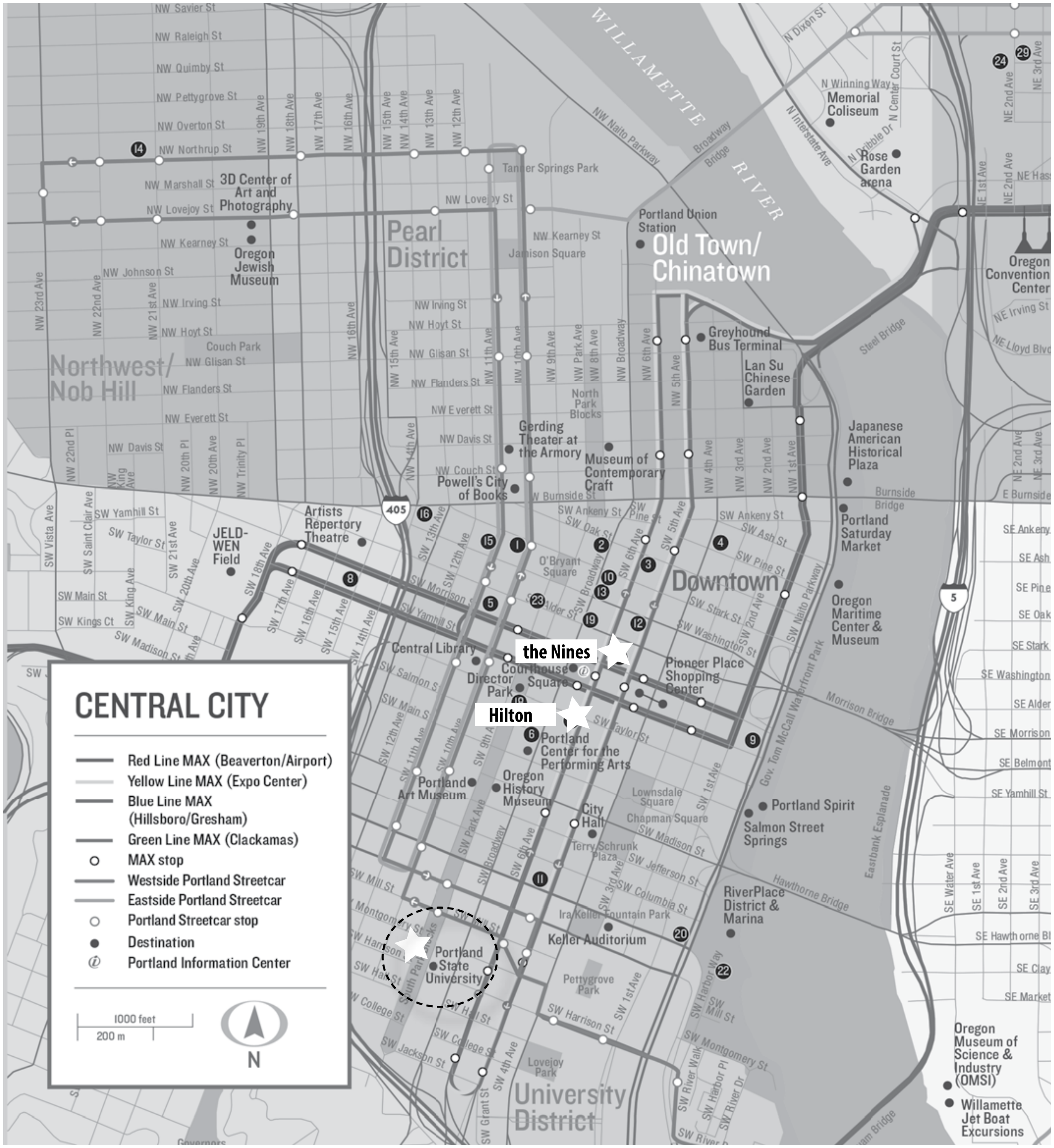
UNIVERSITY HOUSING

Blackstone (BLK) F4
The Broadway (BHB) I7
Joseph C Blumel Hall (JCB) D2
King Albert (KNGA) E2
Montgomery Court (MONT) E4
Ondine (OND) H8
Parkway (PRKW) C4
St Helens (STHL) E2
Stephen Epler Hall (SEH) F2
Stratford (STFR) C3
University Pointe I-8

Not pictured

PSU Business Accelerator, Corbett Building, 2828 SW Corbett Ave.

Portland City Center



Walking Directions from Portland Hilton and Executive Tower to The Nines Hotel

1. Start out going north on SW 6th Ave toward SW Taylor St.
2. Turn right onto SW Morrison St.
3. 525 SW MORRISON ST is on the left.

From the Portland Hilton to Portland State University (Southbound)

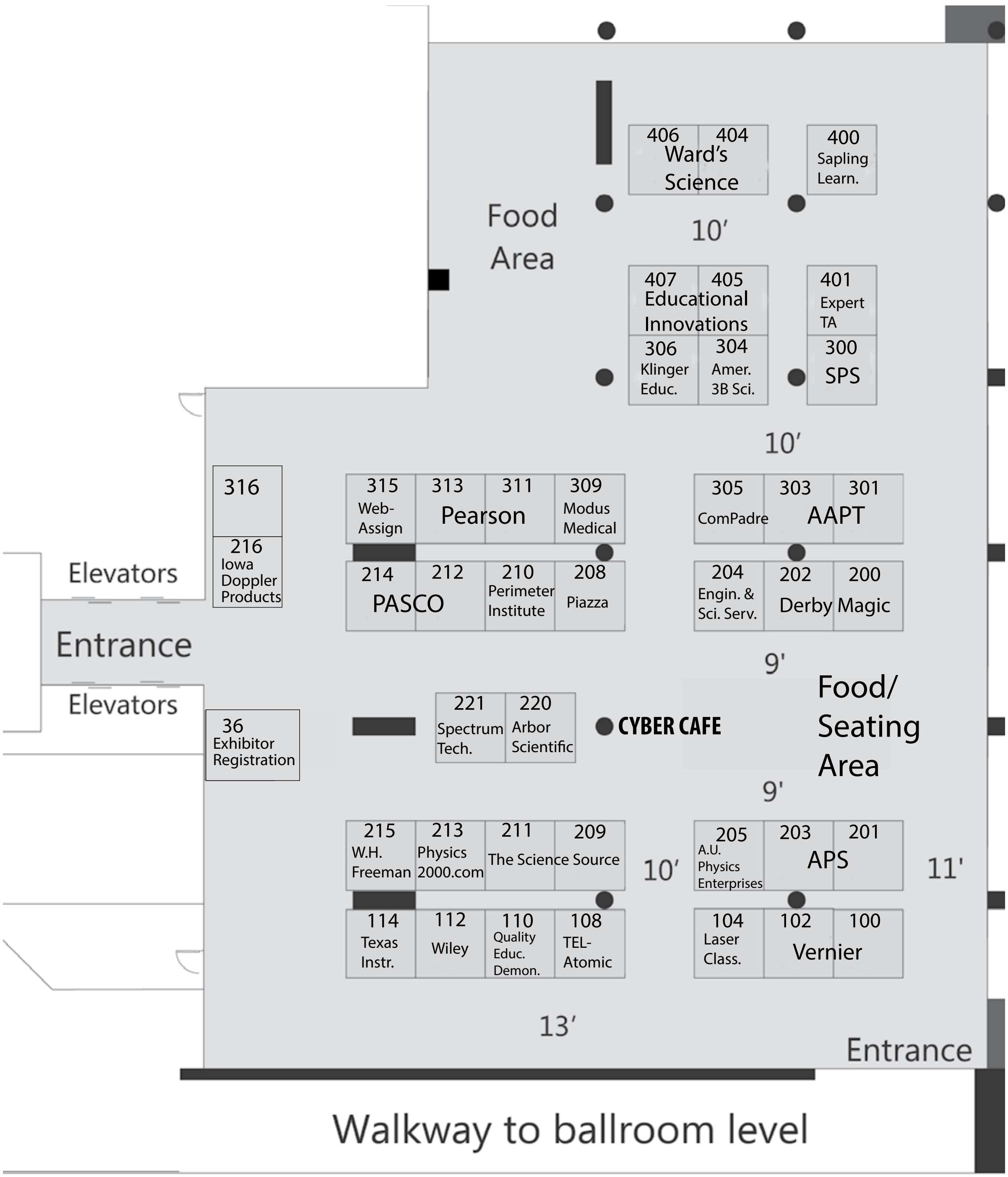
Station Stops: Pioneer Place (SW 5th Avenue) to PSU Urban Center (SW 5th and Mill)

From Portland State University to the Portland Hilton (Northbound)

Station Stops: PSU Urban Center (SW 6th Avenue and Montgomery) to Pioneer Courthouse (SW 6th Avenue) Walk 0.1 mile north to Hilton Hotel (921 SW 6th Avenue)

Trains run on three lines every 5-15 minutes every day between 4:30 a.m. and midnight.

AAPT Exhibit Hall



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