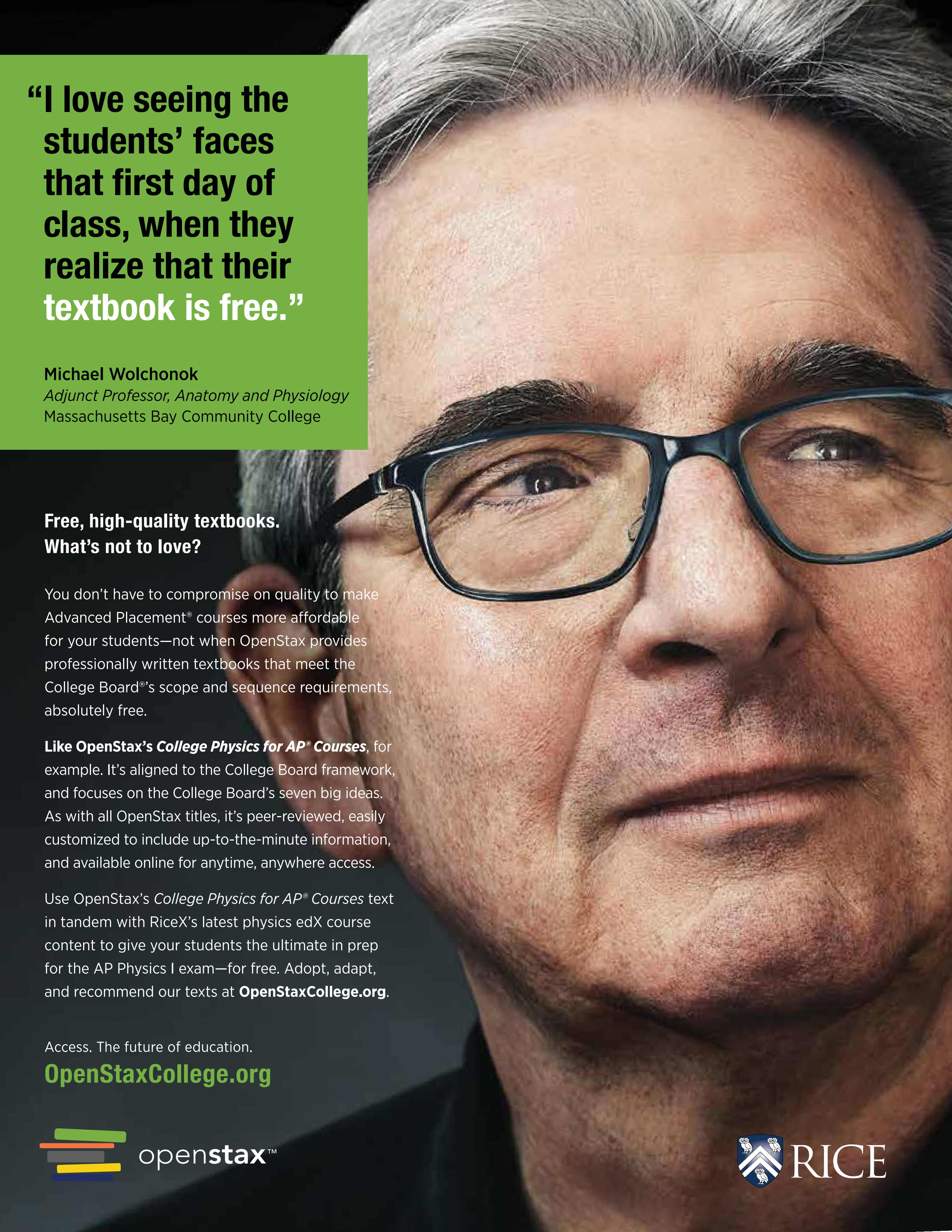
2016 AAPT Winter Meeting

New Orleans, Louisiana
January 9 - 12

AAPT American Association of Physics Teachers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New Orleans, LA
January 9–12, 2016

Hyatt Regency New Orleans

AAPT American Association of **Physics Teachers**

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

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Special Thanks

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

Mostafa Elaasar, Southern University, for organizing the workshops

Paper sorters:

- Sean Bentley, Society of Physics Students, AIP
- Richard Gelderman, Western Kentucky University
- Kelly O'Shea, Elisabeth Irwin High School
- Eric Williams, Florida International University
- Gina Passante, California State University, Fullerton
- Charlene Rydgren, Franklin Academy High School
- David Sturm, University of Maine
- Sam Sampere, Syracuse University

Facebook/Twitter at Meeting

We will be posting updates to Facebook and Twitter prior to and during the meeting to keep you in the know! Participate in the conversation on Twitter by following us at **twitter.com/AAPTHQ** or search the hashtag **#aaptwm16**. We will also be posting any changes to the schedule, cancellations, and other announcements during the meeting via both Twitter and Facebook. Visit our Pinterest page for suggestions of places to go and things to do in Orlando. We look forward to connecting with you!

Facebook: facebook.com/AAPTHQ
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First time at an AAPT meeting?

Welcome to the 2016 AAPT Winter Meeting in New Orleans! 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 11 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. Sunday in Imperial 5**. It is a wonderful way to learn more about the meeting and about AAPT.
- 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 Topical Discussions are entirely devoted to such discussions.
- Be sure to make time to visit the exhibits in the Exhibit Hall in Storyville Hall, 3rd Floor. This is a great place to learn what textbooks and equipment are available in physics education.

Bus Schedule for AAPT Workshops

Saturday, January 9

Buses departing Hyatt to Southern Univ.

- 7:15 a.m.
- 7:25 a.m.
- 12:20 p.m.

Buses departing Southern Univ., returning to Hyatt

- 12:15 p.m.
- 1:00 p.m.
- 5:15 p.m.
- 5:30 p.m.

Sunday, January 10

Buses departing Hyatt to Southern Univ.

- 7:15 a.m.
- 7:25 a.m.

Buses departing Southern Univ., returning to Hyatt

- 12:15 p.m.
- 12:40 p.m.

T02, T03, and T04 will be held at the Hyatt Regency;
all other workshops will take place at Southern University.

Buses will depart from the Hyattt from the first floor behind the registration desk.

Southern University
6400 Press Drive, New Orleans, LA 70126

SEES Program for area students!

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, and receptions. All rooms will be in the Hyatt Regency New Orleans. Workshops on Saturday and Sunday will be at Southern University, Brown or Old Science Bldg. (BRN) and New Science Bldg. (NSC) (Tutorials will be held at the hotel.)

FRIDAY, January 8

4–6 p.m.		French Quarter History and Pub Crawl Tour	Offsite
4–7 p.m.		**REGISTRATION**	**Strand Foyer**
4:30–5:30 p.m.		Finance Committee	Imperial 12
5:45–6:45 p.m.		New AAPT Board of Directors Orientation	Imperial 12
7–10 p.m.		AAPT Board of Directors I	Imperial 12

SATURDAY, January 9

7 a.m.–4 p.m.		**REGISTRATION**	**Strand Foyer**
8–10 a.m.		Meetings Committee	Strand 10 A
8–10 a.m.		Publications Committee	Strand 10 B
8 a.m.–2 p.m.		Laser Interferometer Gravitational Waves Observatory Tour	offsite
		(WORKSHOPS ARE AT SOUTHERN UNIVERSTIY, bus schedule, p. 6)	
8 a.m.–5 p.m.	W01	Research-based Alternatives to Traditional Physics Problems	BRN 205
8 a.m.–12 p.m.	W02	Submitting Successful Proposals to the NSF IUSE Program	BRN 209
8 a.m.–12 p.m.	W03	Ramps and Bungee Cords: Bringing It Together	NSC 327
8 a.m.–12 p.m.	W04	Creating Physics Simulations Using HTML5, Part 1:Introduction for Beginners	NSC 329
8 a.m.–12 p.m.	W05	Using 3D Printing and Open Source Software to Motivate Self-directed Learning	BRN 311
8 a.m.–12 p.m.	W10	Fun & Engaging Labs	NSC 316
10 a.m.–7 p.m.		High School Resource Lounge	Imperial 11
10:15 a.m.–4:45 p.m.		Board of Directors II	Imperial 12
11:30 a.m.–2:30 p.m.		Resource Letters Committee	Strand 10 B
12:30–1:30 p.m.		LGBT+ Meet-up for Members and Supporters of LGBT+ Community	Strand 4
1–5 p.m.	W14	Introductory Physics for Life Science: Curricular Resources and Activities	NSC 327
1–5 p.m.	W15	Creating Physics Simulations in HTML5, Part 2: Intermediate Level	BRN 309
1–5 p.m.	W16	Low-Cost, At-Home Labs for School-based or Online Courses	BRN 201
1–5 p.m.	W19	Changing How Students Learn in Gateway Physics Courses	BRN 311
1–5 p.m.	W21	Examining the Relationships Among Intuition, Reasoning, & Conceptual Understanding	BRN 209
1–5 p.m.	W32	Projects and Practices in Physics – Inquiry-based Computational Modeling	NSC 329
3–4:30 p.m.		Nominating Committee I (Closed)	Strand 2
5:30–7 p.m.		ALPhA Committee	Strand 3
5:30–6:30 p.m.		New Area Chairs Orientation	Strand 10 B
5:30–8 p.m.		Section Representatives and Officers	Strand 10 A
6–7 p.m.		Tweet-up Event	Strand 4
6:30–8 p.m.		Programs Committee I	Stand 10 B
7:30–9 p.m.		**REGISTRATION**	**Strand Foyer**
8–10 p.m.		SPS Undergraduate Research and Outreach Poster Session	Storyville Hall, 3rd Floor
8–10 p.m.		Exhibit Hall Opens / Welcome Reception	Storyville Hall, 3rd Floor
10–Midnight		Winter Meeting Dance Party	Empire D

SUNDAY, January 10

7 a.m.–4 p.m.		**REGISTRATION**	**Strand Foyer**
7–8 a.m.		First Timers' Gathering	Imperial 5
7:30–9 a.m.		Review Board	Strand 2
8–9 a.m.		Physics Bowl Advisory Committee	Bolden 3
8 a.m.–12 p.m.	W22	Slingshot Physics	NSC 318
8 a.m.–12 p.m.	W23	Fun, Engaging, and Effective Labs and Demos in Mechanics and Optics	BRN 201
8 a.m.–12 p.m.	W26	The Menu of Physics Pedagogies: How To Choose – Or Do You Have To?	NSC 327
8 a.m.–12 p.m.	W27	Making Physics Accessible to Students with Different Abilities Using iPads, 3D Worlds	BRN 209
8 a.m.–12 p.m.	W28	Activities for Teaching About Climate Change	NSC 316
8 a.m.–12 p.m.	W30	Integrating Computation into Undergraduate Physics	NSC 329
9–10 a.m.		Venture/Bauder Committees	Strand 6
9–10 a.m.		Committee on Governance Structure	Imperial 12
9–11 a.m.	T02	Teaching Mathematical Methods with Active Learning Exercises	Strand 3 (Hyatt)
9–11 a.m.	T03	Electrostatics from Gilbert to Volta	Strand 4 (Hyatt)
9–11 a.m.	T04	Using Children's Literature to Teach Physics: Storybooks, Graphic Novels, Simpsons	Bolden 1 (Hyatt)

10 a.m.–5 p.m.		**Exhibit Hall Open**	Storyville, 3rd Floor
10–10:30 a.m.		Exhibit Hall Morning Break (10:15 a.m. Sony SmartWatch Drawing)	Storyville, 3rd Floor
10–11 a.m.		Spouse/Guest Gathering	Strand 2
10 a.m.–7 p.m.		High School Physics Teachers Lounge	Imperial 11
10–11:50 a.m.	AA	Meeting the Breadth of NGSS	Strand 11 A
10–11:50 a.m.	AB	Maker Movement (FabLab/Tech. Shop/Maker Space)	Strand 10 B
10 a.m–12 p.m.	AC	Best Practices in Educational Technologies	Strand 10 A
10–11:10 a.m.	AD	Professional Concerns in High School	Strand 11 B
10–11:40 a.m.	AE	PER: Evaluating Instructional Strategies	Bolden 5
10 a.m.–12 p.m.	AF	Teaching Electronics in Upper Level Undergraduate Physics	Empire C
11 a.m.–12 p.m.	CW05	Cengage Learning: Physics for Scientists and Engineers: Foundations & Connections	Strand 5
12–1:30 p.m.		Early Career Professionals Speed Networking Event	Empire B
12:30–1:30 p.m.	CW01	Expert TA: Realigning Homework Grades and Test Scores in the Modern Classroom	Empire D
12:30–1:30 p.m.	CW02	WebAssign: Enrich Your Physics Lecture and Lab Courses with WebAssign Content	Strand 3
12:30–1:30 p.m.	CW03	PASCO scientific: PASCO Capstone™, Ultimate Data Collection and Analysis Software	Strand 4
12:30–2 p.m.		Committee on the Interests of Senior Physicists	Strand 2
12:30–2 p.m.		Committee on Physics in Undergraduate Education	Bolden 3
12:30–2 p.m.		Committee on Teacher Preparation	Bolden 2
12:30–2 p.m.		Committee on Women in Physics	Strand 10 B
12:30–2 p.m.		High School Physics Teachers Day Luncheon	Imperial 5
2–3 p.m.	BA	AP Physics Exam Questions and How They Assess Science Practices	Strand 10 A
2–3:20 p.m.	BB	The Planetarium Classroom	Strand 11 A
2–3 p.m.	BC	Lessons from the Pre-HS Classroom	Bolden 5
2–3:30 p.m.	BD	Flipped Classrooms	Bolden 1
2–3 p.m.	BE	Celebrating Latina/Hispanic Women Physicists	Bolden 6
2–3 p.m.	BF	Licensure Issues for Teachers: Alternative and State Level Challenges	Bolden 4
2–3:30 p.m.	BG	Doubling Minority PhDs: The APS Bridge Program	Empire C
2–3:10 p.m.	BH	PER: Evaluation of Curricular Strategies for Introductory Physics for Life Science	Empire D
2–3:20 p.m.	BI	Lab Guidelines Focus Area 2: Designing Experiments	Strand 11 B
3:30–4 p.m.		**Exhibit Hall** Afternoon Break (3:45 p.m. AmEx Gift Card Drawing)	Storyville Hall, 3rd Fl.
4–5:10 p.m.	CA	Discovery Physics in the Classroom	Strand 11 B
4–5:10 p.m.	CB	Flipped Classrooms B	Bolden 1
4–6 p.m.	CC	Writing and Assessing Biology-based Problems in the Introductory Physics Course	Empire C
4–5:40 p.m.	CD	Research on Ethnic Minorities: PER, DBER, and Science Education	Strand 10 B
4–6 p.m.	CE	Astronomy Education Research: Current Trends and Future Directions	Bolden 6
4–5:50 p.m.	CF	PER: Diverse Investigations	Strand 10 A
4–5:30 p.m.	CG	International Programs and Teaching Experiences	Bolden 4
4–6 p.m.	CH	Panel – Electronic Physics Education Resources for Teachers and Teacher Educators	Bolden 5
4–5:50 p.m.	CI	Effective Practices in Educational Technologies	Bolden 2
6–7 p.m.		Early Career and First Timers' Meet-up	The Cellardoor
6–7:30 p.m.		Committee on History & Philosophy in Physics	Bolden 1
6–7:30 p.m.		Committee on Laboratories	Strand 3
6–7:30 p.m.		Committee on Physics in High Schools	Strand 10 B
6–7:30 p.m.		Committee on Physics in Two-Year Colleges	Strand 4
6–7:30 p.m.		Committee on Research in Physics Education (RiPE)	Empire D
6–7:30 p.m.	TOP1A	iOS and Android App Show	Strand 11 A
6–7:30 p.m.	TOP2B	Topical Discusssion: Forum on Teaching Pre-Service and In-Service Teachers	Bolden 3
6–7:30 p.m.	TOP6F	Identifying the Needs of Early Career TYC and 4YR Physics Faculty	Strand 11 B
7:30–8:30 p.m.	**Plenary**	Dr. Benjamin D. Santer, Lawrence Livermore National Laboratory	Celestin A-C
8:30–10 p.m.		Meeting of the AAPT Members	Celestin A-C
8:30–10 p.m.		High School Share-a-thon	Empire C

MONDAY, January 11

7 a.m.–5 p.m.		**REGISTRATION**	**Strand Foyer**
7–8 a.m.		Two-Year College Breakfast	8 Block Kitchen & Bar
7–8 a.m.		AAPT French Quarter Jogging / Walking Tour	offsite
7:30–9 a.m.		Awards Committee (Closed)	Strand 6
7:30–9 a.m.		Investment Advisory Committee (Closed)	Invitation Only
7:30–8:30 a.m.		Executive Programs Committee	Strand 2
8–9:30 a.m.	PST1	Poster Session 1	Storyville Hall, 3rd Fl.
8–9:30 a.m.	TOP4D	Topical Discussion: Physics and Society	Strand 10 A
8–9:30 a.m.	TOP5E	Graduate Student Topical Discussion	Strand 10 B
8–9:30 a.m.	TOP3C	Identifying the Needs of Preservice and Early Career HS Physics Teachers	Strand 11 B
9:30–11 a.m.	**Awards**	Richtmyer Memorial Lecture Award – **Derek Muller,** Veritasium; SPS Chapter Award	Celestin A-C
10 a.m.–4 p.m.		**Exhibit Hall Open**	Storyville Hall, 3rd Fl.

10 a.m.–7 p.m.		High School Physics Teachers Lounge	Imperial 11
10:30–11 a.m.		**Exhibit Hall Break** (10:45 a.m. Roku 3 Media Player Drawing)	Storyville Hall, 3rd Fl.
11 a.m.–12:50 p.m.	DA	SPS Contributed Talks	Strand 10 B
11 a.m.–12:30 p.m.	DB	Outcomes from the 2015 Conference on Laboratory Instruction Beyond the First Year	Empire C
11 a.m.–12:10 p.m.	DC	K-12 PER	Strand 11 B
11 a.m.–12:30 p.m.	DD	Climate Change	Bolden 6
11 a.m.–12 p.m.	DE	30 Demos in 60 Minutes	Strand 10 A
11 a.m.–12:30 p.m.	DG	At Home Labs	Bolden 5
11 a.m.–12:20 p.m.	DH	Undergraduate Research at Two Year Colleges	Bolden 1
12:30–2 p.m.		Multicultural Luncheon	Q Smokery and Café
12:30–2 p.m.		Committee on Educational Technologies	Bolden 4
12:30–2 p.m.		Committee on Graduate Education in Physics	Strand 10 A
12:30–2 p.m.		Committee on Professional Concerns	Strand 2
12:30–2 p.m.		Committee on Science Education for the Public	Bolden 2
12:30–1:30 p.m.	CW04	PASCO: Come See What's New from PASCO scientific	Strand 5
12:30–2 p.m.		Retired Physicists Luncheon	8 Block Kitchen & Bar
2–3 p.m.	**Plenary**	Dr. Kimberly Ennico Smith, NASA's Ames Research Center	Celestin A-C
3–3:30 p.m.		**Afternoon Break in Exhibit Hall** (3:15 p.m. Kindle Fire HD drawing)	Storyville Hall, 3rd Fl.
3:30–5:10 p.m.	EA	Climate Change B	Empire D
3:30–5:10 p.m.	EB	Outreach Physics Courses for Non-Science Majors	Imperial 5
3:30–5:30 p.m.	EC	Focused Collection on Upper-Division PER	Empire C
3:30–5:10 p.m.	ED	History of Physics and Astronomy	Strand 10 A
3:30–5 p.m.	EE	Educational Applications of Arduino Microcontrollers	Strand 10 B
3:30–5 p.m.	EF	Other Papers	Strand 11 B
3:30–5:30 p.m.	EG	Graduate International Experiences	Bolden 5
3:30–5:30 p.m.	EH	The PhysTEC 5+ Club	Bolden 6
3:30–5:10 p.m.	EI	Quadcopters, Drones and High Altitude Balloons	Bolden 2
4–4:30 p.m.		Great Book Giveaway	Storyville Hall, 3rd Fl.
5:30–6:30 p.m.		Membership and Benefits Committee	Imperial 12
5:30–6:30 p.m.		Committee on SI Units and Metric Education	Strand 6
5:30–7 p.m.		Committee on Apparatus	Strand 3
5:30–7 p.m.		Committee on International Physics Education	Bolden 4
5:30–7 p.m.		Committee on Physics in Pre-High School Education	Bolden 2
5:30–7 p.m.		Committee on Diversity in Physics	Strand 2
5:30–7 p.m.		Committee on Space Science and Astronomy	Bolden 3
5:30–7 p.m.		PTRA Oversight Committee	Strand 4
5:30–7 p.m.		American Institute of Physics: Science Communication Awards Celebration	Foster 1
6–7:30 p.m.		SPS Awards Reception	Foster 2
6–7:30 p.m.		PER Leadership Organizing Council (PERLOC)	Imperial 5
7–8:10 p.m.	FA	Physics Outside the Classroom: After School Clubs, Summer Camps, Enrichment	Bolden 1
7–8:30 p.m.	FB	Recovery of New Orleans Physics Post-Katrina	Strand 10 A
7–8:30 p.m.	FC	The Best Physics on YouTube	Strand 11 B
7–8 p.m.	FD	International Women in Physics	Bolden 6
7–8:30 p.m.	FE	Developing and Sustaining Collaborations in IPLS	Empire C
7–8 p.m.	FF	Interactive Lecture Demonstrations - What's New? ILDs Using Clickers, Video Analysis	Strand 10 B
7–8 p.m.	FG	High School	Bolden 5
7–8:30 p.m.	FH	Lessons Learned from the Demise of the SSC	Empire D
8:30–10 p.m.		Poster Session 2	Storyville Hall

TUESDAY, January 12

7–8:30 a.m.		Programs Committee II	Imperial 5 A
7:30–8:30 a.m.		PERTG Town Hall Meeting	Strand 11 B
8 a.m.–3 p.m.		**REGISTRATION**	Strand Foyer
8:30–9:50 a.m.	GA	Educational Applications of 3D Printers	Bolden 1
8:30–10:30 a.m.	GB	K-16 Physics Education Collaboratives	Strand 11 A
8:30–10:20 a.m.	GC	Physics on the Road	Strand 10 B
8:30–10:10 a.m.	GD	Introductory Courses	Bolden 2
8:30–10:20 a.m.	GE	PER: Examining Content Understanding and Reasoning	Strand 11 B
8:30–10:30 a.m.	GF	Big Science Data in the Classroom	Bolden 5
8:30–10 a.m.	GG	Enhancing Diversity in Astronomy	Bolden 6
8:30–10:10 a.m.	GH	Introductory Labs/Apparatus	Bolden 4
8:30–10:30 a.m.	GI	The Wonderful World of *AJP*	Strand 10 A
8:30–10:30 a.m.	GJ	Teaching with LIGO	Foster 1
9 a.m.–12 p.m.		SEES (Students to Experience Engineering and Science)	Empire B

10 a.m.–3 p.m.		High School Physics Teachers Lounge	Imperial 11
10:30 a.m.–12 p.m.	**Awards**	**Oersted Medal:** John W. Belcher, DSCs, AIP Writing Awards, Presidential transfer	Celestin A-C
12:30–1:30 p.m.	HA	Astronomy Papers	Strand 10 A
12:30–1:30 p.m.	HB	Energy in the Classroom	Bolden 1
12:30–1:30 p.m.	HC	Professional Skills for Graduate Students	Strand 11 B
12:30–1:30 p.m.	HD	Innovations in Online Education	Bolden 5
12:30–1:40 p.m.	HE	Women Physicists in Leadership Positions	Bolden 6
12:30–1:50 p.m.	HF	Upper Division Concerns	Strand 11 A
12:30–1:20 p.m.	HG	Teacher Training/Enhancement	Strand 10 B
2–3:30 p.m.		AAPT Symposium on Physics Education and Public Policy	Celestin A-C
3:30–5 p.m.		Post-deadline Poster Session	Storyville Hall
3:30–4:20 p.m.	IA	Post-deadline Abstracts (Papers)	Bolden 1
3:30–5 p.m.	IB	Post-deadline Abstracts II (Papers)	Bolden 5
3:30–5 p.m.	IC	Post-deadline Abstracts III (Papers)	Bolden 6
3:30–5 p.m.		Nominating Committee II (closed)	Strand 6
4:30–5:30 p.m.		Board of Directors III	Imperial 12

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Committee Meetings

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

Friday, January 8

Finance Committee	4:30–5:30 p.m.	Imperial 12
New Board of Directors Orientation	5:45–6:45 p.m.	Imperial 12
Board of Directors I	7–10 p.m.	Imperial 12

Saturday, January 9

Meetings Committee	8–10 a.m.	Strand 10 A
Publications Committee	8–10 a.m.	Strand 10 B
Resource Letters Committee	11:30 a.m.–2:30 p.m.	Strand 10 B
Board of Directors II	10:15 a.m.–4:45 p.m.	Imperial 12
Nominating Committee I (closed)	3–4:30 p.m.	Strand 2
ALPhA Committee	5:30–7 p.m.	Strand 3
New Area Chairs Orientation	5:30–6:30 p.m.	Strand 10 B
Section Representative and Officers	5:30–8 p.m.	Strand 10 A
Programs Committee I	6:30–8 p.m.	Strand 10 B

Sunday, January 10

Review Board	7:30–9 a.m.	Strand 2
Physics Bowl Advisory Committee	8–9 a.m.	Bolden 3
Governance Structure Committee	9–10 a.m.	Imperial 12
Venture/Bauder Fund Committees	9–10 a.m.	Strand 6
Undergraduate Physics Education*	12:30–2 p.m.	Bolden 3
Interests of Senior Physicists*	12:30–2 p.m.	Strand 2
Teacher Preparation*	12:30–2 p.m.	Bolden 2
Women in Physics*	12:30–2 p.m.	Strand 10 B
History and Philosophy of Physics*	6–7:30 p.m.	Bolden 1
Laboratories*	6–7:30 p.m.	Strand 3
Physics in High Schools*	6–7:30 p.m.	Strand 10 B
Physics in Two-Year Colleges*	6–7:30 p.m.	Strand 4
Research in Physics Education*	6–7:30 p.m.	Empire D
Meeting of the AAPT Members	8:30–10 p.m.	Celestin A-C

Monday, January 11

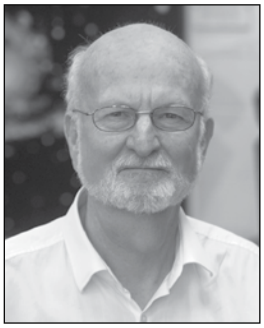
Awards Committee (closed)	7:30–9 a.m.	Strand 6
Investment Advisory Committee (closed)	7:30–9 a.m.	Invite Only
Executive Programs Committee	7:30–8:30 a.m.	Strand 2
Educational Technologies*	12:30–2 p.m.	Bolden 4
Graduate Education in Physics*	12:30–2 p.m.	Strand 10 A
Professional Concerns*	12:30–2 p.m.	Strand 2
Science Education for the Public*	12:30–2 p.m.	Bolden 2
Membership and Benefits Committee	5:30–6:30 p.m.	Imperial 12
SI Units and Metric Education*	5:30–6:30 p.m.	Strand 6
Apparatus*	5:30–7 p.m.	Strand 3
International Physics Education*	5:30–7 p.m.	Bolden 4
Pre-High School Education*	5:30–7 p.m.	Bolden 2
Diversity in Physics*	5:30–7 p.m.	Strand 2
Space Science and Astronomy*	5:30–7 p.m.	Bolden 3
PTRA Oversight Committee	5:30–7 p.m.	Strand 4
PERLOC (closed)	6–7:30 p.m.	Imperial 5

Tuesday, January 12

Programs Committee II	7–8:30 a.m.	Imperial 5 A
PERTG Town Hall Meeting	7:30–8:30 a.m.	Strand 11 B
Nominating Committee II (Closed)	3:30–5 p.m.	Strand 6
Board of Directors III	4:30–5:30 p.m.	Imperial 12



Awards at the AAPT 2016 Winter Meeting



John W. Belcher
MIT
Department of Physics
Boston, MA

The Challenges of Pedagogical Change at a Research I University

Tuesday, January 12

10:30 a.m.–12 p.m.

Celestin A-C

Oersted Medal 2016

John W. Belcher has been named as the 2016 recipient of the Hans Christian Oersted Medal in recognition of his outstanding, widespread, and lasting impact on the teaching of physics through his tireless work with TEAL (Technology Enabled Active learning) and Massive Open Online Courses (MOOCs).

Belcher graduated summa cum laude from Rice University in 1965 with a double major in math and physics, He then went to Caltech for graduate school. His Doctoral thesis, under the direction of Professor Leverett Davis, Jr. involved analysis of magnetic field data from Mariner 5, a 1967 mission to Venus, and also theoretical work on the acceleration of the solar wind.

Belcher joined the faculty at Massachusetts Institute of Technology (MIT) in 1971 to work with Professors Herbert Bridge and Alan Lazarus, who had the plasma probe on board Mariner 5. Just after he arrived, the MIT Space Plasma Group wrote a proposal for the Voyager mission to Jupiter and Saturn. After reaching these two planets, as well as Uranus and Neptune, Voyager is still going strong, with an expected demise in 2031. In its most recent incarnation, it is referred to as the Voyager Interstellar Mission.

In 2004, MIT awarded Belcher the Class of '22 Professorship, designed to honor "a tenured faculty member with a record of excellence in education, with respect to both curriculum development and classroom teaching." He was the Associate Chair of the MIT Faculty in AY 2013-2014. He is an MIT MacVicar Faculty Fellow.

The Oersted Medal recognizes Belcher's efforts to introduce an active learning format into the main-stream physics introductory courses at MIT. Technology Enabled Active Learning (TEAL) is a teaching format that merges lectures, simulations, and hands-on desktop experiments to create a rich collaborative learning experience. As a result of the TEAL project, MIT has replaced its main-stream two-semester freshman physics sequence (the largest subjects at MIT) with studio-mode classes, where students work collaboratively on laboratory work in a computer-rich environment. The TEAL group has also developed an extensive suite of simulation and visualization software for electromagnetism, which is being distributed across the world through MIT OpenCourseWare.

His subsequent developmental work with Massive Open Online Courses (MOOCs) has enabled educators to expand their outreach beyond the classroom, making the content available to many more students.

The Oersted Medal is named for Hans Christian Oersted (1777-1851), a Danish physicist who, in the course of creating a demonstration for teaching his class, discovered that electric currents caused a magnetic field. This was a crucial step in establishing the theory of electromagnetism, so important in building modern technology and modern physics. The award was established by AAPT in 1936.

Derek Muller
creator of YouTube channel *Veritasium*

Why Some Confusion is Good – Evidence for How to Make Learners Think

Monday, January 11

9:30–11 a.m.

Celestin A-C

Richtmyer Memorial Lecture Award 2016

Derek Muller has been selected to receive the 2016 Richtmyer Memorial Lecture Award. Muller is recognized with the award for outstanding contributions to physics and effectively communicating those contributions to physics educators. Muller, a physics educator and science communicator, film-maker, and television personality is best known for creating the YouTube channel *Veritasium*, which has received over 200 million views on YouTube.

Regarding his selection for this award Muller said, "I am honored to be recognized by the AAPT and delighted to have the opportunity to speak to the talented and dedicated physics educators at the Winter Meeting."

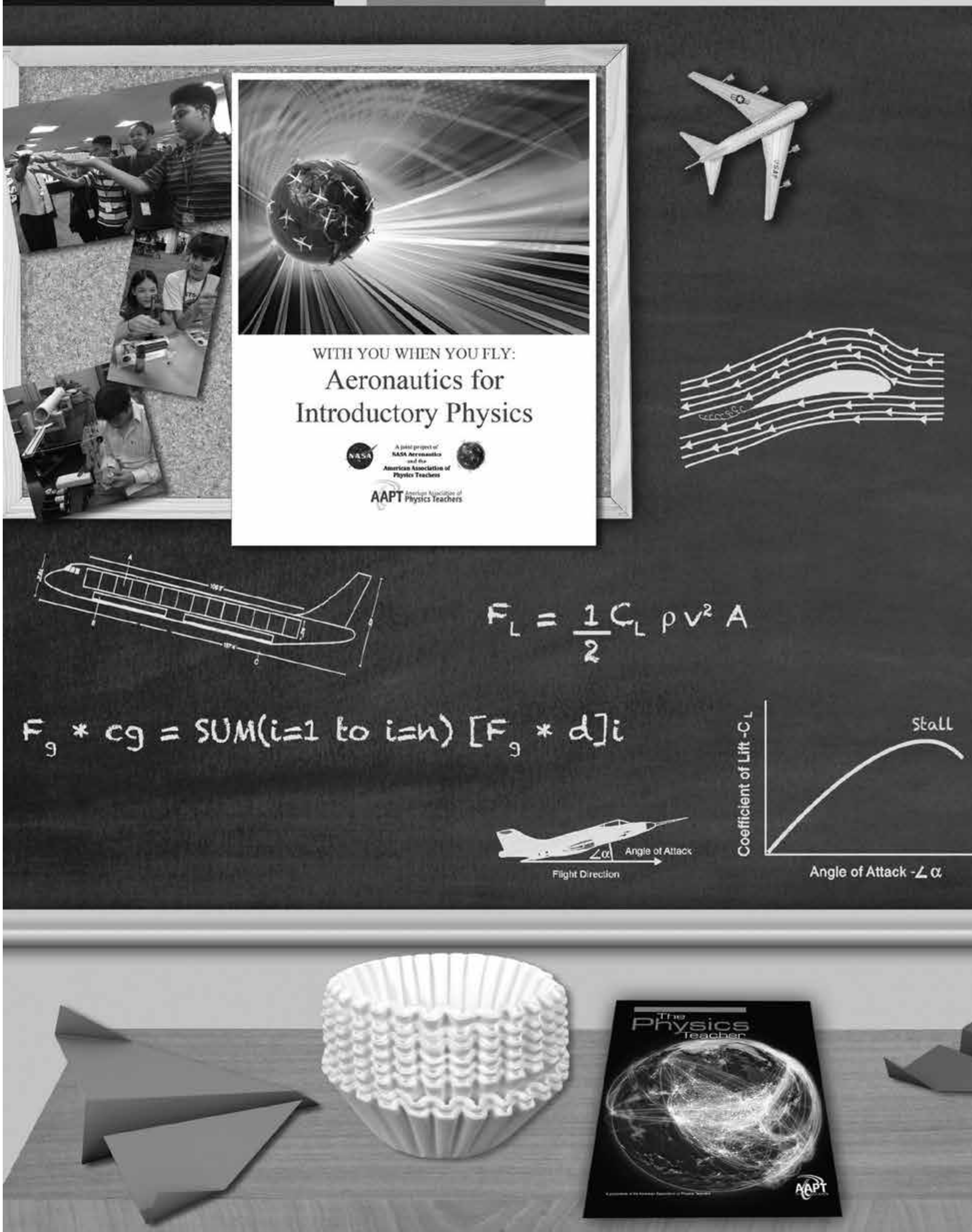
A native of Australia, raised in Canada, he graduated with a BSc in Engineering Physics from Queen's University in Ontario. Then he attended the University of Sydney where he completed his PhD in Physics Education Research in 2008 with a thesis, "Designing Effective Multimedia for Physics Education." He began putting his research into practice with his Veritasium YouTube channel in 2011. This quickly led to joining the team of Catalyst, Australia's premiere science TV programme. He has also been featured on the BBC, Discovery Channel, History Channel, and he recently presented a two-part documentary on PBS entitled Uranium: Twisting the Dragon's Tail.

Muller is guided by the great quote by Richard Feynman, "The first principle is that you must not fool yourself, and you are the easiest person to fool." His goal is to help people across the world not fool themselves when it comes to science and how it pertains to their lives.

Named for Floyd K. Richtmyer, distinguished physicist, teacher, and administrator and one of the founders of AAPT, the Richtmyer Memorial Lecture Award recognizes those who have made outstanding contributions to physics and their communication to physics educators. The recipient delivers the Richtmyer Lecture at an AAPT Winter Meeting on a topic of current significance and at a level suitable for a non-specialist audience and receives a monetary award, an Award Certificate, and travel expenses to the meeting. The award was established in 1941.

National Aeronautics and Space Administration

GRADES 9-12



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- Constant Velocity
- Uniform Acceleration
- Terminal Velocity
- Force Particle - Inertia
- Constant Net Force
- 2-D Combination
- Energy
- Rotational Motion

http://www.aapt.org/Resources/Aeronautics-for-Introductory-Physics.cfm

AAPT PHYSICS EDUCATION

Homer L. Dodge Citations for Distinguished Service to AAPT

Tuesday, January 12 • 10:30 a.m.–12 p.m. • Celestin A-C

Marina Milner-Bolotin

Marina Milner-Bolotin

Marina Milner-Bolotin, assistant professor at the University of British Columbia, is recognized for her outstanding service as a section representative and as a member of the AAPT Board of Directors. She earned her BSc and MSc in Physics at V.N. Karazin Kharkiv National University, Ukraine. Her MA and PhD in Science Education were earned at The University of Texas at Austin. Her service to AAPT includes section representative of the Ontario and British Columbia Sections, Vice Chair and Chair of the Section Representatives, Publications Committee member, and Board of Directors member. She served on the organizing committee for several national meetings and has made numerous invited and contributed presentations at AAPT meetings.

Michael Faleski

Michael Faleski

Michael Faleski, a professor of Physics at Delta College, joined AAPT in 1998. He earned his BS in physics at the Rochester Institute of Technology. His MS and PhD in physics were from Syracuse University, where he also received a certificate for completing the Future Professoriate Program. He has been working with the PhysicsBowl for 15 years, originally serving on the committee and becoming the academic coordinator in 2008. One of the challenges he faces is crafting a test that challenges the very top students while not discouraging the majority of students. Each year, over 7,000 students take this 40-question, 45-minute timed, multiple-choice test, and Faleski is responsible for scoring the tests and publishing results in just a few weeks. In addition to all of these regular duties, he has worked hard to expand the PhysicsBowl in a variety of ways.

Karl Mamola

Karl C. Mamola

Karl C. Mamola, physics professor emeritus at Appalachian State University, is being recognized for his distinguished service to AAPT in a wide range of leadership roles at the section and national levels. He served as editor of *The Physics Teacher* from 2000-2013. Throughout his career, Mamola has touched a multitude of lives, as a physics teacher, a prolific author, a presenter at national and local meetings, as editor of the "Apparatus for Teaching Physics" column in *The Physics Teacher*, and as editor of *The Physics Teacher,* AAPT's signature publication. He consistently produced an extraordinary publication with content accessible to and usable by physics teachers at all levels. Regarding his selection to receive this honor Mamola said, "AAPT has played a major role in my professional life for more than 50 years. I am pleased and honored to receive the Association's Homer L. Dodge Distinguished Service Citation."

Gay Stewart

Gay Stewart

Gay Stewart, Eberly Professor of STEM Education and director of the West Virginia University Center for Excellence in STEM Education is recognized for her outstanding service as a member of the AAPT Board of Directors, serving in the presidential chain from 2011–2015. Stewart has served as AAPT liaison to the APS Forum on Education (FEd) Executive Committee, and as chair of the FEd Executive Committee. She was a member of the PhysTEC Leadership Council, PKAL Faculty for the 21st Century, the NRC-BOSE k-12 Science Education Frameworks focus group, the APS Committee on Education, and chair of the AP Physics Redesign Commission and Curriculum Development and Assessment Committee. She is a friend of the AAPT Teacher Preparation Committee, chair of the College Board AP Physics Test Development Committee, and a member of the APS Board of Directors and Council of Representatives.

David Weaver

David Weaver

David Weaver, a member of AAPT since 1992, recently retired from teaching at Chandler-Gilbert Community College (C-GCC) in Chandler, AZ, where he served as a division chair, occupational program designer and director, occupational dean, faculty senate president, member and chair of the C-GCC Instructional Technology committee, chair and co-chair of district-wide instructional technology initiatives, curriculum design facilitator, staff development coordinator, and district-wide chair of the physics instructional council. He received Emeritus distinction from C-GCC and is currently teaching at Estrella Mountain Community College as a sabbatical replacement. His contributions to AAPT include service at both the national and the local level. Nationally, he has served on the Committee on Physics in Two-Year Colleges as a member and also as chair, member of the Programs Committee, Secretary of the Section Representatives and as Co-Chair of the AAPT Ad Hoc Committee on Alternative Access. Locally, David served as president, vice president, two-year college representative, and section representative of the Arizona section of the American Association of Physics Teachers. He is known as a leader in the two-year college community. Tom O'Kuma noted that David "has been involved in every major two-year college initiative of AAPT." He was active in the TYC21 (Two-Year College for the Twenty-First Century) and the SPIN-UP/TYC project.

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

#AAPTWM16

JOIN US FOR A TWEET UP

SATURDAY, JANUARY 9

6:00-7:00 PM IN STRAND 4

Gather with attendees and Tweet about the highlights of the meeting, and grab a Bugnes - an essential Mardi Gras dessert

SYMPOSIUM on Physics Education

AAPT Symposium on Physics Education and Public Policy

Tuesday, January 12 • 2–3:30 p.m. • Celestin A-C

Policymakers formulate decisions everyday that impact curriculum, standards, funding, and many other aspects of physics education at all levels. AAPT works with a number of partners to keep policymakers informed on the views of physics educators and to suggest appropriate policy options within the Association's sphere of influence. This session brings together individuals who play pivotal roles in helping to shape policies and who provide information to policymakers. We hope to provide a look at the process of policy making as well as actions you might make to contribute to decisions about policies affecting physics and STEM education.

Facilitator: *Noah Finkelstein, Professor of Physics at University of Colorado at Boulder*

Speakers:

Ramón Barthelemy

Ramón Barthelemy, *AAAS (American Association for the Advancement of Science) Science Policy Fellow in the U.S. Department of Education*

Dr. Ramón Barthelemy is currently an AAAS (American Association for the Advancement of Science) Science Policy Fellow in the U.S. Department of Education, after completing a Fulbright Scholarship at the University of Jyväskylä in Finland. He holds a BS in Astrophysics from Michigan State University and PhD in Science Education from Western Michigan University. His work centers around broadening student participation in STEM as well as improving their educational experience. This has included a focus on issues of gender, sexual orientation, race, and understanding the graduate student experience in PER (physics education research).

Meredith Drosback

Meredith Drosback, *Assistant Director, Education and Physical Sciences, Science Division, Office of Science and Technology Policy, U.S. White House*

Meredith Drosback serves as the Assistant Director for Education and Physical Sciences at the White House Office of Science and Technology Policy (OSTP). Her work focuses largely on improving learning outcomes and opportunities in undergraduate science, technology, engineering, and mathematics (STEM) education, as well as a variety of topics in the physical sciences, including space science. She has been at OSTP since 2012 when she joined the office to work on the Materials Genome Initiative, a multi-agency initiative designed to accelerate the discovery, development, and deployment of advanced materials. Prior to coming to OSTP, Meredith served as a Congressional Fellow on the Senate Commerce, Science, and Transportation Committee, Subcommittee on Science and Space. There her work supported a wide range of scientific and STEM education policy issues relevant to the National Science Foundation, National Institute of Standards and Technology, and NASA. She completed a postdoctoral research assistantship at the University of Virginia and received her PhD in Astrophysics from the University of Colorado, an MS in Physics from North Carolina State University, and a BS in Chemistry from Duke University.

Evidence for Human Effects on Global Climate

by Benjamin D. Santer

Sunday, January 10 • 7:30–8:30 p.m. • Celestin A-C

Benjamin D. Santer
Lawrence Livermore National Lab

Ben Santer is an atmospheric scientist at Lawrence Livermore National Laboratory (LLNL). His research focuses on such topics as climate model evaluation, the use of statistical methods in climate science, and identification of natural and anthropogenic "fingerprints" in observed climate records. Santer's early research on the climatic effects of combined changes in greenhouse gases and sulfate aerosols contributed to the historic "discernible human influence" conclusion of the 1995 Report by the Intergovernmental Panel on Climate Change (IPCC). His recent work has attempted to identify anthropogenic fingerprints in a number of different climate variables, such as tropopause height, atmospheric water vapor, the temperature of the stratosphere and troposphere, ocean heat content, and ocean surface temperatures in hurricane formation regions.

Santer holds a PhD in Climatology from the University of East Anglia, England. After completion of his PhD in 1987, he spent five years at the Max-Planck Institute for Meteorology in Germany, where he worked on the development and application of climate fingerprinting methods. In 1992, Santer joined LLNL's Program for Climate Model Diagnosis and Intercomparison.

Santer served as convening lead author of the climate-change detection and attribution chapter of the 1995 IPCC report. His awards include the Norbert Gerbier–MUMM International Award (1998), a MacArthur Fellowship (1998), the U.S. Department of Energy's E.O. Lawrence Award (2002), a Distinguished Scientist Fellowship from the U.S. Dept. of Energy, Office of Biological and Environmental Research (2005), a Fellowship of the American Geophysical Union (2011), and membership in the U.S. National Academy of Sciences (2011). He recently visited the Juneau Icefield in Alaska, and enjoys rock-climbing, mountaineering, and exploring the beautiful state of California with his wife Kris.

Pluto Revealed: First Results from the Historic 1st Fly-by Space Mission

by Kimberly Ennico Smith

Monday, January 11 • 2–3 p.m. • Celestin A-C

Kimberly Ennico Smith
NASA

Dr. Kimberly Ennico Smith is a research astrophysicist at NASA's Ames Research Center. She is a Co-Investigator and Deputy Project Scientist on NASA's New Horizons Pluto Fly-by Mission, leading the calibration activities and doing compositional mapping of Pluto and Charon with color imagery and spectroscopy. Dr. Ennico is also an Instrument Scientist for the Near-Infrared Volatile Spectrometer System instrument in the Regolith & Environment Science and Oxygen & Lunar Volatile Extraction lunar payload suite and an Instrument Scientist for the Mid-Infrared Spectroscopy Mode for the Stratospheric Observatory for Infrared Astronomy FORCAST Instrument. She is also a Principal Investigator developing innovative telescope designs using small satellites and is actively working to mature low-cost, quick turn-around suborbital and balloon payloads that deliver focused science measurements and promote broader hands-on experience. Her prior space mission experience includes being Instrument Scientist on the Spitzer Space Telescope Far-Infrared camera MIPS, specialist in detector radiation testing for the James Webb Space Telescope, and Payload Scientist and Integration & Test Lead for the Lunar Crater Observation and Sensing Satellite, where she successfully demonstrated a cost-effective Class D test program of modified COTS hardware.

Outstanding SPS Chapter Advisor Award

Monday, January 11 • 9:30–11 a.m. • Celestin A-C

Kiril Steletsky

Kiril Streletsky is the 2015 SPS Outstanding Chapter Advisor Award Recipient. Streletzky is an Associate Professor of Physics at Cleveland State University. He is currently serving as the Zone 7 Councilor on the SPS National Council. He received his BS from the Moscow Institute of Physics and Technology, and his PhD from Worcester Polytechnic Institute. Streletzky has invested endless time, energy, and passion into helping CSU physics students build an effective SPS chapter. His constant challenge to physics students to excel coupled with his flexibility and compassion has been a key in helping undergraduates develop as leaders in the department and in the community.

AIP Science Writing Awards

Tuesday, January 12 • 10:30 a.m.–12 p.m. • Celestin A-C

Agnieszka Biskup

The American Institute of Physics (AIP) has named three winners for this year's AIP Science Writing Awards in the Writing for Children category for fun works on the science behind a famous superhero and the solution to a kids' mystery: Agnieszka Biskup and Tammy Enz will receive the prize for *Batman Science: The Real-world Science Behind Batman's Gear*, published by Capstone Young Readers; and Dia L. Michels, who led a team of writers, will receive the prize for *Ghost in the Water,* published by Science, Naturally.

Agnieszka Biskup

Agnieszka Biskup is a managing editor at Kindermusik International. She is a former science editor at the *Boston Globe* as well as a Knight Fellow at MIT, where she studied science journalism. She served as managing editor of the children's science magazine *Muse* and has written numerous children's books in addition to many articles for newspapers, magazines, and websites. Her books have received awards from Learning magazine, the Association of Educational Publishers, the Society of School Librarians International, and have been chosen as Junior Library Guild selections.

Tammy Enz

Tammy Enz

Tammy Enz is a civil engineer, a writer and an adjunct instructor in the Master's program at the University of Wisconsin–Platteville. She has written dozens of books, articles and stories about engineering, science and technology for young people. Her 'Invent It' Series with Capstone Press received the Teachers' Choice Award for the Family. In her spare time, she fixes up old houses and conducts experiments in her garden and kitchen. She loves reading books about anything and everything and asking "why?" She lives in Wisconsin with her husband and two children.

Dia L. Michels

Dia L. Michels

Dia L. Michels is an award-winning, internationally-published science and parenting writer and the author or editor of over a dozen books for children and adults. Her books have been translated into Spanish, Dutch, Hebrew, Chinese and Korean. She is also founder and president of two publishing houses—Platypus Media, committed to creating and distributing materials on the healthy development of infants and children, and Science, Naturally, publishing books designed to increase science and math literacy by exploring and demystifying topics in entertaining and enlightening ways. Both houses have been honored with numerous awards and professional endorsements. She is very proud to add the AIP award to their acclaim. Dia is also a popular speaker, lecturing and leading hands-on workshops regularly for educators, families and children. She lives in Washington, D.C., with her husband and their three children.

WELCOME FIRST TIME MEETING ATTENDEES!

Meet newbies and check out what resources AAPT has to support you during the **First-Timers' Breakfast** on Sunday, January 10 from 7:00 - 8:00AM.

Then, join us for the **Early Career and First Timers' Meet-up*** on Sunday, January 10 from 6:00 - 7:00 PM at the Cellardoor on 916 Lafayette Street. Take this opportunity to get social with other attendees and have some fun! Check out www.littlegemsaloon.com.
*Food and drink will not be provided so please plan accordingly.

Not Sure who's new? Spot other First Time Attendees wearing newbie/bee stickers on their badges.
Pick yours up at the Registration Desk or AAPT Booth!

Free Commercial Workshops

CW01: Expert TA: Realigning Homework Grades and Test Scores in the Modern Classroom

Location: Empire D
Date: Sunday, January 10
Time: 12:30–1:30 p.m.
Sponsor: Expert TA

Leader: Jeremy Morton

The gap between students' homework grades and test scores is a concern we share with you. In order to study this, in 2012 Expert TA launched its Analytics platform and entered into the arena of "Big Data." Using this platform, we worked with instructors to do an intense analysis of data from 125 classes from the 2013-2014 AY; cross-referencing an aggregate data set involving approximately 1200 assignments and 2.4 million submitted answers. We identified three major factors causing these gaps: access to immediate and meaningful feedback, practice on symbolic questions, and a minimized ability to find problem solutions online. Knowing this, we have worked to develop the largest available library of "symbolic" questions and we use Analytics to data mine every incorrect answer ever submitted, in order to continually improve our feedback for these questions. We have also established very effective strategies to guard our problem solutions. The ultimate goal is to keep students focused on the physics; and then as they are working problems to provide them with meaningful, Socratic feedback that helps resolve misconceptions. Please join us and learn how other instructors are using Expert TA to reduce cost to students, increase academic integrity, and improve overall outcomes.

CW02: Enrich Your Physics Lecture and Lab Courses with WebAssign Content

Location: Strand 3
Date: Sunday, January 10
Time: 12:30–1:30 p.m.
Sponsor: WebAssign

Leader: Matt Kohlmyer

Since 1997, WebAssign has been the online homework and assessment system of choice for introductory physics lecture courses. Many veteran instructors already know that WebAssign supports over 150 introductory physics textbooks with precoded, assignable questions and advanced learning tools. In this presentation, we will focus on the wide array of WebAssign content you can use to enhance both your lecture course and your lab sections. WebAssign offers great resources for physics instruction, many of which can be adopted to supplement publisher offerings for no additional charge to your students. These include original question collections with feedback, solutions, and tutorials paired to some of the most popular textbooks; direct measurement videos that help students connect physics to real-world scenarios; and conceptual question collections authored by experienced educators and designed around physics education research principles. WebAssign also offers ready-to-use lab solutions, designed and tested at major universities, which you can adopt and customize to fit your needs. In some cases we can even build custom lab programs based on your specific lab materials and setup. This workshop is intended for current WebAssign users, but newcomers are welcome to join.

CW03: Physics with PASCO scientific, Featuring PASCO Capstone™, the Ultimate Data Collection and Analysis Software for Physics

Location: Strand 4
Date: Sunday, January 10
Time: 12:30–1:30 p.m.
Sponsor: PASCO

Leader: Brett Sackett

Get hands-on with the most sophisticated and flexible Physics software available today, PASCO Capstone, with advanced Physics analysis features including video analysis. See how using PASCO probeware, software, and equipment will enhance your physics demonstrations and labs. Enter to win a copy of PASCO Capstone!

CW04: Come See What's New from PASCO scientific!

Location: Strand 5
Date: Monday, January 11
Time: 12:30–1:30 p.m.
Sponsor: PASCO

Leader: Brett Sackett

From demonstration equipment to new lab apparatus and data logging, at PASCO we are constantly developing new products for both high school and university physics labs. Please join us for a look at the new innovative products from PASCO for your lab and lecture.

CW05: Cengage Learning – Physics for Scientists and Engineers: Foundations and Connections – A New Approach in Applying Physics Education Research (PER)

Location: Strand 5
Date: Sunday, January 10
Time: 11 a.m.–12 p.m.
Sponsor: Cengage Learning

Leader: Debora Katz

Dr. Debora Katz is the author of a groundbreaking calculus-based physics program, Physics for Scientists and Engineers: Foundations and Connections, published by Cengage Learning. The author's one-of-a-kind case study approach enables students to connect mathematical formalism and physics concepts in a modern, interactive way. By leveraging physics education research (PER) best practices and her extensive classroom experience, Dr. Katz addresses the areas students struggle with the most: linking physics to the real world, overcoming common preconceptions, and connecting mathematical formalism to physics concepts. How Dr. Katz deals with these challenges—with case studies, student dialogues, and detailed two-column examples—distinguishes this text from any other on the market and will assist you in taking your students "beyond the quantitative." .

AAPT Journals

Booth #305
One Physics Ellipse
College Park, MD 20740
301-209-3300
mgardner@aapt.org
www.aapt.org

Drop by for information on how you can become part of the AAPT Publications program. Learn why you should submit articles for publication, consider becoming a reviewer, and make sure your physics department subscribes to *American Journal of Physics* and *The Physics Teacher.* It is rumored that it may be possible to catch up with journal editors and other members of the Publications Committee during your visit. If you are an online only member, you'll get a chance to see the print copies and reconsider your choice. If you aren't yet an AAPT member we will do our best to help you decide which option is best for you.

American Association of Physics Teachers

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

Welcome to New Orleans! Join us at the AAPT booth and spin the wheel for your chance to win awesome prizes! We will have a large selection of educational resources available to meet the needs of everyone from students to faculty. Pick up information on some of AAPT's leading programs such as PTRA, eMentoring, and the U.S. Physics Team. Learn about some of our engaging online physics demos and lessons from ComPADRE. Check out the latest and greatest items from The Physics Store catalog including publications, AAPT-branded merchandise, and a limited collection of member-only items. Items will be available for purchase at the booth at a significant savings. Lastly, do not forget to pick up your ticket for the Great Book Giveaway!

American Institute of Physics

Booth #311
One Physics Ellipse
College Park, MD 20740
301-209-3100
cunger@aip.org
www.aip.org

AIP has been sending *Physics Today* magazine to AAPT members for more than 60 years. Come by the booth to learn about other AIP benefits to which you're entitled, including career resources like employment statistics, Society of Physics Students and an online job board.

American Physical Society

Booth #313
One Physics Ellipse
College Park, MD 20740
301-209-3206
thompson@aps.org
www.aps.org

The American Physical Society's Public Outreach Department aims to bring the excitement of physics to all. Stop by to grab our new retro poster series, your copy of Spectra's Quantum leap or hear more about www.physicscentral.com. We will also be demoing our new comic book app as well as SpectraSnapp for android.

Arbor Scientific

Booth #201
PO Box 2750
Ann Arbor, MI 48106
800-367-6695
peter@arborsci.com
www.arborsci.com

For 25 years, Arbor Scientific has worked with physics and physical science teachers to develop educational science supplies, science instruments, and physics lab equipment that make learning fun for students in elementary grades through college. Stop by our Booth and try the most fascinating, dynamic, hands-on methods that demonstrate key concepts and principles of physics and chemistry. We find the cool stuff!

Cengage Learning

Booth #304
55 Maxwell Dr.
Clifton Park, NY 12065
518-373-6226
michael.j.smith@cengage.com
www.cengage.com

Cengage Learning is a leading educational content, technology, and services company for the higher education and K–12, professional and library markets worldwide. The company provides superior content, personalized services and course-driven digital solutions that accelerate student engagement and transform the learning experience. www.cengage.com.

CPO Science, School Specialty Science

Booth #206
80 Northwest Blvd.
Nashua, NH 03063
603-579-3467
dot.rivard@schoolspecialty.com
www.cposcience.com

CPO Science focuses on educators, so educators can focus on achievement by providing high-quality, inquiry-based teaching and learning systems for science, in grades 6-12. CPO offers innovative science textbook programs (that integrate the student text, teacher support materials, and lab equipment), and nationally recognized professional development programs.

Expert TA

Booth #207
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 207 for a demonstration.

GradSchoolShopper

Booth #309
One Physics Ellipse
College Park, MD 20740
301-209-3007
jyork@aip.org
gradschoolshopper.com

JGSS features the profiles of several hundred graduate programs with comparative information on degrees offered, admissions, financial aid, housing, degree requirements, department and faculty research specialties, facilities, notable alumni, etc. The Graduate Programs in Physics, Astronomy, and Related Fields is its print companion. The book is celebrating its 50th Anniversary this year.

IntellADAPT inc.

Booth #213
UMass Boston, Venture Development Center
100 Morrissey Blvd
Boston, MA 02125
617-694-1767

IntellADAPT is an Adaptive Learning Platform for Physics and other STEM courses. It delivers content to students in a manner that is best suited to that student's learning strategy. IntellADAPT automatically differentiates instruction by learning strategy, drastically reducing the time needed by teachers and professors to prepare lectures, and incredibly increasing student understanding of concepts and performance on assessments. Big data and real-time analytics show students and instructors where weaknesses are. The dynamic courseware directs students to alternate lessons if assessment reveals weakness in comprehension. IntellADAPT is a great resource for high school or college level students learning Physics!

Klinger Educational Products Corp.

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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. X-rays are detected with an End-window Counter or an Energy Detector.

In addition we will have a Diode pumped Nd:YAG Laser with Frequency Doubling to demonstrate optical pumping, second harmonic generation and spectroscopy.

Laser Classroom

Booth #217
1419 Main Street NE
Minneapolis, MN 55413
763-234-0692
colette@laserclassroom.com
www.laserclassroom.com

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Houston, TX 77005
713-348-3674
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Society of Physics Students

Booth #307
One Physics Ellipse
College Park, MD 20740
301-209-3008
lquijada@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 undergraduate physics students and their mentors with a chapter in nearly every physics program in the country and several international chapters. Sigma Pi Sigma, with over 95,000 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, internships, research awards, physics project awards, outreach/service awards, and a job site for summer and permanent bachelor's level physics opportunities (jobs.spsnational.org).

Southern University

Booth #310
6400 Press Dr.
New Orleans, LA 70126
MElaasar@suno.edu
http://suno.edu/

Southern University at New Orleans, founded in 1956, is a four-year public institution categorized as an SREB Four-Year 5 institution, a Carnegie Master's College and University I, and as a SACSCOC Level III institution. As an accredited liberal arts teaching institution and a member of the Southern University System, SUNO is known for its highly engaged faculty and personal academic support. The University offers a wide range of baccalaureate programs and is committed to graduate education through the master's degree, offering graduate programs to meet regional and statewide needs. For information, please visit the University's Web site at www.SUNO.edu.

Vernier Software and Technology

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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). Come by Booth 201 to learn more about College Physics, to hear about the newest features in smartPhysics, and to browse through other market-leading physics and astronomy titles. www.whfreeman.com/physics. whfreeman.com/physics.

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SHARED BOOK EXHIBIT

Take a look at the books exhibited from the following publishers in the Exhibit Hall!

Princeton University Press

1. Canales, *The Physicist and the Philosopher*
2. Carlson, *Tesla*
3. Einstein, *Relativity*
4. Feynman, *The Quotable Feynman*
5. Frebel, *Searching for the Oldest Stars*
6. Gutfreund/Renn, *The Road to Relativity*
7. Hawking/Penrose, *The Nature of Space and Time [Princeton Science Library]*
8. Johnson, *How Do You Find an Exoplanet?*
9. Kinder/Nelson, *A Student's Guide to Python for Physical Modeling*
10. Ostriker/Mitton, *Heart of Darkness*
11. Robinson, *Einstein*
12. Stillinger, *Energy Landscapes, Inherent Structures & Condensed Matter…*
13. Stone, *Einstein and the Quantum*

Sunday, January 10, 2016 – Session Schedule

	Strand 11 A	Strand 10 B	Strand 10 A	Strand 11 B	Bolden 5	Empire C	Bolden 1	Empire D	Bolden 6	Bolden 3	Bolden 2	Bolden 4	Celestin A-C
10:00 a.m.	**AA** Meeting the Breadth of NGSS	**AB** Maker Movement (FabLab/ Tech. Shop/ Maker Space)	**AC** Best Practices in Educational Technology	**AD** Professional Concerns in High School	**AE** PER: Evaluating Instructional Strategies	**AF** Teaching Electronics in Upper Level Undergraduate Physics							
10:30 a.m.													
11:00 a.m.													
11:30 a.m.													
12:00 p.m.													
2:00 p.m.	**BB** The Planetarium Classroom		**BA** AP Physics Exam Questions	**BI** Lab Guidelines Focus Area 2: Designing Experiments	**BC** Lessons from the Pre-HS Classroom	**BG** Doubling Minority PhDs: The APS Bridge Program	**BD** Flipped Classrooms	**BH** PER: Curricula for Intro. Physics for Life Science	**BE** Latina/Hispanic Women Physicists			**BF** Licensure Issues for Teachers	
2:30 p.m.													
3:00 p.m.													
3:30 p.m.													
4:00 p.m.		**CD** Research on Ethnic Minorities: PER, DBER, and Science Education	**CF** PER: Diverse Investigations	**CA** Discovery Physics in the Classroom	**CH** *Panel* – Electronic Physics Education Resources for Teachers and Teacher Educators	**CC** Writing and Assessing Biology-based Problems in the Introductory Physics Course	**CB** Flipped Classrooms B		**CE** Astronomy Education Research: Current Trends and Future Directions		**CI** Effective Practices in Educational Technologies	**CG** International Programs and Teaching Experiences	
4:30 p.m.													
5:00 p.m.													
5:30 p.m.													
6:00 p.m.	**TOP1A** iOS and Android App Show			**TOP3C** Identifying the Needs of Preservice and Early Career HS Physics Teachers						**TOP2B** Forum on Teaching Pre-Service and In-Service Teachers			
6:30 p.m.													
7:00 p.m.													
7:30 p.m.													**PLENARY:** Dr. Benjamin D. Santer
8:00 p.m.													
8:30 p.m.													

AAPT PHYSICS EDUCATION 2016 WINTER MEETING JANUARY 9-12 NEW ORLEANS, LA

Monday, January 11, 2016 – Session Schedule

Poster Session 1, 8 to 9:30 a.m. • Poster Session 2, 8:30 to 10 p.m. (Storyville Hall –3rd floor)

	Strand 10 B	Strand 10 A	Strand 11 B	Bolden 5	Empire C	Bolden 1	Empire D	Bolden 6	Bolden 2	Imperial 5	Celestin A-C
8:00 a.m.	**TOP5E** Graduate Student Topical Discussion	**TOP4D** Physics and Society	**TOP6F** Identifying the Needs of Early Career TYC and 4YR Physics Faculty								
8:30 a.m.											
9:00 a.m.											
9:30 a.m.											**Richtmyer Memorial Lecture Award:** Derrick Muller
10:00 a.m.											
10:30 a.m.											
11:00 a.m.	**DA** SPS Contributed Talks	**DE** 30 Demos in 60 Minutes	**DC** K-12 PER	**DG** At Home Labs	**DB** Outcomes from the 2015 Conference on Laboratory Instruction	**DH** Undergrad Res. at 2-Year Colleges		**DD** Climate Change			
11:30 a.m.											
12:00 p.m.											
12:30 p.m.											
1:00 p.m.											
2:00 p.m.											**Plenary** Kimberly Ennico Smith
2:30 p.m.											
3:00 p.m.											
3:30 p.m.	**EE** Educational Applications of Arduino Microcontrollers	**ED** History of Physics and Astronomy	**EF** Other Papers	**EG** Graduate International Experiences	**EC** Focused Collection on Upper-Division PER		**EA** Climate Change B	**EH** The PhysTEC 5+ Club	**EI** Quadcopters, Drones and High Altitude Balloons	**EB** Outreach Physics Courses for Non-Science Majors	
4:00 p.m.											
4:30 p.m.											
5:00 p.m.											
5:30 p.m.											
7:00 p.m.	**FF** Interactive Lecture Demonstrations - What's New? ILDs Using Clickers	**FB** Recovery of New Orleans Physics Post-Katrina	**FC** The Best Physics on YouTube	**FG** High School	**FE** Collaborations in IPLS: The Role of Focused Conferences	**FA** Physics Outside the Classroom: After School Clubs etc.	**FH** Lessons Learned from the Demise of the SSC	**FD** International Women in Physics			
7:30 p.m.											
8:00 p.m.											
8:30 p.m.											

AAPT PHYSICS EDUCATION 2016 WINTER MEETING JANUARY 9-12 NEW ORLEANS, LA

Tuesday, January 12, 2016 – Session Schedule

Poster Session 3, 3 to 4:30 p.m. (Storyville Hall, 3rd floor)

	Strand 11 A	Strand 10 B	Strand 10 A	Strand 11 B	Bolden 5	Bolden 1	Bolden 6	Bolden 2	Bolden 4	Foster 1	Celestin A-C
8:30 a.m.	**GB** K-16 Physics Education Collaboratives	**GC** Physics on the Road	**GI** The Wonderful World of *AJP*	**GE** PER: Examining Content Understanding and Reasoning	**GF** Big Science Data in the Classroom	**GA** Educational Applications of 3D Printers	**GG** Enhancing Diversity in Astronomy	**GD** Introductory Courses	**GH** Introductory Labs/Apparatus II	**GJ** Teaching with LIGO	
9:00 a.m.											
9:30 a.m.											
10:00 a.m.											
10:30 a.m.											**Oersted Medal** John W. Belcher **DSCs** **Presidential transfer**
11:00 a.m.											
11:30 p.m.											
12:00 p.m.											
12:30 p.m.	**HF** Upper Division Concerns	**HG** Teacher Training/Enhancement	**HA** Astronomy Papers	**HC** Professional Skills for Graduate Students	**HD** Innovations in Online Education	**HB** Energy in the classroom	**HE** Women Physicists in Leadership Positions				
1:00 p.m.											
1:30 p.m.											
2:00 p.m.											**Symposium on Physics Education and Public Policy**
2:30 p.m.											
3:00 p.m.											
3:30 p.m.					**IB** Post Deadline Papers II	**IA** Post Deadline Papers	**IC** Post-Deadline III				
4:00 p.m.											
4:30 p.m.											
5:00 p.m.											

Workshops – Saturday, January 9

Transportation between the Hyatt Regency and Southern University will be provided. Sunday morning tutorials (T02, T03, and T04) will be held at the Hyatt.

(BRN: Brown, Old Science Bldg. NSC: New Science Bldg.)

W01: Research-based Alternatives to Traditional Physics Problems

Sponsor: Committee on Research in Physics Education
Time: 8 a.m.– 5 p.m. Saturday
Member Price: $80 **Non-Member Price:** $105
Location: BRN 205

Kathleen A. Harper, Engineering Education Innovation Center, 244 Hitchcock Hall, Columbus, OH 43210; harper.217@osu.edu

Thomas M. Foster, David P. Maloney

Accumulating research on problem solving in physics clearly indicates that traditional, end-of-chapter exercises in physics texts are not useful and may actually hinder students' learning of important physics concepts. The research also raises questions about the efficacy of such tasks for helping students develop "problem solving skills." In light of these results the question is: What alternative tasks can we use to help students develop problem solving skills and a conceptual understanding? This workshop will review the research and then provide examples of several alternative tasks and their use. Participants will also get practice writing alternative problems in a variety of formats for use in their own classrooms.

W02: Submitting Successful Proposals to the NSF IUSE Program

Sponsor: AAPT
Time: 8 a.m.–12 p.m. Saturday
Member Price: $60 **Non-Member Price:** $85
Location: BRN 209

Kevin Lee, National Science Foundation, 4201 Wilson Blvd., Arlington, VA 22230; KELEE@nsf.gov

This workshop will provide an overview of the National Science Foundation's Improving Undergraduate STEM Education Program. We will cover all aspects of its history including the programs that preceded it, their goals, and their evolution over time. A complete description of the present IUSE program and the distinguishing characteristics of grants in today's portfolio will be given. We will then explore the process of proposal review, examples of good and bad reviews, and the benefits of reviewing. The characteristics of a good proposal will be analyzed from looking at several project summaries as well as a full proposal. Guest speakers will detail the strategies that led to their submission of a funded IUSE proposal. All topics will be explored through classroom techniques developed for modern interactive teaching. Participants will leave with numerous resources and guidance essential for submitting their own IUSE proposal.

W03: Ramps and Bungee Cords: Bringing it Together

Sponsor: Committee on Laboratories
Co-sponsor: Committee on Physics in High Schools
Time: 8 a.m.–12 p.m. Saturday
Member Price: $60 **Non-Member Price:** $85
Location: NSC 327

Aaron Osowiecki, Boston Latin School, Boston MA 02115; aosowiecki@bostonpublicschools.org

Jesse Southwick

The Next Generation Standards call for the integration of modeling, content, and engineering within science classrooms. In our energy unit, students "discover" energy conservation by analyzing speed data obtained from rolling marbles down a series of ramps of different heights and slopes. After some significant practice applying the concept, students apply energy conservation to design and build a rubber band bungee cord to provide a safe, yet thrilling drop, for a raw egg. Participants in this session will explore this unit, collecting their own data and building their own bungee cord while seeing how we incorporate formative and summative assessment, as well as "5E" design, throughout the unit to ensure student success.

W04: Creating Physics Simulations Using HTML5, Part 1: Introduction for Beginners

Sponsor: Committee on Educational Technologies
Time: 8 a.m.–12 p.m. Saturday
Member Price: $70 **Non-Member Price:** $95
Location: NSC 329

Andrew Duffy, Department of Physics, Boston Univ., 590 Commonwealth Ave., Boston, MA 02215; aduffy@bu.edu

HTML5 and JavaScript have replaced Java and Flash as the leading technology for in-browser software, with the ability to deliver high-performance, graphics-intensive simulations over the web to both personal computers and mobile devices. Participants in this workshop will learn to use this technology to create educational physics simulations that students can run on almost any computer, tablet, or smartphone that can browse the web. The workshop will cover HTML basics, the JavaScript programming language, graphics using the HTML5 canvas element, and essential user-interface controls. Participants should have some prior programming experience (in any language) and must bring their own laptop computers with up-to-date versions of Firefox, Chrome, and a programmer's text editor such as Notepad++ or TextWrangler. Participants are also encouraged to bring ideas for simulations they would like to create.

W05: Using 3D Printing and Open Source Software to Motivate Self-directed Learning in Physics and Astronomy Courses

Sponsor: Committee on Physics in Two-Year Colleges
Time: 8 a.m.–12 p.m. Saturday
Member Price: $60 **Non-Member Price:** $85
Location: BRN 311

C. Dianne Phillips, NorthWest Arkansas Community College, One College Drive, Bentonville, AR 72712; dphillips@nwacc.edu

The Maker Club Team

A team of undergraduate presenters, from NorthWest Arkansas Community College, will engage Physics faculty in "best practices" strategies and technologies (3D Printers) for motivating undergraduates to be self-directed in their learning of physics. During the workshop, the team will use 3D printers and open source software and "games" familiar to undergraduate students, to engage faculty in their own collaborative project. In addition, Physics faculty will learn how to have this affordable technology in their courses and more importantly HOW to motivate undergrads to want to engage in self-directed projects in a Physics or Astronomy course. Faculty will leave this workshop with ideas on how to get funding for their own printers and ideas for how to integrate using the technologies in their curriculum. Participants should bring their own laptops – all operating systems will work.

W06: Digital Astronomical Spectroscopy

Sponsor: Committee on Space Science and Astronomy
Time: 8 a.m.-12 p.m. Saturday
Member Price: $65 **Non-Member Price:** $90
Location: BRN 201

Trina Cannon, Eastfield College Dallas County Community College District Dallas TX; cannonb75@gmail.com

New Demonstration Experiments in Spectrum Analysis. In this workshop, master demonstrator James Lincoln instructs on new techniques in performing spectrum analysis experiments with your students that are sure to improve their learning experience. Also, involved are some old classic trusted demos. Learn how to use the RSPEC Explorer, a new and inexpensive apparatus that makes teaching spectrum clear to all. Participants are encouraged to bring their own laptop computer.

W10: Fun & Engaging Physics Labs

Sponsor: Committee on Teacher Preparation
Co-sponsor: Committee on Physics in High Schools
Time: 8 a.m.-12 p.m. Saturday
Member Price: $60 **Non-Member Price:** $85
Location: NSC 316

Wendy Adams, University of Northern Colorado, CB 133, Greeley, CO 80639; wendy.adams@unco.edu

Duane Merrell

n this workshop we will share many labs that are suitable for both high school and introductory college physics. The labs are challenging but not too difficult and, leave plenty of room for creativity! We have found success by limiting the goals for the labs to: 1. Fun and engaging, 2. Built in student choice, 3. Related to this week's material. The labs are effective at engaging the students in problem solving and conceptual understanding. Merrell used this type of lab as a high school teacher and physics quickly became one of the most popular classes in the school. Adams, inspired by Merrell, has found that her college students no longer rush to leave, and in some cases stay to see how other groups do even after they've turned in their lab write up for the day! This workshop will allow you to try out these labs for yourself.f.

W11: Pedagogical Content Knowledge in Physics Teaching

Sponsor: Committee on Science Education for the Public
Time: 8 a.m.-12 p.m. Saturday
Member Price: $75 **Non-Member Price:** $100
Location: BRN 309

Matt Bobrowsky, Kennesaw State University, Science Building, 370 Paulding Ave., Building 12, Room 525, Kennesaw, GA 30144; matt.bobrowsky@faculty.umuc.edu

David Rosengrant

This two-part workshop will feature research-based practices for incorporating pedagogical content knowledge in your teacher training, as well as methods for taking the activities presented and implementing them directly into your own classroom. The first half of the workshop will be run by Dr. Matt Bobrowsky. He will describe how you can use Phenomenon-Based Learning (PBL) to not only get your students excited about learning science, but also to better understand its relevance to their lives. Experience the kind of teaching the propelled Finland to educational excellence! The second half of the workshop will be run by Dr. David Rosengrant. Dr. Rosengrant is an Associate Professor at Kennesaw State University and was also voted science teacher of the year in Georgia in 2014. He will show you strategies to incorporate the history of physics into an inquiry based approach in the classroom and will show you how you can make culturally relevant pedagogy inquiry based in the classroom as well. All participants will receive inquiry lessons and a manipulative to take home with them..

W14: Introductory Physics for Life Science: Curricular Resources and Activities

Sponsor: Committee on Physics in Undergraduate Education
Co-sponsor: Committee on Laboratories
Time: 1–5 p.m. Saturday
Member Price: $70 **Non-Member Price:** $95
Location: NSC 327

Nancy Beverly, Mercy College 555 Broadway, Dobbs Ferry, NY 10522; NBeverly@mercy.edu

Ralf Widenhorn, Dawn Meredith, James Vasenka, Juan Rodrigues

The Introductory Physics for Life Sciences curriculum continues to be in an exciting period of development, sharing, and expansion. One size does not fit all, as every institution has its own particular mix of life science students as well as its unique set of institutional constraints and resources. A wide community of people from a variety of institutions have been developing and sharing their curricular materials, activities, and approaches, from which you can adopt or adapt the ones best suited for your students, or just get ideas. At this workshop, curricular resources for a wide array of presently accessible materials and activities will be organized and available for participant exploration and discussion. Several new curricular materials and activities will also be showcased for participant experience and discussion with developers.

W15: Creating Physics Simulations in HTML5, Part 2: Intermediate Level

Sponsor: Committee on Educational Technologies
Time: 1–5 p.m. Saturday
Member Price: $70 **Non-Member Price:** $95
Location: BRN 309

Wolfgang Bauer, Department of Physics and Astronomy, Michigan State University, East Lansing, MI 48824; Bauer@pa.msu.edu

This HTML5 workshop will enable you to write your own physics simulations, which can be used on computers, tablet devices, and smartphones. If you have ever programmed anything in any language, you will emerge from this workshop with the ability to program your own simulations. Participants without prior programming experience might first want to enroll in the "basic" HTML5 workshop, but the essential elements of that workshop will also be briefly reviewed in the first 30 minutes. This workshop will cover the use of canvas, svg, user input (mouse, keyboard, and touch screens), graphics files, and HTML5 video and audio. Participants are expected to bring their own computing device with an up-to-date browser (Chrome, Firefox, Opera, Safari, Internet Explorer, …) and some basic text editor. All source code files will be distributed to all participants and can serve as the basis for their own interactive physics simulations tool set.

W16: Low-Cost, At-Home Labs for School-Based or Online Courses

Sponsor: Committee on Laboratories
Time: 1–5 p.m. Saturday
Member Price: $85 **Non-Member Price:** $110
Location: BRN 201

Alex Burr, 695 Stone Canyon Drive, Las Cruces, NM 88011 (New Mexico State University); aburr@aol.com

A physics course without experiments is not a physics course. However many instructors teaching high school, college, or online courses feel pressured in terms of money, time, and room to neglect this aspect of physics instruction. This workshop will address these problems. The participants will actually do real experiments, which do not have to use expensive, sophisticated equipment. The experiment instructions are simple, written notes which do not need class time to explain. The experiments can be done at home or some other place so a laboratory room is not needed. The experiments can be done at several levels, so they are appropriate for several types of general physics courses. The experiments can illustrate advanced experimental concepts if you wish but all will show that if you ask questions of nature, she will answer. Topics mentioned include mechanics, electricity, and optics. The experiments will be done individually and in groups. Participants should bring Apple or Android smart phones or tablets if they have them. Participants will leave with inexpensive apparatus, detailed notes, and a renewed commitment to physics as an experimental science.

W19: Changing How Students Learn In Gateway Physics Courses

Sponsor: Committee on Physics in Undergraduate Education
Co-sponsor: Committee on Women in Physics
Time: 1–5 p.m. Saturday
Member Price: $60 **Non-Member Price:** $85
Location: BRN 311

Calvin Kalman, Science College, Concordia University, 7141 Sherbrooke St., West Montreal, QC H4B 1R6; Calvin.Kalman@concordia.ca

Our research using epistemological tests seems to indicate that if students in gateway physics courses participate in an activity called "reflective writing" and another interactive activity that they change the way that they learn. Participants will experience activities that they could incorporate in their classes: Use of Reflective Writing to engage students before class. Collaborative Groups to Promote Critical Thinking. Critique: a writing tool to enhance Critical Thinking Skills. We will also discuss an interactive laboratory method called "labatorial. Based upon my book "An Invitation To Successful Science and Engineering Teaching in Colleges and Universities" Jossey Bass/ Wiley and upon research in the classroom that I have been conducting and publishing over many years using qualitative and quantitative methods. We will also look at the epistemological test results and some of the results obtained on interviewing and testing students in the classroom. http://reflectivewriting.concordia.ca/

W21: Examining the Relationships Among Intuition, Reasoning, and Conceptual Understanding in Physics

Sponsor: **Committee on Research in Physics Education**
Time: **1–5 p.m. Saturday**
Member Price: $60 **Non-Member Price: $85**
Location: BRN 209

MacKenzie Stetzer, 5709 Bennett Hall, Room 120 Orono, ME 04469-5709; mackenzie.stetzer@maine.edu

Andrew Boudreaux, Paula Heron, Mila Kryjevskaia, Beth Lindsey

It is a common expectation that, after instruction, students will consciously and systematically draw on their formal knowledge of relevant physics concepts in order to construct chains of reasoning that start from established scientific principles and lead to well-justified predictions. When student performance on course exams does not reveal such patterns, it is often assumed that students either do not possess the requisite conceptual understanding or are unable to chain the appropriate ideas together due to deficiencies in their reasoning abilities. An emerging body of research also suggests that students may "abandon" suitable formal reasoning in favor of reasoning based on ideas that are (perhaps) more intuitively appealing at that moment. Although relatively little is known about the complex relationships among intuition, reasoning, and conceptual understanding, insight into these relationships is important for both researchers and practitioners. In this workshop, participants will have the opportunity to explore these relationships by examining student responses to various research probes and tasks, participating in the process of data analysis and interpretation, and discussing implications for instruction.

W32: Projects and Practices in Physics – Inquiry-based Computational Modeling

Sponsor: Committee on Educational Technologies
Time: 1–5 p.m. Saturday
Member Price: $70 **Non-Member Price: $95**
Location: NSC 329

Danny Caballero; caballero@pa.msu.edu

Paul W. Irving, Michael J. Obsniuk

Most introductory science courses emphasize the acquisition of conceptual and procedural knowledge, but fail to prepare students to engage in science practice including constructing explanations, developing models, and using computational modeling. We have designed an introductory mechanics course that engages students with computational modeling through the use of short modeling projects. By engaging students in more authentic science activities, we aim to help students develop their science identity while they also appropriate the practices and understanding of a scientist. These projects require students to negotiate meaning of physics concepts in small groups and to develop a shared vision for their group's approach to developing a solution. The projects that the groups are presented with are sufficiently complex such that students make use of and move between analytical and computational approaches to creating a solution. In this highly interactive workshop, we will engage participants with the course materials and pedagogy and discuss implementation issues as well as learning outcomes and assessment.

Workshops – Sunday, January 10

Workshops are held at Southern University. (Tutorials at hotel.)

T02: Teaching Mathematical Methods with Active Learning Exercises

Sponsor: **Committee on Physics in Undergraduate Education**
Co-sponsor: **Committee on Graduate Education in Physics**
Time: **9–11 a.m. Sunday**
Member Price: $60 **Non-Member Price: $85**
Location: Strand 3 (Hyatt)

Gary Felder, Smith College Physics Department, Northampton, MA 01063; gfelder@smith.edu

Kenny Felder

"Active Learning"—a catch-all term for a variety of techniques that put students in the position of active participants rather than passive receptacles during class time—has been shown to lead to deeper understanding and longer retention. Many resources are available to facilitate active lesson plans for introductory classes, but content for higher-level classes lags behind. The problem is particularly acute in the "Math Methods" (or "Applied Math") course taught in physics and engineering departments: students are given brief exposure to a large number of techniques, often with little physical context or motivation, and are expected to recall those techniques in subsequent courses years later. Under the auspices of an NSF grant, the authors have developed a series of exercises that can be plugged into your existing lesson plans. These exercises—about 90 in total, covering topics such as differential equations, multivariate calculus, linear algebra, and special functions—are all available at www.felderbooks.com/mathmethods/exercises for free download. In this workshop we discuss active learning in general: a brief overview of its benefits, and a survey of techniques and best practices. Our main focus, however, is how to use our exercises to engage the students in your "Math Methods" course..

T03: Electrostatics from Gilbert to Volta

Sponsor: **Committee on Physics in High Schools**
Time: **9–11 a.m. Sunday**
Member Price: $60 **Non-Member Price: $85**
Location: Strand 4 (Hyatt)

Bob Morse, 5530 Nevada Ave, NW, Washington, DC 20015; ramorse@rcn.com

With inexpensive equipment, students can carry out activities to build a conceptual understanding of electrostatic phenomena. In this short tutorial we will build the equipment and learn to carry out experiments patterned after those from William Gilbert to Alessandro Volta, including charge detection, electric field patterns and electrostatic induction.

T04: Using Children's Literature to Teach Physics: Storybooks, Graphic Novels and the Simpsons

Sponsor: **Committee on Physics in Pre-High School Education**
Time: **9–11 a.m. Sunday**
Member Price: $99 **Non-Member Price: $124**
Location: Bolden 1 (Hyatt)

William Reitz, 2921 Kent Dr., Stow, OH 44224; wreitz@neo.rr.com

This workshop will explore how we can use children's literature at a number of different levels. Whether we are working with pre service or practicing elementary teachers or our own physics students, children's books provide a spring board to science investigations, a way to model the processes of science and even serve as assessment for our instruction. Examples are taken from a spectrum of literary genre: classic childhood favorites, the increasingly accepted Graphic Novel, fiction/non-fiction parings, and popular forms of visual literacy. This Tutorial will be hands on and interactive. Participants will receive a DVD of activities, book and topic pairings, children's literature resources, bibliographies, websites and lesson guides. •ENGAGE students and introduce performance expectations with familiar fiction and storybooks •EXPLORE the topic using non-traditional non-fiction and graphic novels •EXPLAIN the phenomenon supported by materials from a variety of sources •ELABORATE using both fiction and non-fiction. •EVALUATE by allowing students to find appropriate non-fiction literature to support their understanding or even creating their own fiction to showcase what they have learned

W22: Slingshot Physics

Sponsor: Committee Research in Physics Education
Co-sponsor: Committee on Physics in High Schools
Time: 8 a.m.-12 p.m. Sunday
Member Price: $60 **Non-Member Price:** $85
Location: NSC 318

Aaron Osowiecki, Boston Latin School, 78 Avenue Louis Pasteur, Boston MA 02115; aosowiecki@bostonpublicschools.org

Jesse Southwick

Physics students typically learn about the work-energy theorem, friction and Newton's Laws of Motion as separate units. Rarely do they see the connections between these concepts. We have designed an interactive (and inexpensive) unit focused on these concepts with a culminating assessment forcing students to bring it all together. Using a rubber band slingshot and their own careful measurements of the stiffness and coefficient of friction, students launch a small box across the ground, calculating the required stretch so that the box stops at a specified location. Aligned with the new science framework, learn how to help your students use and adjust the work-energy model for a successful launch.

W23: Fun, Engaging, and Effective Labs and Demos in Mechanics and Optics with Clickers, Video Analysis, and Computer-Based Tools

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on Educational Technologies
Time: 8 a.m.-12 p.m. Sunday
Member Price: $75 **Non-Member Price:** $100
Location: BRN 201

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

Ronald Thornton, Priscilla Laws

RealTime Physics and Interactive Lecture Demonstrations have been available for over 15 years—so what's new? Participants in this workshop will have hands-on experience with some of the new activities in RTP and ILD using of clickers, video analysis and computer-based tools to teach mechanics and optics concepts. These active learning approaches for lectures, labs, and recitations (tutorials) are fun, engaging and validated by physics education research (PER). Research results demonstrating the effectiveness of these curricula will be presented. 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.

W26: The Menu of Physics Pedagogies: How to Choose – or Do You Have To?

Sponsor: Committee on Physics in High Schools
Time: 8 a.m.-12 p.m. Sunday
Member Price: $135 **Non-Member Price:** $160
Location: NSC 327

Matt Bobrowsky; expert_education@rocketmail.com

Despite the fact that we were all taught mostly via traditional lectures, it should be common knowledge now that this is a very ineffective way to teach. In the long term, students retain very little of what is delivered in a standard lecture. So now we have alternative — and often better — pedagogical techniques. We have progressive inquiry, problem-based learning, project-based learning, collaborative learning, responsive teaching, phenomenon-based learning, lecture tutorials, role playing, Socratic questioning, just-in-time teaching, and so on. The idea is to teach broader concepts and useful thinking and performance skills (as with NGSS) rather than asking students to simply memorize facts and formulas. In this workshop, research-based practices will be employed that are very effective with diverse learners and that promote science and engineering practices. Participants will engage in hands-on activities and will leave with a copy of one of the NSTA *Phenomenon-Based Learning* books and with a couple of the interesting gizmos that go with the book.

W27: Making Physics Accessible to Students with Different Abilities Using iPads and Simulated 3D Worlds

Sponsor: Committee on Educational Technologies
Time: 8 a.m.-12 p.m. Sunday
Member Price: $60 **Non-Member Price:** $85
Location: BRN 209

Andre Bresges, University of Cologne Institute of Physics Education, Gronewaldstrasse 1 50931, Cologne, Germany; andre.bresges@uni-koeln.de

Christoph Wollny

Educational Technology always had the potential to serve as bridge-builder. In this workshop, the potential of iPads for inclusive learning in heterogeneous Learning Groups will be explored. We use the free MacOS Software iBooks Author and the built-in accessibility features of the iPad to demonstrate its possibilities. In addition, we show how even students with severe disabilities can freely explore the environment and solve complex tasks using immersive 3D Goggles and Personal Computers, as demonstrated using an Oculus Rift VR. An introduction into the creation of virtual Worlds using Unity3D will also be included in the Workshop.

W28: Activities for Teaching About Climate Change

Sponsor: Committee on Science Education for the Public
Time: 8 a.m.-12 p.m. Sunday
Member Price: $60 **Non-Member Price:** $85
Location: NSC 316

Brian Jones, Physics Department 1875, Colorado State University, Fort Collins, CO 80523; brian.jones@colostate.edu

Sheila Ferguson

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.

W30: Integrating Computation into Undergraduate Physics

Sponsor: Committee on Educational Technologies
Co-sponsor: Committee on Physics in Undergraduate Education
Time: 8 a.m.-12 p.m. Sunday
Member Price: $20 **Non-Member Price:** $45
Location: NSC 329

Larry Engelhardt; lengelhardt@fmarion.edu

Marie Lopez Del Puerto, Kelly Roos, Danny Caballero

In this workshop we will discuss the importance of integrating computation into the physics curriculum and will guide participants in discussing and planning how they would integrate computation into their courses. The PICUP partnership has developed materials for a variety of physics courses in a variety of platforms including Python/VPython, C/C++, Fortran, MATLAB/Octave, Java, and Mathematica. Participants will receive information on the computational materials that have been developed, will discuss ways to tailor the materials to their own classes, and will learn about opportunities that are available to receive additional support through the PICUP partnership. This workshop is funded by the National Science Foundation under DUE IUSE grants 1524128, 1524493, 1524963, 1525062, and 1525525. PLEASE BRING A LAPTOP COMPUTER WITH THE PLATFORM OF YOUR CHOICE INSTALLED.

Session SPS: SPS Undergraduate Research and Outreach Posters

Location: Storyville Hall – 3rd Floor
Sponsor: Committee on Physics in Undergraduate Education
Date: Saturday, January 9
Time: 8–10 p.m.

Presider: Sean Bentley

SPS01: 8-10 p.m. Motion of a Ball on a Board Tilted About the Two Axes

Poster – Nick Kasle, 2510 W. Dean Ct., River Hills, WI 53217; kaslen12@highpoint.edu

Aaron Titus, High Point University

An Arduino microcontroller and accelerometer are used to control a wooden board tilted about two perpendicular axes and to control a virtual board in a VPython simulation. The Arduino and accelerometer are attached to a handheld breadboard. The tilt of the Arduino is used to tilt the board using two attached servos, with each one tilting the board about one axis. The tilt is also used to control a virtual board in VPython. The motion of a ball on the wooden board is compared to the motion of a virtual ball in VPython in order to establish the efficacy of the computational model in VPython.

SPS02: 8-10 p.m. Nonlinear Vibration Experiments: Clamped Circular Elastic Plate with Sand Loading

Poster – Eloni Avery, Physics Department, U.S. Naval Academy, 572 C Holloway Road, Annapolis, MD 21402; korman@usna.edu

Sarah D. Erteschik, Murray S. Korman, U.S. Naval Academy

Experiments using a soil-plate oscillator (SPO) involve a vertical cylindrical column of granular medium (sand, soil, pebbles or even uncooked brown rice) that is supported by a thin circular elastic plate that is rigidly clamped to the bottom of a thick walled aluminum tube. The circular acrylic plate (11.4 cm diam and 3.2 mm thick) is air-backed. The soil column is driven from below by a 3-inch loudspeaker that is electrically driven by an amplified swept sinusoidal slowly varying chirp. The speaker rests on a baseplate supporting the apparatus. A small accelerometer attached to the bottom of the circular plate (at the center) is used to measure the vibration. In nonlinear tuning curve experiments the resonant frequency decreases significantly with increased amplitude – representing a softening in the nonlinear system. The unloaded plate resonance is 638 Hz, with 1 cup sand, 274 Hz, decreasing ~ 5 % with moderate drive amplitude.

SPS03: 8-10 p.m. Resistive Switch Properties of Pt/Al2O3/Nb:SrTiO3 device

Poster – Yushi Chang, School of Physics & Engineering,Sun Yat-sen University Xingang West Road, Haizhu Guangzhou, Guangdong 510275; changysh3@mail2.sysu.edu.cn

Weimin Li, Yiqing Luo, School of Physics & Engineering,Sun Yat-sen University

We report on the resistive switching in Pt/Al2O3/Nb:SrTiO3 heterostructures. The device can stablely switch its resistance between a high state and a low state driven by a reverse bias and a forward bias respectively and the high (low) resistance state is nonvolatile. The sensibility of the switch is within 10ns. However, there is always a sharp downward pinnacle at around -0.5V when applied reverse bias. This downward pinnacle appears at higher voltage as the reverse bias increases. Our experiments suggest the character of this pinnacle can be explained by the energy band structure of the heterostructure.

SPS04: 8-10 p.m. Simulations for More Efficient Wind Turbines

Poster – Mehmet I. Goksu, Millersville University, PO Box 1002, 1 South George St., Millersville, PA 17551; mehmet.goksu@millersville.edu

George Miller, Millersville University

The main goal of this research is to develop a mechanism that will change with wind speed to get maximum efficiency from the wind turbine while it is operating. We will determine optimal condition to develop more efficient wind turbines using computational fluid dynamics simulations. So far we successfully made a three-dimensional model of an airfoil, applied specific boundary conditions to the flow of air, ran time-dependent simulations, and gained results of the simulation giving force, pressure, and velocity of the air along the surface of an airfoil. This research is being done in an effort to make wind power a more economically viable option and alternative to fossil fuels.

SPS05: 8-10 p.m. The Developments and Potentials of Light Carrying Orbital Angular Momentum

Poster – Heyun Tan, School of Physics & Engineering, Sun Yat-sen University, Xingang West Road, Haizhu Guangzhou, Guangdong 510275; 2603675717@qq.com

Xinlun Cai, School of Physics & Engineering, Sun Yat-sen University

Application of light beam carrying orbital angular momentum, which was first mentioned by Poynting in 1909, has become a popular area in recent years. The number of essays published per year in the area of OAM has increased from 50 in 1996 to about 400 in 2014. OAM is a natural character of all helical phased beams. A light beam comprising l helical phasefronts has an infinite number of eignstate states, which can lead to a physical realization of unlimited quits accordingly. Moreover, there are a wide range of applications in optical information, quantum information system and manipulation systems. Various methods have been established to produce light with OAM, like the emitter based on 36um-sized micro-ring resonators by Cai et al. OAM is promising to dissolve many problems, but how to deal with all the potentials and challenges it brings out is a question for us all.

SPS06: 8-10 p.m. Using FORTRAN and GROMACS in Biomaterial Research*

Poster – Binaya Bajgain, Southeastern Louisiana University, Department of Chemistry and Physics, Hammond, LA 70402-0001; binaya.bajgain@selu.edu

Cameron Dean, Hye-Young Kim, Department of Chemistry and Physics, Southeastern Louisiana University

FORmula TRANslation (FORTRAN) is a fast, robust computing language specific for scientific computing. GROningen Machine for Chemical Simulations (GROMACS) is a fast, flexible and free molecular dynamics package. We have been using FORTRAN for data collection and analysis of large-scale atomistic simulation for self-assembled nanostructures of VECAR molecules in water at room temperature and atmospheric pressure. GROMACS is used in order to perform molecular dynamics simulation and also for data analysis. From our experience, FORTRAN is easy to use and comes with nice array notation. GROMACS helps us to simulate the dynamics of our research subject of a system of molecules in a controlled environment.

*National Institute Of General Medical Sciences of the National Institutes of Health under Award Number P20GM103424 (Kim). The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH. Computational resources were provided by the Louisiana Optical Network Initiative (http://www.loni.org).

SPS07: 8-10 p.m. Who Gets to Ride Shotgun? Is the Rear Seat Safe?

Poster – William Z. Vernon, Randolph College, P.O. 730, Lynchburg, VA 24503; wzvernon@randolphcollege.edu

Peter Sheldon, Russell Burt, Sarah Sojka, Randolph College

Historically, the rear seat in passenger vehicles has been safer for passengers than the front seat. However, vehicle safety advances have focused on the front row, potentially reversing this trend. We compiled data on passenger vehicle collisions between 1997 and 2013 from the National Automotive Sampling System (NASS). Across all vehicle types and impact speeds, the incidence of severe injury was lower for passengers in the front seats than passengers in the second row. However, when the data was analyzed by age, age groups except children had a greater incidence of severe injury in the second row.

For example, an adult not wearing seatbelts in the second row had 36% greater chance of severe injury than an adult not wearing seatbelts in the front row. We will discuss our findings and how they may inform vehicle safety in the future.

SPS08: 8-10 p.m. A Study on Electrical Characteristics of Photovoltaic Cells

Poster – Mehmet Goksu, PO Box 1002, 1 South George St., Millersville University, Millersville, PA 17551; mehmet.goksu@millersville.edu

Daniel Cox, Millersville University

Renewable energy production is one of the most important topics in energy today due to increasing global energy needs and global warming. Today, as fossil fuel reserves continue to diminish, scientists try to make Photovoltaic cells a more viable and cost-effective method of generating electricity to partially fulfill the world's energy needs. We determined the electrical characteristics of a PV cell by a variety of measurements by a variety of measurements including: Current-Voltage (I-V) characteristic curve, fill factor, internal resistance, and temperature dependence of the Power-Voltage (P-V) characteristic curve of the PV cell.

SPS09: 8-10 p.m. Acoustic Analog to Avoided Crossing of Energy Levels

Poster – Shawn A. Hilbert, Berry College, 2299 Martha Berry Highway, Mount Berry, GA 30149-0001; shilbert@berry.edu

William Newman, Alex Skinner, Berry College

Fundamental properties of quantum mechanics tend to be unintuitive to students new to the topic. One way to illustrate these properties is a lab demonstration, but the equipment is often too expensive or impractical. Since sound waves behave very similarly to quantum waves, acoustics is a good medium for developing analogies to demonstrate quantum properties. Here, we are presenting an acoustic analog that mimics an avoided crossing using sounds waves in PVC pipes. Experimental results are shown and progress to fitting this to a quantum system is presented.

SPS10: 8-10 p.m. Acoustic Analog to Level-Splitting Route to Band Gaps

Poster – Mitchell Crum, Berry College, 2299 Martha Berry Highway, Mount Berry, GA 30149-0001; Mitchell.Crum@vikings.berry.edu

Marissa D'Onofrio, Shawn A. Hilbert, Berry College

Demonstrations of quantum phenomena are typically difficult. Analogs can be a valuable substitution. In time-independent situations, acoustics is mathematically equivalent to the Schrödinger equation, which makes it a good medium for such analogs. This presentation investigates an acoustic band structure that acts as an analog to an infinite square well with multiple delta well perturbations. The analog is accomplished through the use of regular sections of PVC pipes connected by variable aluminum diaphragms to allow coupling between the pipe sections. Equivalence between resonances in the acoustic system and the eigenenergies of the quantum mechanical system is examined for multiple-cavity situations. Both the acoustic system and the analytic solution of the quantum system demonstrate the same band formation for similar reflectivities and frequencies, as well as dependence of the band gap width on the hole size of the disks.

SPS11: 8-10 p.m. Apparatus for Study of Coriolis Forces

Poster – Amiras S. Simeonides, High Point University, 4733 Eastwin Dr., Winston-Salem, NC 27104; sasimeonides@gmail.com

The study of motion in non-inertial reference frames in the laboratory setting is limited by a lack of precise yet affordable apparatus for experiments. This presentation details the construction, programming, and testing of a computer-controlled apparatus that allows students to study various types of motion in inertial and non-inertial reference frames.

SPS12: 8-10 p.m. Building Strong Bodies and Minds Through Service Learning

Poster – David Sederberg, Purdue University, 525 Northwestern Ave., West Lafayette, IN 47907; dsederbe@purdue.edu

In Physic and Astronomy at Purdue, service learning is an essential component to our outreach programs. While providing authentic deliverables to the "customer," service learning engages individuals in ways through which they are able to make meaningful contributions for the benefit of others, while at the same time developing their own knowledge and expertise in an area of personal interest or commitment. That learning may involve leadership, the communication of science related ideas and principles to the public, experience in teaching in K-12 classrooms, research, the design and creation of instructional materials and assessment, reflective practice, and acquired skills that last a lifetime.This presentation will illustrate ways in which we leverage resources made available through service learning for successful outreach programs in Physics and Astronomy.

SPS14: 8-10 p.m. Computational Study of Self-Assembly of VECAR in Water*

Poster – Bijay Shrestha, Southeastern Louisiana University, Department of Chemistry and Physics, Hammond, LA 70402; bijay.shrestha@selu.edu

Hye-Young Kim, Southeastern Louisiana University

VECAR molecule consists of variants of vitamin-E and carnosine, linked by a hydrocarbon chain. Three VECAR molecules with the hydrocarbon chain composed of 4, 13 and 22 carbons were studied. VECAR molecules are bolaamphiphilic and thus self-assemble in aqueous solution. The microscopic analysis of each self-assembly was done by calculating the radial distribution function, the angle distribution function and the atomistic density profile. Results showed that the cluster shape and the atomistic distribution within clusters depend on the chain length. We also calculated the mean square displacement of atoms in a merging process, during which a band of nitrogen was visible at the merging interface. The mean square displacement calculation provided the quantitative information of the diffusion of the nitrogens near the merging interface. Using g_energy, g_hbond and g_gyrate we also calculated the change of various energies of the system, the number of hydrogen bond and the cluster shape, respectively. *National Institute Of General Medical Sciences of the National Institutes of Health under Award Number P20GM103424 (Kim). The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH. Computational resources were provided by the Louisiana Optical Network Initiative (http://www.loni.org).

*National Institute Of General Medical Sciences of the National Institutes of Health under Award Number P20GM103424 (Kim). The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH. Computational resources were provided by the Louisiana Optical Network Initiative (http://www.loni.org).

SPS15: 8-10 p.m. Negative Differential Resistance and Characteristic Nonlinear Electromagnetic Response of a Topological Insulator

Poster – Bochen Guan, Yat-Sen School and School of Physics & Engineering, Sun Yat-sen University, No. 135, Xingang Xi Road, Guangzhou, Guangdong, 510275 China; guanboch@mail2.sysu.edu.cn

Xiao Zhang, School of Physics & Engineering, Sun Yat-sen University

Qinghua Lee, Stanford University

Materials exhibiting negative differential resistance have important applications in technologies involving microwave generation, which range from motion sensing to radio astronomy. In this work, we show that negative differential resistance also generically arise in Dirac ring systems, an example of which has been experimentally observed in the surface states of Topological Insulators. This novel realization of negative differential resistance is based on a completely different physical mechanism from that of the Gunn effect, relying on the characteristic non-monotonicity of the response curve that remains robust in the presence of nonzero temperature, chemical potential, mass gap and impurity scattering. As such, it opens up new possibilities for engineering applications, such as frequency upconversion devices which are highly sought for terahertz signal generation.

SPS16: 8-10 p.m. Latitude Dependence of the Primary Stellar Wind of eta Carinae

Poster – Rachel Odessey, Scripps College, 420 Mansfield Rd., Silver Spring, MD 20910; rachel.odessey@gmail.com

The binary star Eta Carinae underwent a massive eruption in the 1840s, resulting in a huge nebula of ejected material, called the Homunculus. Despite preventing us from the direct view from the central source, the Homunculus acts like a mirror, allowing us to see the spectrum of the central binary system from different stellar latitudes. By mapping the spectrum along the nebula we are actually probing the dependence of the spectrum with stellar latitude. Our project focuses on the P Cyg absorption component of H lines mostly in the optical and near-infrared wavelengths. in order to investigate the structure of the primary stellar wind. A full spectral mapping of the entire nebula was constructed by combining multiple dithered long slit observations using the ESO/X-Shooter high-resolution spectrograph. Such mapping allowed us to assemble a data cube containing the spectrum of each position along the nebula. Preliminary analysis confirms that the primary wind indeed has a deeper absorption component at high stellar latitudes (polar region). Also, contrary to our expectations, our analysis indicates that the polar region does not seem entirely radially symmetric in terms of density, which invites further investigation into the source of these discrepancies.

Sunday, January 10 Highlights

First Timers' Gathering
7–8 a.m.
Imperial 5

Exhibit Hall Open
10 a.m.–5 p.m.
Storyville Hall, 3rd Floor

Exhibit Hall Sony SmartWatch SW2 Drawing
10:15 a.m.
Storyville Hall, 3rd Floor

High School Resource Lounge
10 a.m.–7 p.m.
Imperial 11

Free Commercial Workshops

CW01: **Expert TA**: Realigning Homework Grades and Test scores in the Modern Classroom
12:30–1:30 p.m. – Empire D

CW02: **WebAssign:** Enrich Your Physics Lecture and Lab Courses with WebAssign Content
12:30–1:30 p.m. – Strand 3

CW03: Physics with **PASCO scientific**, Featuring PASCO Capstone™, the Ultimate Data Collection and Analysis Software for Physics
12:30–1:30 p.m. – Strand 4

CW05: **Cengage Learning** – Physics for Scientists and Engineers: Foundations and Connections – A New Approach in Applying Physics Education Research (PER)
11 a.m.–12 p.m. – Strand 5

Committees, 12:30–2 p.m.

Interests of Senior Physicists	Strand 2
Undergraduate Education	Bolden 3
Teacher Preparation	Bolden 2
Women in Physics	Strand 10 B

High School Teachers Day Luncheon
12:30–2 p.m., Imperial 5

Early Career Professional Speed Networking
12–1:30 p.m., Empire B

Exhibit Hall $100 AmEx Gift Card Drawing
3:45 p.m., Storyville Hall, 3rd Floor

Committees, 6–7:30 p.m.

History & Philosophy in Physics	Bolden 1
Laboratories	Strand 3
Physics in High Schools	Strand 10 B
Two-Year Colleges	Strand 4
Research in Physics Education	Empire D

PLENARY – Dr. Benjamin D. Santer
7:30–8:30 p.m., Celestin A-C

Meeting of the Members
8:30–9 p.m., Celestin A-C

High School Share-a-thon
8:30–10 p.m., Empire C

Session AA: Meeting the Breadth of NGSS

Location: Strand 11 A
Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on Physics in Pre-High School Education
Date: Sunday, January 10
Time: 10 a.m.–11:50 a.m.

Presider: Rachael Lancor

AA01: 10-10:30 a.m. Projected Impacts on K-12 Classrooms of the Next Generation Science Standards

Invited – Kevin J. Niemi, University of Wisconsin-Madison, WISCIENCE, 445 Henry Mall, 104A, Madison, WI 53706-1577; kjniemi@wisc.edu

The National Research Council's A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas lays out a new approach to K-12 science education. The writing team of the Next Generation Science Standards (NGSS) followed the philosophy of the Framework and composed three-dimensional Performance Expectations for the K-12 science education community. The three dimensions are the Practices of Science and Engineering, the Crosscutting Concepts, and the Disciplinary Core Ideas. This session will present an overview of the NGSS with an emphasis on its physics concepts, the three dimensions of the Performance Expectations, discuss the status of adoption of NGSS by states, highlight the actions of a state (Wisconsin) that has not adopted NGSS, and finally explore some of the anticipated professional development needed by teachers so that the NGSS can be fully implemented with fidelity in the classroom.

AA02: 10:30-11 a.m. Preparing the Next Generation of Ambitious Science Teachers

Invited – Melissa Braaten, University of Wisconsin-Madison, 225 N. Mills St., Madison, WI 53706-1380; melissa.braaten@wisc.edu

The NRC Framework for K12 Science Education and the NGSS are grounded in research on student learning and research on professional practice in science and engineering fields. However, these documents do not give guidance about science teaching and do not suggest how to support teachers as learners. This presents an ongoing dilemma for science education – we have refined visions for student learning in science, but not for science teaching or teacher education. In-depth research on science teacher learning and novice practice is beginning to offer insights that can help to fill this gap in science education. This session will share results from on-going research into teacher learning and teacher preparation from a decade of longitudinal studies examining how beginning teachers learn ambitious and equitable science teaching practices. Design principles, teacher learning frameworks, instructional practices, and resources for science teacher education will be shared with attendees.

AA03: 11-11:30 a.m. Implementing the NGSS: One School's Process, Successes, Struggles, and Future

Invited – Amy Schiebel, Edgewood College, 1000 Edgewood College Drive, Madison, WI 53711; aschiebel@edgewood.edu*

The Next Generation Science Standards (NGSS) are defining the way many states, school districts, schools, and individual teachers seek to approach science education. The NGSS represent a significant change from current practice in regards to science program requirements, course and lesson design, and teaching and assessment strategies. Adopting the NGSS is easy to say but not so easy to do. This session will follow one fairly typical science department's journey towards adoption with a particular focus on the physics instructors. Among the cast of characters are the young and eager, the new-fad avoiders, and the staunch resisters (you will have to wait to see into which category the physics teachers fall). The path has not been smooth but it has been generally in the right direction. The role of teachers, administrators, professional development providers and college physics faculty will be discussed.

*Sponsor: Rachael Lancor

AA04: 11:30-11:40 a.m. Implementation of Engineering Units in Secondary Science and Mathematics Classrooms

Contributed – Lindsay Owens, University of Cincinnati, 3843 Mantell Ave., Cincinnati, OH 45236; owensly@mail.uc.edu

Helen Meyer, University of Cincinnati

The Cincinnati Engineering Enhanced Math and Science Program (CEEMS) is a two-year professional development program that collaborates with local school districts in assisting science and mathematics teachers to incorporate engineering units into their curriculum, which align with the current NGSS standards. During two consecutive summers, the teachers participate in science and engineering courses taught by university faculty in order to develop the teachers' knowledge of engineering and the engineering design process. During the intervening school years, the teachers implement multiple engineering units, which they have designed into their classrooms. These units blend 21st Century Learning Skills with open-ended real world application. Throughout the program, the teachers receive classroom implementation support by a variety of coaches, some of whom have educational backgrounds, while others have engineering backgrounds. This presentation will highlight currently implemented engineering units as well as discuss the important of support in implementing those units.

AA05: 11:40-11:50 a.m. A Workshop on Incorporating Engineering Design With Physics and Chemistry*

Contributed – Kathleen A. Harper, Engineering Education Innovation Center, The Ohio State University, 2070 Neil Ave., Columbus, OH 43210; harper.217@osu.edu

In the summer of 2015, a one-week workshop was piloted to explore ways in which high school physics and chemistry teachers could modestly incorporate elements of engineering design into their existing science courses. As part of the workshop, participants developed a basic understanding of engineering design principles by completing a small in-class project in the role of a student. After debriefing on the experience, pairs of teachers developed, tested, and piloted additional design activities that could serve the same purpose in their classrooms. The presentation will focus on these activities. It will also briefly describe how they served as a platform for incorporating elements of engineering design into existing science activities, specifically within the framework of Modeling Instruction.1. *The workshop was supported by the Ohio Board of Regents through the Improving Teacher Quality Program, grant 14-37.[1]

*The workshop was supported by the Ohio Board of Regents through the Improving Teacher Quality Program, grant 14-37.

1.Hestenes, *Modeling Methodology for Physics Teachers*, ICUPE proceedings, 1996.

Session AB: Maker Movement (FabLab/Tech. Shop/Maker Space)

Location: Strand 10 B
Sponsor: Committee on Physics in Two-Year Colleges
Date: Sunday, January 10
Time: 10-11:50 a.m.

Presider: C. Dianne Phillips

AB01: 10-10:30 a.m. Maker Infancy at EMCC

Invited – Dwain Desbien, Estrella Mountain Community College, 10530 W Angels Lane, Peoria, AZ 85383; dwain.desbien@emcmail.maricopa.edu

The make movement means many things to different people. At EMCC while we don't have (currently but that is changing) space with the common maker tools (3d printers...) students have been making and creating devices and projects for years. In this talk I will share how we have been involved in the maker movement even if we are in the infancy in terms of the tools we have used. I will share some of the projects and how the students built their projects with little more than simple power tools.

AB02: 10:30-11 a.m. What Do YOU Make of This?

Invited – David Weaver, Estrella Mountain Community College, 1225 N. 36th St #1085, Phoenix, AZ 85008; david.weaver@cgc.edu

Many of us became "makers" in grad school as we worked on experimental apparatus, etc. and many physics teachers have included projects in their classes that made their students "makers." Many/most of our students have not had the experience of taking stuff apart and trying to fix it or figure out how it works. However, a recent Horizon Report indicated that an educational trend at work is students morphing from educational consumers to educational creators. With the proliferation of maker spaces (Fab Labs, Tech Shops, Maker/Hacker Spaces), society is recognizing the utility of using tools to solve problems in their world. I'll talk about electric guitar building, wearable electronic art creation, Arduino cool projects, building solar death rays, light boards, and a muon detector in two year college physics classes. Have I mentioned 3D printers and LASER cutters? I will in this talk.

AB03: 11-11:30 a.m. MAKE-ing Opportunities for Computational Thinking

Invited – Marcos Caballero, Michigan State University, 567 Wilson Rd., Rm. 1310A, East Lansing, MI 48824-2320; caballero@pa.msu.edu

The Maker movement encourages people to design, hack, build, and invent using a wide variety of media. Makers design new web tools, hack existing electronics, build robotic gadgetry, and, generally, invent new ways of doing things. While these activities are diverse, what underlies the myriad of ways that people MAKE is computational thinking. In this talk, I will introduce different ideas around computational thinking, how we might bring those ideas into the physics classroom, and some tools that we, as the physics education community, might use in our classrooms to give students opportunities to think computationally.

AB04: 11:30-11:40 a.m. Teaching Engineering Design and Entrepreneurship to Physics Students

Contributed – Eric C. Martell, Millikin University, 1184 W. Main St., Decatur, IL 62522; emartell@millikin.edu

Many students majoring in physics have an interest in pursuing careers in Engineering, but historically, physics programs do not offer courses focusing on foundational knowledge and skills designed to help prepare students for these careers. Moreover, in part due to the growth of DIY resources such as Arduinos, 3D printers, and Maker Spaces, as well as cultural shifts from an evolving global economy, an increasing number of students are coming to the classroom with entrepreneurial mindsets, looking to either open their own business or carve out a unique career path. In the Engineering Design course, we teamed students up with clients from the community to explore the design process, relationships with clients, and the risks and rewards of real-world Performance Learning. Students utilized a variety of tools to brainstorm, model, and prototype their projects, including the Business Model Canvas, a woodshop, and a nascent "fab-lab" including a 3D printer.

AB05: 11:40-11:50 a.m. Engineering a STEM Exhibit

Contributed – Anne J. Cox, Eckerd College, 4200 54th Ave. S St., Petersburg, FL 33711; coxaj@eckerd.edu

We have developed a new first-year course for potential physics and engineering students with a Maker-ethos. Students build demonstrations and hands-on activities to take to a local science festival and area schools. This gets students doing service-learning (for general education) and building things while taking the intro calculus and physics sequence. This talk will discuss how and why we added the course to the curriculum and what worked well and what didn't.
Educational Technology

Session AC: Best Practices in Educational Technologies)

Location: Strand 10 A
Sponsor: Committee on Educational Technologies
Date: Sunday, January 10
Time: 10 a.m.–12 p.m.

Presider: Rebecca Vieyra

AC01: 10-10:30 a.m. Using the Constructivists Learning Cycle to Apply Technology in Education

Invited – Andre Bresges, University of Cologne, Institute of Physics Education, Gronewaldstrasse 2, NRW 50931 Germany; andre.bresges@uni-koeln.de

Use of technology in the classroom should not be defined by the technology you want to use, but by the problems you want to solve. We start with a given problem: conducting hands-on experiments and inquiry learning even in a heterogeneous classroom environment with an inclusive setting. We discuss how tablets may: 1) address the goal of the experiment; 2) identify and confront misconceptions; 3) guide the educational process, 4) take measurements, 5) produce a video report about the experiment, and 6) reflect and share the outcome with others. With regard to the position of teachers and PER researchers, tablets provide research-based tools for assessment and self-assessment, putting Hattie's "visible teaching" into action. We recommend applying a "design cycle" to record and improve the conduct of a lesson over time, using the aforementioned technology and research tools.

AC02: 10:30-11 a.m. Mathematical Modeling via Computer Programming: From Tools to Pedagogy

Invited – Emmanuel Schanzer, 140 Pasito Ter, Alexandria, VA 22314; schanzer@bootstrapworld.org

Given the important role that functions play in Physics, many have looked to programming as a way of boosting algebraic proficiency. Many assume that "Programming is like Math," and expect stronger mathematical foundations from students who've taken Java, Scratch or Python. Meanwhile, the hype surrounding CS has led many teachers to search for authentic ways to integrate programming into their classes. But what does it mean to use programming "authentically" when teaching another discipline? This talk will describe the approach taken with Bootstrap, the research-based algebra and programming curriculum used by hundreds of teachers across the country. Bootstrap teaches students to program their own videogames using purely algebraic and geometric concepts, and is closely aligned with the Common Core Standards for Mathematics. The lessons learned from developing Bootstrap are applicable to physics, offering possible routes forward for an authentic approach to physics education through the appropriate use of computer programming.

AC03: 11-11:30 a.m. Students Reading Real Science: Primary Literature in the Classroom

Invited – Melissa McCartney, AAAS 1200 New York Ave., NW Washington, DC 20005; mmccartn@aaas.org

"Science in the Classroom" (http://scienceintheclassroom.org) is a collection of annotated research papers and accompanying teaching materials designed to help students at the advanced high school, community college, and undergraduate level understand the structure of professional scientific research. Each annotated science paper contains a "Learning Lens," which is used to selectively highlight and explain original text of the research article. Discussion questions, connections to learning frameworks, and additional activities designed around raw data provided by the authors accompany each annotated paper. Science in the Classroom promotes the development of transferable learning skills by engaging students in the fundamental scientific principles of experimental design and critical analysis. In essence, students will be exposed to the process of science. By focusing on the universal language of experimental design and data analysis, Science in the Classroom presents science as an endeavor grounded on common principles, rather than a disjointed sum of individual disciplines.

AC04: 11:30 a.m.-12 p.m. Simultaneous Use of Sensors in Experiments with Smartphones

Invited – Martín Monteiro, Universidad ORT, Uruguay Aconcagua 5152 Montevideo, 11400 Uruguay; fisica.martin@gmail.com

Cecilia Stari, Cecilia Cabeza, Arturo Martí, Physics Institute, Universidad de la República

The use of smartphones in physics has been increasing during the last years. Several experiments have been proposed that exploit the functionality of the sensors incorporated in these devices. The most important mechanical sensor of the smartphone is the accelerometer, then mechanical experiments are mainly based on the use of this sensor. The other mechanical sensor, the gyroscope or rotation sensor, has received less attention. Our purpose is to show, in first place, the value of this important sensor alone, the gyroscope, and in a step forward, that an additional advantage is obtained in the simultaneous use of both sensors, the accelerometer and the gyroscope.

Session AD: Professional Concerns in High School

Location: Strand 11 B
Sponsor: Committee on Physics in High Schools
Co-Sponsor: Committee on Professional Concerns
Date: Sunday, January 10
Time: 10–11:10 a.m.

Presider: Colleen Megowan-Romanowicz

AD01: 10-10:30 a.m. Framing the Professional Concerns of the High School Physics Teacher

Invited – Bradley F. Gearhart, Buffalo Public Schools,1982 Stony Point Rd., Grand Island, NY 14072 fizz6guy@yahoo.com

Undergraduate and graduate teacher preparation programs are charged with providing pre-service physics teachers solid conceptual and pedagogical foundations to draw upon in their classroom instruction. However, in an authentic setting, content and pedagogy are but two strands in the thread of the teaching profession. Navigating teacher evaluation systems, state standards, diverse student populations, building politics, logistical details, and various other facets of the profession are essential to maintaining a lasting career in teaching. My experience has shown that these are often overlooked aspects of the profession that are largely left "as an exercise for the reader." In this presentation, I will draw upon my experience as a physics teacher at a private catholic, a public suburban, and a public urban high school to frame the professional concerns that come with teaching physics in high school. Also, it is my hope that I am able to offer some perspective on the preparation of high school physics teachers for the purpose of obtaining, and maintaining, a career in the teaching profession.

AD02: 10:30-11 a.m. Breadth vs Depth: Addressing the Time Crunch Dilemma

Invited – Lee Trampleasure, Sacred Heart Cathedral Preparatory, 1055 Ellis St., San Francisco, CA 94109; lee@trampleasure.net

The "cannon" of high school physics is fairly broad, and all of it seems important. We "learned" it all, so why can't our students? We are confronted with demands/requests from both our administration and from universities regarding what we must cover, while at the same time being told we should integrate "critical thinking," engineering practices, and programming. All these require time of their own, so we often feel that we have to give up some topics. This talk will address both (1) how to decide what to "cut," (2) how to justify this to those who question your decisions, and (3) how the College Board is addressing this with the 'new' AP Physics 1 and 2. The talk will involve poll responses from the audience, so please bring your smart-phone or other internet connected device.

AD03: 11-11:10 a.m. Building Teacher e-Portfolios: 21st Century CV, Outreach and Tracking & Training

Contributed – Fatih Gozuacik, Harmony Science Academy, 1124 Central Blvd., Brownsville, TX 78520; fgozuacik@harmonytx.org

21st Century: everything has changed, all moved into digital based systems. One great way to build up your resume, keep track of your awesome work, do school outreach, attract best students into your AP classes and satisfy your principal...Benefits don't fit here. I started using Google+, YouTube, and Facebook as an educational tool and it sparkled my teaching way. Parents see and get proud of their kids' work, school yells out that they are a STEM academy, teachers create their name brands... Reaching your society with such tools inspires next generations and increases STEM awareness. You can also use these interactive albums to train other teachers even in other countries! Only thing you need is an Internet connection and then "share& shine." In this session you will see how to use and reroute social media, and critical points need to be careful.

Session AE: PER: Evaluating Instructional Strategies

Location: Bolden 5
Sponsor: Committee on Research in Physics Education
Date: Sunday, January 10
Time: 11–11:40 a.m.

Presider: Jonathan Gaffney

AE01: 10-10:10 a.m. Guiding Laboratory Reform and Professional Development Using RIOT Data

Contributed – Eric Hickok, San José State University, 624 Cypress Street, Monterey, CA 93940, ehickok@gmail.com

Cassandra Paul, San José State University

Physics education research has consistently shown that students have higher learning outcomes when enrolled in interactive-engagement courses. Consequently, many schools are actively reforming their introductory curricula. For courses where the interactive sections (labs, tutorials, and/or workshops) are mostly taught by graduate student teaching assistants (TAs), good TAs are instrumental to the success of the reform. Many studies have investigated specific interactions between TAs and students, but more can be learned through a holistic examination of TA-student interactions. Over the course of one semester, I observed TAs in their various teaching roles using the Real-time Instructor Observation Tool (RIOT). These observations serve to show what TAs may "default to" with little to no intervention. I present a snapshot of a department in the early stages of reform and discuss how we used RIOT data to develop training targeted to the specific needs of our TAs.

AE02: 10:10-10:20 a.m. Longitudinal Study of Students' Participation in an Active Learning Classroom

Contributed – Binod Nainabasti, Florida International University, 11200 SW 8th St., CP 204, Miami, FL 33199; bnain001@fiu.edu

David T. Brookes, California State University, Chico

Eric Brewe, Florida International University

We analyzed the relationship between students' participation in classroom review sessions during two Interactive Learning Environment (ILE) physics courses in a studio format that implemented the Investigative-Science-Learning-Environment (ISLE) curriculum and their success through the courses. Research has shown that ILE can be an effective learning environment for acquiring transferrable knowledge. These classroom review sessions took place at the beginning of each class meeting throughout the two courses and were student directed. To quantify students' participation we coded the review session in real time without videotaping according to a coding scheme that we developed which included codes for interacting, disengagement and uncodable. Each student was assigned a single code for the entire review session. We found that students' interactional codes during the first semester were strongly predictive of their interactional codes during a subsequent semester. This indicates that students directed interaction does not bring changes in their nature of participation.

AE03: 10:20-10:30 a.m. Assessing a Flipped, Biomedically Focused Curriculum for IPLS

Contributed – Warren M. Christensen, North Dakota State University, 513 9th Ave., N Fargo, ND 58102; Warren.Christensen@ndsu.edu

Matt Urich, North Dakota State University

Ralf Widenhorn, Portland State University

A one-quarter-long algebra-based introductory physics course for pre-health and life science majors at Portland State features authentic biomedically inspired physics content. The course uses multimedia-learning-modules via flipitphysics.com (formerly smartphysics). These modules include videos with biomedical experts explaining aspects of specific biomedical equipment. Students answer "Pre-lecture questions" and "Checkpoints" during and after these videos on both the medical content covered in the video media and the physics concepts in written materials provided for students in order to prepare them for activities during the class. Students continue to engage with the material during class and through online homework assignments that explore the connections of physics and the medical field in a quantitative manner. We have attempted to assess the cognitive level using a modified Bloom's taxonomy with further analysis of questions sequence and student performance. We also report on the positive impact on students' attitudes as measured by the CLASS.

AE04: 10:30-10:40 a.m. A Model for a Physics Class for Future Elementary Teachers*

Contributed – Claudia Fracchiolla, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506; fracchiollac@ksu.edu

N. Sanjay Rebello, Purdue University

The importance of strengthening STEM education in public schools is a theme that is currently at the center of discussions in education reform. Research has shown that in order to improve science programs we first need to develop good teacher education programs. In this study we investigate whether a redesigned physics class for future elementary teachers addresses three main issues in elementary teacher preparation (Mikeska et al. 2009): engagement in science, understanding of children's ideas of science, and understanding the relevance of what future teachers learn in class for their impending careers. To do this we evaluate whether the incorporation of social structures in the class impact students' engagement in science by integrating PCK into the core of the class to see if it produces changes in students' knowledge of kids' ideas and frames learning in an expansive manner that promotes transfer.

*Supported in part by NSF grant 1140855.

AE05: 10:40-10:50 a.m. Developing Assessment Strategies for Laboratory Skills Within the UW-Whitewater Program

Contributed – Steven C. Sahyun, University of Wisconsin-Whitewater, Physics Department, Whitewater, WI 53190-1319; sahyuns@uww.edu

Jalal Nawash, Paul Rybski, Ozgur Yavuzcetin, University of Wisconsin-Whitewater

During the summer of 2014, a faculty team developed a student laboratory skills assessment program to be given in the laboratory courses taken by physics majors. We created a program where the assessment instruments, while unique to each course, all followed a theme that students should be able to set up equipment to Acquire some "signal," Analyze data related to the signal, and Assimilate the results by communicating results in a manner consistent with departmental goals. We call the evaluation of students' ability for Acquisition, Analysis and Assimilation our "AAA" activities. This talk is a report on the results from initial implementation in our courses over the past year and an update on the progress made to develop a consistent set of laboratory skills assessment rubrics across the intermediate and advanced laboratory courses in the UW-Whitewater physics program.

AE06: 10:50-11 a.m. Using Motivational Interviewing to Describe Responsive Teaching*

Contributed – Leslie Atkins, 100 W. 1st St., Chico, CA 95929-535; ljatkins@csuchico.edu

"Responsive teaching," that is, teaching in which instructors shape instruction in response to students' ideas, is a promising approach that serves to integrate the epistemic, conceptual, and "practice" aspects of scientific inquiry. However, clearly characterizing this instructional practice is challenging, as is providing professional development to support responsive teaching. In this talk, I will discuss an approach therapy, "Motivational Interviewing," as a possible direction for both characterizing and supporting this practice.

*Supported in part by NSF #1140785

AE07: 11-11:10 a.m. The Role of Personality in Performance in Physics

Contributed – John C. Stewart, West Virginia University, 235 White Hall, Morgantown, WV 26506; jcstewart1@mail.wvu.edu

Rossina Miller, West Virginia University

The Big Five Inventory (BFI) measuring the 5-factor personality model was given to 440 science and engineering students in introductory physics classes at a large U.S. university. Science and engineering students showed similar personality characteristics as would be expected from measurements of the general population, with women scoring significantly differently only on the neuroticism scale. The BFI facets had differential explanatory power for test average and course grade with the conscientiousness facet as the only significant treatment effect for course grade, but it was not significant for test average. High school GPA explained substantially different levels of variance in course grade for male and female students; these differences were reduced with the addition of BFI facets to the regression models.

AE08: 11:10-11:20 a.m. Transition Matrices: Tool for Assessing Student Learning and Improving Instruction

Contributed – Paul J. Walter, St. Edward's University, 3200 S. 1st St. Apt 322 Austin, TX 78704; pauljw@stedwards.edu

Gary A. Morris, Brenna K. Thompson, St. Edward's University

Spencer Skees, Valparaiso Univeristy

Not all wrong answer choices are created equal. We introduce a new tool for adoption by high school and college-level physics teachers who use a common assessment such as the Force Concept Inventory (FCI). The tool uses a spreadsheet application to create a simple matrix that identifies the percentage of students that who select each possible pre-/post-test answer combination on each question of the diagnostic exam such as the FCI. Having ranked each answer choice from best to worst (using Item Response Curves as our guide), the transition matrices provide detailed information on the percentages of students that move toward better or worse answer choices on the pre-/post-test and identify the misconceptions they may have. The transition matrices tool provides a way to better meet the needs of our students by tailoring our instruction in an informed way.

AE09: 11:20-11:30 a.m. Multiple Choice Answers: To Change or Not to Change?

Contributed – Heidi Wainscott, United States Air Force Academy, 2354 Fairchild Drive, USAF Academy, CO 80840; heidi.wainscott@usafa.edu

When grading student papers it seems that students are always changing their multiple choice answers from right to wrong. Colleagues have made similar observations and some books on test taking advise against answer changing.[1] Intrigued, I collected some data and dug a little deeper into the research. My hypothesis was that students most frequently changed their answers from right to wrong. The subjects were 985 college physics students enrolled in a two-semester calculus-based physics course. Did students most frequently change their answers from right to wrong, from wrong to right or from wrong to wrong? How do my results compare to similar studies? Was there a difference between results for the two semesters? Answers to these questions will be discussed as well as implications for further studies.

1. D. Huff, *Score-The Strategy of Taking Tests* (Ballantine Books, New York, NY, 1961).

AE10: 11:30-11:40 a.m. Impact of Educational Framework Tools in Physics Contests Preparation

Contributed – Tamas G. Orosz, Óbuda University / Alba Regia Technical Faculty, Budai, Hungary; orosz.tamas@amk.uni-obuda.hu

Éva Stefánkó Jáky. József Secondary School

Generally, it is difficult to assess the knowledge and competencies of physics students at high school, who prepare for contests. There are multiple educational approaches, such as didactical and competency-based methodologies which can help either teachers or students to improve their skills in problem-solving techniques and understanding Physics phenomena. However, using such traditional methods, it is hard to evaluate and control the individual learning progress of students continuously. Therefore, application of Educational Framework Tools seems to be a good choice to extend the support functions in classes. This paper discusses the benefits of E-learning technologies applied to helping students for physics contest preparations. Several embedded E-learning functions are being applied and to tuition in physics. The outcome of innovative educational methods and extensions has been evaluated. Our tuition methods resulted in achieving a dynamically changing educational framework that can be matched to our students and to the actual physics contest.

AAPT Poster Sessions

with refreshments

Poster Session 1

8–9:30 a.m.

Monday, January 11
Storyville Hall, 3rd floor

Poster Session 2

8:30–10 p.m.

Monday, January 11
Storyville Hall, 3rd floor

Session AF: Teaching Electronics in Upper Level Undergraduate Physics

Location: Empire C
Sponsor: Committee on Physics in Undergraduate Education
Co-Sponsor: Committee on Laboratories
Date: Sunday, January 10
Time: 10 a.m.–12 p.m.

Presider: Juan Burciaga

AF01: 10-10:30 a.m. Modern Electronics – Organizing Principles and Topic Choices

Invited – Dale Syphers, Bowdoin College, Physics Department, 8800 College Station, Brunswick, ME 04011-8448; dsyphers@bowdoin.edu

Teaching a course in Modern Electronics for undergraduate physics majors has roots in digital electronics courses of the past, but is far too complex an area to approach as a sequence of specialized topics in the vast fields of electronics. My solution to this educational problem has been to arrange the course around three main aspects that are central to many electronic projects encountered in physics. These three aspects are 1) sensing with some form of transducer, which has as output a time-dependent voltage or series of voltages, 2) converting the signal to a digital signal and using digital electronics or microprocessors to make decisions, and 3) converting the signal back to an analog signal and turning something on (I prefer inductive loads). Much of this can be done empirically, but also leaves the instructor opportunities for choosing specific sub-topics for more in-depth understanding.

AF02: 10:30-11 a.m. Restructuring a Junior-level Electronics Course to Support Engagement in Scientific Practices

Invited – Heather Lewandowski, University of Colorado, CB 440 Boulder, CO 80309; lewandoh@colorado.edu

Building on successful work in studying and transforming the senior-level Advanced Lab course, we have transformed our junior-level electronics course to engage students in a variety of authentic scientific practices, including constructing, testing, and refining models of canonical measurement tools and analog circuits. We describe our approach to the transformation, provide a framework for incorporating authentic scientific practices, and present initial outcomes from the project.

AF03: 11-11:30 a.m. Computer-based Instrumentation in the Upper-Level Electronics Curriculum

Invited – John Essick, Reed College, 3203 SE Woodstock Blvd., Portland, OR 97202; jessick@reed.edu

The electronics topics typically taught in an upper-level instructional lab course offer hands-on demonstrations of important concepts such as filtering, bandwidth, spectral analysis, curve fitting, and digital logic. While the conceptual understanding gleaned from these traditional exercises is quite valuable, much of the actual technology used does not provide an up-to-date presentation of electronics or of the techniques currently used in experimental physics. Incorporating affordable instruction in modern electronics technologies (such as field-programmable gate arrays, microelectromechanical system chips, and microprocessor-based instrumentation) into the physics curriculum is a current challenge for advanced instructional lab developers. In this talk, one approach will be presented in which traditional op-amp analog circuits such as amplifiers, filters, and constant-current sources are first taught. These circuits then become the interfacing circuits students utilize as they learn to build computer-based instruments of the type used in a contemporary research lab.

AF04: 11:30-12 p.m. Fitting It All into a One Semester Electronics Course

Poster – Michele McColgan, 515 Loudon Road, Loudonville, NY 12211; mmccolgan@siena.edu

A one-semester electronics course is required of students at Siena College, a liberal arts college in upstate, NY. Many students are interested in pursuing a career in engineering through our 3-2 or 4-1 engineering programs, with a number pursuing electrical engineering advanced degrees. It's a challenge to provide them with a strong foundation in analog and digital circuits, soldering, and microprocessors as well as experience using simulation tools expected of engineers. Our course will be presented and will include online resources such as CircuitLab and EveryCircuit, class activities, and labs. In addition, problems and projects using Matlab and Simulink will be included.

AF05: 11:30 a.m.-12 p.m. Flipping (and Scrambling) the Introductory Electronics Course

Poster – Eric Ayars, California State University, Chico, 1866 Lodge Pine Lane, Chico, CA 95929-0202; ayars@mailaps.org

The "flipped" classroom approach, in which content presentation occurs outside of class time and class itself is used for problem-solving, has generated considerable interest in the education community. In physics teaching this approach has most often been applied to the introductory course, but it also promises potential benefit in upper-division courses such as "Electronics for Scientists" at CSU Chico. In the course of re-thinking and reorganizing material for such a flipped electronics course, it became apparent that the usual linear approach to topics in electronics could be replaced by a series of topic modules arranged in a "Tech Tree" offering multiple pathways through the material. I will be presenting preliminary work on this flipping/scrambling course redesign, in hopes that other instructors can offer helpful suggestions before I hit students with it and discover glaring problems with the approach.

AF06: 11:30 a.m.-12 p.m. In-phase and Quadrature Detection Circuitry for Phase Detection of Sound

Poster – Stephen G. Bishop, United States Naval Academy, 38 Robinson Rd., Severna Park, MD 21146; gbishop@usna.edu

Gary G. Bishop, Murray S. Korman, United States Naval Academy

An in-phase and quadrature detection circuit (I & Q) is useful in determining the relative phase difference between two sinusoidal signals. The overall circuit is made up of analog integrated circuit (IC) components using two multipliers (AD734), two op-amp ICs (OP27) for making two individual low-pass filters, an op-amp differentiator circuit (for generating a Pi/2 phase shift), and a variable phase shift op-amp circuit with flat gain for testing purposes. The circuit was designed for use with low-cost 25 kHz ultrasonic transducer elements. High school students and early high school graduates involved in a summer internship at USNA get involved in doing physics experiments and get to build circuitry. The theory involving I and Q detection required students the opportunity to learn the fundamentals of op-amp circuitry along with gaining an appreciation for the physics involving wave signals that are out of phase with each other.

AF07: 11:30 a.m.-12 p.m. Integrating Arduino Microcontrollers into Undergraduate Electronics Laboratories

Poster – Ryan P. Smith, California State University - East Bay, 25800 Carlos Bee Blvd., Hayward, CA 94542; r31415smith@gmail.com

We present examples of implementation of the Arduino microcontroller into electronics course curriculum and term projects. The accessible and low-cost Arduino presents an exciting showcase of electronic phenomena. As students combine analog circuitry with the digital capabilities of the Arduino, they learn the basics of data acquisition, precision timing, digital feedback loops, and experimental control. Exposure to the microcontroller environment provides a foundation for successful experimental design and the development of industrial products.

AF08: 11:30 a.m.-12 p.m. Microcontrollers in the Upper Level Electronics Lab

Poster – Steve Spicklemire, University of Indianapolis, 1400 E Hanna Ave., Indianapolis, IN 46227; spicklemire@uindy.edu

We have migrated our upper-level electronics lab from a "Horowitz and Hill" based course to a series of experiments driven and monitored by microcontrollers and credit card sized computers (e.g., raspberry pi). Many of the same concepts arise (e.g., discrete components, op-amps, digital circuits) but in the context of interfacing a microcontroller with transducers, instruments and other random items we find laying about! The course culminates in an independent project developed and implemented by each student.

Session BA: AP Physics Exam Questions and How They Assess Science Practices

Location: Strand 10 A
Sponsor: Committee on Physics in High Schools
Co-Sponsor: Committee on Teacher Preparation
Date: Sunday, January 10
Time: 2–3 p.m.

Presider: Kenneth Cecire

BA01: 2-3 p.m. AP Physics Exam Questions and How They Assess Science Practices

Invited – Connie Wells, Pembroke Hill School, 5121 State Line Road, Kansas City, MO 64112; cwells@pembrokehill.org

Dolores Gende, Pine Crest School

Presenters who have worked on development of the AP Physics Curriculum Framework and AP Physics 1 and 2 test development will share insights on test item types, how those item types test science knowledge as well as science practices, and how test item types can be used effectively to inform instruction in the classroom. The language used in the AP Physics Curriculum Framework, such as learning objectives, essential knowledge, and science practices will be clarified and used in the context of question item type examination. The presenters will use sample exam questions with the audience—both multiple choice and free response—to illustrate and practice with question types such as ranking tasks, qualitative/quantitative translation, and paragraph-length responses. Results from the first testing in May 2015 will help to reveal how these item types tested with AP students.

Session BB: The Planetarium Classroom

Location: Strand 11 A
Sponsor: Committee on Space Science and Astronomy
Date: Sunday, January 10
Time: 2–3:20 p.m.

Presider: Don Smith

BB01: 2-2:30 p.m. Planetarium Possibilities: Teaching Under the Stars

Invited – Heather P. Jones, Mt. San Antonio College, 1100 North Grand Ave.,Walnut, CA 91789; hjones3@mtsac.edu

The faculty at Mt. San Antonio College frequently uses a planetarium to teach astronomy curricula. Despite the light-polluted skies of Los Angles County, planetariums offer an effective alternative for observing. Many astronomy concepts are difficult to grasp from the page of a book, a power point slide, or the four walls of a classroom. Although a dark night sky is the ideal for teaching an astronomy class, in a planetarium you have the luxury of speeding up time, observing the night sky at all seasons, and seeing every phase of the moon within moments. This presentation will explore effective ways to teach astronomy in a planetarium as well as investigate a planetarium's potential for teaching other subjects such as public speaking, computer programming, and film.

BB02: 2:30-3 p.m. Under the Classdome, a Middle School Planetarium

Invited – Jack L. Northrup, Dr. Martin Luther King, Jr. Planetarium at King Science and Technology, Magnet 3720, Florence, Omaha, NE 68110; jack.northrup@ops.org

There is a wide variety of science topics that can be taught in a planetarium. Ranging from the traditional Astronomy and Physics to Ecology and Engineering. The immersive environment of a planetarium is useful to help create a strong foundation that later sciences can be built on. This environment also has the ability to link to many forms of formal, informal, and distance learning programs.

BB03: 3-3:10 p.m. Strategies for Avoiding Information Overload in the Planetarium

Contributed – Timothy F. Slater, University of Wyoming, 1000 E. University, Laramie, WY 82071; timslaterwyo@gmail.com

Coty B. Tatge, Kenneth C. Brandt, University of Wyoming

As one of the ultimate virtual reality simulators, the planetarium allows us to view the dynamic sky from any place and any time. Whereas the ancient sky observers had to carefully catalog movements of stars and planets over decades, planetarium visitors can make the same tedious observations in a matter of minutes. Because of the tremendous amount of information available on one's fingertips, the risk of cognitive overload is quite high when teaching in the planetarium. Systematic results from experimental psychologists working in the domain of multi-media caution planetarium educators to beware of unconsciously asking learners to unnecessarily process extraneous information instead of focusing on the generative processing needed for meaningful learning to happen in the planetarium. If a picture is worth 1,000 words, then how do we best teach in the planetarium?

BB04: 3:10-3:20 p.m. Personalizing the Recognition of Star Patterns

Contributed – Richard Gelderman, Western Kentucky University, Hardin Planetarium, 1906 College Heights Blvd., Bowling Green, KY 42101-1077; gelderman@wku.edu

Our "Star Stories" night sky shows avoid the usual tour of official constellations or presentation of their myths. Instead, the celestial sphere is presented without providing the common names, connect-the-dot outlines, or overlaid artwork. We distribute placards marked with star patterns and have each group share their own identification and myth. They locate their pattern on a star chart and use a laser pointer to identify that pattern on the dome. The personal association results in participants more readily recalling and locating star patterns.

Session BC: Lessons from the Pre-HS Classroom

Location: Bolden 5
Sponsor: Committee on Physics in Pre-High School Education
Date: Sunday, January 10
Time: 2–3 p.m.

Presider: Wendy Adams

BC01: 2-2:30 p.m. Lessons from the Pre-High School Classroom

Invited – Amy Nicholl, University of Northern Colorado, 501 20th St., Greeley, CO 80639; anic@comcast.net

Watching a child swing, skateboard, bounce a ball, or just their never ceasing motion informs us that the basic concepts of physics apply from preschool all the way through to high school and beyond. Building the conceptual understanding of physics, the study of matter and motion through space and time needs to start as early as possible. If we begin early on by helping curious students discover relationships with different kinds of forces that make something move, we will build a confidence in students that will allow them to tackle the tougher physics problems later on their learning career. By allowing young students to explore the how's and whys of something as simple as rolling different balls down ramps on different surfaces and then discussing variables such as: gravity, motion, force, and friction curiosity will be kindled and carried on through the grades.

BC02: 2:30-3 p.m. Development of a Pre-Engineerging Course for 8th Grade

Invited – Marsha Hobbs, Jackson Preparatory School, PO Box 4940, Jackson, MS 39236; mhobbs@jacksonprep.net

A semester-long elective course, "Engineering Design," was developed to serve 8th grade students. Many students lose interest in science during the middle school years, and the course was designed as a project-oriented course to engage students in the scientific process while introducing them to fundamental concepts of engineering. The course includes units on Lego EV3 robotics, 3-D printing, Sketch-Up, bridge design, programmable controllers (Arduino), and wearable technology. Success of the course is evident through increases in enrollment as well as increased demand for high school engineering courses. This talk will focus on the curriculum and lessons learned from the first year.

Session BD: Flipped Classrooms

Location: Bolden 1
Sponsor: Committee on Physics in Undergraduate Education
Date: Sunday, January 10
Time: 2–3:30 p.m.

Presider: Kathleen Falconer

BD01: 2-2:30 p.m. Flipped Upper-Division Physics at the Colorado School of Mines

Invited – Patrick B. Kohl, Colorado School of Mines, 1523 Illinois St., Golden, CO 80401; pkohl@mines.edu

Mark T. Lusk, Eric S. Toberer, Colorado School of Mines

The Colorado School of Mines physics department has been teaching one or more upper-division courses using a flipped approach since the fall of 2013. In a typical implementation, students are asked to watch one or more videos before class as preparation, with the actual class period occupied by Q&A, clicker questions, group problem solving, and various other activities. This year, we expect to have three courses conducted using a full or partial flip, including senior-level electrodynamics, junior-level mechanics, and senior-level solid state physics. Two of the instructors involved are non-PER faculty. In this talk, we'll report on variations on the flipping theme, including different methods of generating online content and the incorporation of Just in Time Teaching elements. We'll also discuss available data, including but not limited to YouTube analytics, qualitative surveys, course evaluations, and senior exit interviews.

BD02: 2:30-3:00 p.m. Using the Flipped Classroom to Teach Strategic Problem Solving

Invited – Zhongzhou Chen, Massachusetts Institute of Technology, 77 Massachusetts Ave., Cambridge, MA 02139-4307; zchen22@mit.edu

Dave Pritchard, MIT

In a flipped classroom, important facts and procedures are learned before class (online for us). Instructors can then use class time to build higher level knowledge and skills. We focus on developing strategic problem solving ability through small group activities supervised by instructors. Our RELATE Group (http://RELATE.MIT.edu) has developed "MAPS" (Modeling applied to problem solving) and uses it in two introductory mechanics courses 8.IAP and 8.011. These "flipped" classes not only improve students' problem solving ability, but also improve students' attitudes about learning science as measured by CLASS. Moreover, this improvement carries forward to their subsequent E&M course. I will also discuss pedagogical experiments in the online contents of the courses, now evolved into an Advance Placement C level MOOC. Starting fall 2015, teachers will be using the contents of this MOOC to flip their own classroom through a new functionality called Custom Coach Course (CCx) that MIT has built.

BD03: 3-3:10 p.m. Using Case Studies in a Flipped Classroom

Contributed – Debora M. Katz, United States Naval Academy, 719 Mills Way, Annapolis, MD 21401; dkatz@usna.edu

Like medical students in a hospital, physics students in a flipped classroom come to class prepared to practice physics rather than to listen to a lecture about physics. Our role, in the flipped classroom, is to guide our students into thinking like physicists as they work on answering conceptual questions, completing simple exercises and solving complex problems. We would like our students to apply the skills they develop in our classroom to questions and problems that arise in their lives outside of the classroom. To help students to bridge the gap between simplified classroom activities and the complex problems found outside the classroom, I use case studies. Case studies play an important role in education at medical, law, and business schools as a way to help students to think like professionals in their fields. In my talk I will provide some examples of case studies written by me, as well as of others written by my students.

BD04: 3:10-3:20 p.m. Lessons Learned from a Project-based, Flipped Classroom

Contributed – Rachael A. Lancor, Edgewood College. 1000 Edgewood College Dr., Madison, WI 53711; rlancor@edgewood.edu

Brian R. Lancor, Edgewood College

At our school, the introductory physics courses meet for two-hour periods, three times per week. The longer class periods give us the opportunity to engage students in group work on a daily basis, and minimize time spent on lectures. Outside of class, students do readings and complete daily online quizzes and homework assignments. Group work includes problem solving, laboratory investigations, tutorials, and projects. In particular, we have recently redesigned our algebra-based courses so that the curriculum is a series of project-based units. For example, the unit on solar cookers involves learning about heat transfer, reflection, blackbody radiation, and the greenhouse effect. The students then demonstrate their understanding of these concepts by constructing a solar oven and writing a paper explaining how their design decisions were based on physics principles. Additional units include video analysis, bridge design, alternative energy, power generation, optics, and cell signaling.

BD05: 3:20-3:30 p.m. Preparing for the AP® Physics 1 Exam – Part 1: Linear Motion

Contributed – Donald G. Franklin, Penfield College of Mercer University, 39 West Main St., Hampton, GA 30228; dgfrank1@aol.com

GiGi Nevils-Noe; Rice University

Learn how to use free online course content to both integrate digital resources in a traditional classroom and "flip" your classroom. We will demonstrate using Rice Online's "Preparing for the AP® Physics 1 Exam," free online course, OpenStax College's College Physics for AP® Courses textbook. These resources include inquiry investigations, Phet simulations, Direct Measurement Videos and engaging Concept Trailers. We model research-driven tools shown to promote long-term retention of AP® physics concepts.

Session BE: Celebrating Latina/ Hispanic Women Physicists

Location: Bolden 6
Sponsor: Committee on Women in Physics
Co-Sponsor: Committee on Diversity in Physics
Date: Sunday, January 10
Time: 2–3 p.m.

Presider: *Geraldine L. Cochran*

BE01: 2-2:30 p.m. Personal Reflections of a Chicana Physicist

Invited – Ximena C. Cid, California State University, Dominguez Hills 1000 E. Victoria St., Carson, CA 90747; ximena.c.cid@gmail.com

The celebration and embrace of my culture has sometimes been in conflict with my identity as a scientist. Likewise, my identity as a scientist has sometimes been in conflict with my ability to remain routed in my culture. This has led me to ask, "how is culture represented in STEM? Does the community still have the idea that 'physics is a culture of no culture', and if it does, how do I fit into this culture?" I was asked to participate in this session that celebrates "Hispanic/Latina" women physicists. My approach for this will be 1) What terms do I use to identify myself, 2) How does that identity relate to a physicist identity, and 3) How has my culture influenced my approaches to conducting physics research.

BE02: 2:30-3 p.m. Professional Development that Connects Content, Students' Ideas, and Pedagogical Strategies

Invited – Carolina A. Alvarado, University of Maine, 5727 Estabrooke Hall, Orono, ME 04469; carolina.alvarado@maine.edu

In the Maine Physical Sciences Partnership (MainePSP), we have been working with teachers to better use a common set of teaching materials. Our design asks teachers to talk about content, students' ideas about the content, and how to address student difficulties by using student strengths. To measure the progress in teacher understanding of these three strands, we have asked a survey over several years and have followed individual teachers over several years. We have analyzed teacher responses and collected the best results to bring back to teachers. As the teachers reflect on the anonymous answers they (or their colleagues) have given, they engage in all three strands, regardless of which is being asked about. Consistent with our design, the three strands are intertwined: talk of content brings up talk of students, talk of pedagogy brings up talk of content, and so on. To illustrate the value of our PD model, we present several examples of the rich intellectual space that the collaborative group of teachers inhabit during these PD activities.

Session BF: Licensure Issues for Teachers: Alternative and State Level Challenges

Location: Bolden 4
Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on Professional Concerns
Date: Sunday, January 10
Time: 2–3 p.m.

Presider: *Monica Plisch*

BF01: 2-2:30 p.m. Easing Pathway to Certification with a Little Help from PhysTEC

Invited – Talat S. Rahman, University of Central Florida, 4000 Central Florida Blvd., Orlando, FL 32816; talat.rahman@ucf.edu

In 2013 University of Central Florida became a PhysTEC comprehensive site embracing three goals: engage the Physics Department in the preparation of teachers; establish successful models for increasing the number of highly qualified physics teachers; promote transformations that foster an active learning, inquiry-based environment in physics courses. I will comment on how the key elements of PhysTEC: teacher-in-residence (TIR), the learning assistant (LA) program, and infusion of pedagogical content knowledge have conspired not only in attracting quality students but also in changing departmental climate. The weekly offerings of pedagogy seminar is having a powerful impact on the teaching skills of graduate students and LAs alike. The LAs, mentored by the TIR, engage in lesson planning, both for early teaching experience and networking with local physics teachers, who in turn mentor our LAs at the semester-end poster presentations. Several pathways to certifications exist and the process is expected to get smoother.

BF02: 2:30-3 p.m. Paths to Licensure: Things Physicists Should Know*

Invited – Gay B. Stewart, West Virginia University, Department of Physics, Box 6315, Morgantown, WV 26506-0006; gbstewart@mail.wvu.edu

John C. Stewart, West Virginia University

The path to licensure can be quite complicated, and can thwart a physics department's efforts to produce more and better prepared high school physics teachers. Each state has different pathways. CAEP and SPA are not within the normal physics vocabulary. Some understanding of these topics can allow us to help our students so that fewer are derailed on their path to the classroom, or take a path that will leave them less well prepared. Examples of different approaches that work within state licensure systems from two different states will be presented.

*Physics teacher preparation efforts in both Arkansas and West Virginia have been supported in part by the Physics Teacher Education Coalition.

Session BG: Doubling Minority PhDs: The APS Bridge Program

Location: Empire C
Sponsor: Committee on Graduate Education in Physics
Co-Sponsor: Committee on International Physics Education
Date: Sunday, January 10
Time: 2–3:30 p.m.

Presider: *Ted Hodapp*

BG01: 2-2:30 p.m. The APS Bridge Program at Florida State University

Invited – Simon Capstick, Florida State University, Department of Physics, Tallahassee, FL 32306-4350; capstick@fsu.edu

This talk describes what we have learned from establishing in 2014 at Florida State University (FSU) an APS and FSU-funded Masters program that bridges minority students to PhD programs in physics, and how this knowledge has led to improvements in our graduate program for all students.

BG02: 2:30-3 p.m. Recruiting Graduate Students from Minority Serving Institutions: The Impact of the APS Bridge Program

Invited – Ramon E. Lopez, The University of Texas at Arlington, Department of Physics, Arlington, TX 76019; relopez@uta.edu

In this presentation I will discuss the challenges of recruiting students from Minority Serving Institutions (MSIs) to our graduate PhD program. I will present some general comments, and then discuss our experiences at UT Arlington before we became a partner institution in the APS Bridge program. Since we became a partner institution we have had mixed success in recruiting students, but great success in developing institutional support to recruiting students from the program.

BG03: 3-3:30 p.m. APS Bridge Program: Overview and Evidence for Success*

Invited – Theodore Hodapp, American Physical Society, One Physics Ellipse, College Park, MD 20740; hodapp@aps.org

In nearly every science, math, and engineering field there is a significant falloff in participation by underrepresented minority (URM) students who fail to make the transition between undergraduate and graduate studies. The American Physical Society (APS) has realized that a professional society can erase this gap by acting as a national recruiter of URM physics students and connecting these individuals with graduate programs that are eager to a) attract motivated students to their program, b) increase domestic student participation, and c) improve the diversity of their program. Now in its fourth year the APS has is placing enough students into graduate programs nationwide to effectively eliminate this achievement gap. The program has low costs, is popular among graduate programs, and has inspired other departments to adopt practices that improve graduate admissions and URM student retention. This presentation will review project activities, present data that demonstrate effectiveness, and discuss future actions.

*This material is based upon work supported by the National Science Foundation under Grant No. NSF-1143070.

Session BH: PER: Evaluation of Curricular Strategies for Introductory Physics for Life Science

Location: Empire D
Sponsor: Committee on Research in Physics Education
Date: Sunday, January 10
Time: 2–3:10 p.m.

Presider: Nancy Beverly

BH01: 2-2:30 p.m. Assessing the Connection of Essential Ideas Across the Disciplines

Invited – Vashti Sawtelle, Michigan State University, 567 Wilson Rd., East Lansing, MI 48824-2320; vashtis@msu.edu

Sonia Underwood, Rebecca Matz, Charles Andersen, Michigan State University

Recently the physics community has been conducting transformations to make physics classes more relevant to life science majors. A primary goal for many of these classes is to help students to develop coherent understanding of essential ideas that span multiple disciplines. Energy, for example, is an important idea in biology, chemistry, and physics, but students often compartmentalize their knowledge and do not see energy as an essential idea to all three disciplines. This presentation will outline the preliminary development of an instrument based on semi-structured interviews to assess how students connect essential ideas across introductory science disciplines. This instrument will provide important information to the research community about the effects of ongoing and future university initiatives in making progress in our design of physics for life science majors classes.

BH02: 2:30-2:40 p.m. IPLS: Teaching Fluid Dynamics Using a Kinesthetic Circulatory System Model*

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

Bradley Moser, David Grimm, University of New England

Rebecca Lindell, Purdue University

Students have substantial difficulties applying physics concepts to anatomy, physiology and pathophysiology (AP&P) and vice versa. We have focused our research on developing a kinesthetic circulatory system, which requires students to apply multiple concepts (conservation of mass, compliance, Bernoulli and Hagen-Poiseuille principles) to understanding the operation of the cardiovascular system. Kinesthetic models allow students to manipulate different aspects of the simulated system. We engineered a circulatory system model made of transparent plastic tubing of different radii, branched connectors, balloons, and pumps that enabled students to see the fluid travel at different speeds (visually) and pressures (through pressure sensors) as the fluid travels through a model cardiovascular system. Pre- and post- assessment through interviews, open-ended questions and draft multiple-choice questions indicate substantial improvement in student understanding and appreciation of real fluid dynamics concepts. Two other IPLS Kinesthetic models are also being developed surrounding the physics concepts encompassing diffusion and electrophoresis.

*Supported by NSF DUE 1044154

BH03: 2:40-2:50 p.m. Development of a Fluid Dynamics Conceptual Assessment I: Concept Domain

Contributed – Dawn C. Meredith, University of New Hampshire, 9 Library Way, Durham, NH 03824; dawn.meredith@unh.edu

Rebecca Lindell, Purdue University

James Vesenka, University of New England

Designed to both uncover areas of students' difficulty as well as provide a reliable and valid method to measure student learning, Conceptual Learning Assessment Instruments (CLAIs) have been essential to the pedagogical improvement within many physics courses. However, to date there exists a dearth of CLAIs developed specifically to assess students' conceptual understanding of concepts unique to the introductory physics courses for life sciences (IPLS). To fill this need, we are currently developing a Fluid Dynamics CLAI specifically for the IPLS course. One of the first steps in assessment development is the determination of the concept domain that will be utilized to create the instrument. We chose to use a Delphi process to reach a consensus among 14+ physics, biology and biophysics on the key concepts to be covered on the instrument. In this talk, we will discuss the details of Delphi process and present the final fluid dynamics concept domain.

BH04: 2:50-3 p.m. Driving Physics Education Home: Teaching Mechanics Through Motor Vehicle Collisions

Contributed – Sarah Sojka, Randolph College, 2500 Rivermont Ave., Lynchburg, VA 24503; Ssojka@randolphcollege.edu

Peter Sheldon, Randolph College

Research and logic both indicate that students learn more when they are engaged with the material. In a two-week summer transition course for students planning to major in any STEM field, we related all physics content to motor vehicle collisions. The students in the course had a wide range of previous exposure to physics and a range of intended majors (biology, chemistry, physics/engineering, math and environmental science). The topic engaged non-physics majors and allowed students with extensive preparation in physics to work on more advanced exercises, such as accident reconstruction. Students responded positively to the topic and more importantly, showed a normalized gain on the FCI of 0.23±0.06 (SE), comparable to a full semester, traditional lecture physics course. We will present an overview of the course, sample exercises and students responses to the course. This approach could be effectively modified for any introductory physics course.

BH05: 3-3:10 p.m. Iconic Problems/Threshold Concepts in Physics and Biology

Contributed – Juan R. Burciaga, Bowdoin College, Department of Physics & Astronomy, 8800 College Station, Brunswick, ME 04011-8448; jburciag@bowdoin.edu

Iconic problems have proven to be a useful paradigm to analyze physics curricula. Though these share many of the characteristics of threshold concepts (transformative, integrative, bounded, …) the iconic problem paradigm allows a closer analysis to the physics curriculum by identifying key problems. Recently the author has begun using the iconic problem paradigm to identify key topics in the biology used in an IPLS course. The paper focuses on the characteristics of iconic problems and their relationship to threshold concepts, identifying the iconic physics problems in an IPLS course, and reports on the characterization of the biology topics of the IPLS course as iconic problems/threshold concepts.

Session BI: Lab Guidelines Focus Area 2: Designing Experiments

Location: Strand 11 B
Sponsor: Committee on Laboratories
Date: Sunday, January 10
Time: 2–3:20 p.m.

Presider: Joe Kozminski

BI01: 2-2:30 p.m. Designing Lab Experiences that Build Experimental Design Skills

Invited – Melissa Eblen Zayas, Carleton College, 1 North College St., Northfield, MN 55057; meblenza@carleton.edu

The AAPT Lab Guidelines recommend students in both the introductory and advanced labs get experience posing scientific questions and designing experiments to answer them. How can instructors provide experiences with experimental design in introductory labs? And how do instructors continue to support development of experimental design skills in more advanced labs? In this talk, I will provide examples of laboratory activities that provide students opportunities to develop experimental design skills and practice troubleshooting experimental set-ups. In addition, I will discuss some of the challenges of supporting students and assessing learning goals in these types of lab activities.

BI02: 2:30-3 p.m. Planning Experiments for a Freshman Project Course

Invited – Gordon P. Ramsey, Loyola University, Chicago, 25311 S. 88th Ave., Frankfort, IL 60423; gpr@anl.gov

Undergraduate research is strongly encouraged in our department. All incoming freshmen are required to engage a one-semester elementary research project. Under the guidance of a faculty member, groups of four carry out research in an area of first year of physics. The faculty advisor and the group discuss possible projects that would have the students' interest. They decide on objectives, tasks to be performed, equipment needed and a timeline. Projects involve an initial proposal, designing and building an experiment, performing theoretical calculations, followed by experimentation and analysis. Finally, they orally present their results to other students and faculty. These projects help our students gain skills such as teamwork, taking a leadership role, engaging in research and communicating results to an audience. I will discuss procedures in selecting projects and subsequent management and outcomes of the projects.

BI03: 3-3:10 p.m. Student Use of Modeling When Troubleshooting an Electronic Circuit

Contributed – Dimitri R. Dounas-Frazer, University of Colorado Boulder, Department of Physics, Boulder, CO 80309-0390; dimitri.dounasfrazer@colorado.edu

Kevin L. Van De Bogart, MacKenzie R. Stetzer, University of Maine

H. J. Lewandowski, University of Colorado Boulder and National Institute of Standards and Technology

Troubleshooting systems is an integral part of experimental physics in both research and educational settings. The AAPT recommendations for laboratory courses identify ability to troubleshoot as an important learning outcome for undergraduate physics students. We investigate students' model-based reasoning on a troubleshooting task using data collected in think-aloud interviews during which pairs of students from two institutions attempted to diagnose and repair a malfunctioning circuit. Our analysis scheme is informed by the Experimental Modeling Framework, which describes physicists' use of mathematical and conceptual models when reasoning about experimental systems. We show that this framework is a useful lens through which to characterize the troubleshooting process. We further highlight how students' model-based reasoning facilitates effective troubleshooting.

BI04: 3:10-3:20 p.m. Experiment Design in a First-Year Thermal Physics Course

Contributed – Mary Ann H. Klassen, Swarthmore College 500 College Ave., Swarthmore, PA 19081; mklasse1@swarthmore.edu

Peter Collings, Swarthmore College

Many of us are daunted by the prospect of developing entirely new lab curricula. A first step can be adapting existing experiments, even "cookbook" ones, so they explicitly teach laboratory skills such as experiment design. In this talk, we describe our experience adapting existing labs for our first-year thermal physics course to allow students time to design their own procedure. Strategies to help students develop good laboratory habits like error estimation and record-keeping will also be discussed.

Session CA: Discovery Physics in the Classroom

Location: Strand 11 B
Sponsor: Committee on Physics in High Schools
Date: Sunday, January 10
Time: 4–5:10 p.m.

Presider: Kenneth Cecire

CA01: 4-4:30 p.m. High School Students Discovering the World of Particle Physics

Invited – Shane Wood, QuarkNet, 350 Hwy 96 W, Shoreview, MN 55126; swood5@nd.edu

What is dark matter? Do supersymmetrical particles exist? Are there extra dimensions that are not yet known? On June 3, 2015 after a two-year period of maintenance and upgrades, CERN's Large Hadron Collider (LHC) began its second research run, ushering in an exciting new chapter of cutting-edge physics research that could help answer such questions. This talk will focus on opportunities for high school teachers and students to discover the world of quarks and leptons and engage in the analysis of real data while covering required standards, including many Next Generation Science Standards (NGSS).

CA02: 4:30-5 p.m. Preparing Producers and Consumers of Science

Invited – Chris Stoughton, Fermilab, MS 127, Batavia, IL 60510; stoughto@fnal.gov

Science continues to revolutionize society. Educational systems can do an even better job of preparing students by considering two aspects: as producers and as consumers of science. I will give examples of how we address these with the outreach activities of the Fermilab/University of Chicago Quarknet group.

CA03: 5-5:10 p.m. Investigate Exoplanets from Your Classroom Using Online Telescopes*

Contributed – Mary E. Dussault, Harvard-Smithsonian Center for Astrophysics, 60 Garden St., Cambridge, MA 02138; mdussault@cfa.harvard.edu

Nathan Carle, Souhegan High School

Roy R. Gould, Harvard-Smithsonian Center for Astrophysics

Bring the excitement of the search for habitable worlds into your classroom while helping your students to consolidate and apply core ideas in physical science. The Laboratory for the Study of Exoplanets (ExoLab) aims to create a model for how to integrate content learning with the practices of authentic scientific study. Using robotic telescopes from the Harvard-Smithsonian Center for Astrophysics, high school students detect actual alien worlds orbiting distant stars, and use their own data sets to determine the size and orbital parameters of these exoplanets. Students learn to deal with the messiness of real data, and use the same analytical methods that professional scientists use every day to separate the signal from the noise in their investigations. This talk will highlight examples of student results using the Exolab, and describe how you can join the ExoLab online learning community of educators, students, and professional exoplanet researchers.

*Supported in part by NSF DRL-1222588. Additional support provided by the Arthur Vining Davis Foundations. https://www.cfa.harvard.edu/smgphp/otherworlds/ExoLab/

Session CB: Flipped Classrooms B

Location: Bolden 1
Sponsor: AAPT
Date: Sunday, January 10
Time: 4–5:10 p.m.

Presider: Kathleen Falconer

CB01: 4-4:30 p.m. The Half-flipped Classroom: Just-in-Time Teaching

Invited – Andrew D. Gavrin, IUPUI, 402 N. Blackford St., LD154, Indianapolis, IN 46202; agavrin@iupui.edu

Many reports suggest the existence of a dichotomy between "traditional" and "flipped" classrooms. This dichotomy is false. Rather, there is a continuum of possibilities that includes these options near the extremes. Just-in-Time Teaching (JiTT) provides one intermediate point between traditional lectures and flipped classroom formats. From the student's point of view, the pre-class preparation is lighter, but still more rigorous than the traditional model. From the instructor's point of view, JiTT requires substantially less investment in developing videos and other materials, and offers an opportunity to expand in-class interactivity without taking over the entire session. In this talk, we will explore the spectrum of approaches that are available to faculty, and the possibilities for moving along that continuum to optimize learning.

CB02: 4:30-4:40 p.m. Faculty Experiences Teaching Studio-mode Classes to Diverse Student Populations*

Contributed – Jacquelyn J. Chini, 4111 Libra Dr., Orlando, FL 32816; jacquelyn.chini@ucf.edu

Jarrad W.T. Pond, University of Central Floirda

Many studio-mode courses make use of "flipped classroom" pedagogy. Students are expected to introduce themselves to the content before class so that they can practice using the content during class. While there are many good reasons to flip your classroom, the fact that it is "flipped" indicates it varies from students' typical experiences. We are exploring faculty and students' experiences with this course format in algebra-based introductory physics courses at a variety of schools. Here, we discuss the course from the instructors' points-of-view, based on interviews with faculty from two universities with large numbers of students from ethnic groups traditionally under-represented in science fields. We will focus on the ways in which instructors feel the course provides support or acts as a barrier for students with diverse backgrounds.

*This work is support in part by NSF Grant No. 1347515.

CB03: 4:40-4:50 p.m. Flipping General Physics: First Experience and Lessons Learned

Contributed – George E. Matthews, Wake Forest University, Department of Physics, Winston Salem, NC 27109; matthews@wfu.edu

My first experience in flipping a first year calculus-based general physics class showed good learning outcomes but yielded important lessons for future success. Class time included little planned lecture, with nearly all content delivery happening via lecture videos viewed before class. Class time was dedicated to active learning, alternating between ConcepTests and small group problem solving. What brief in-class lecture did occur was prompted by gaps in understanding uncovered during small group problem solving. Critical success factors: communicate reasons for flipping; quiz students on lecture video content; provide each small group with its own whiteboard; choose in-class problems with great care. Students reported little concern over the modest production quality of lecture videos. Students overwhelmingly reported that they would advise other science faculty to flip their classes. For additional information, see http://users.wfu.edu/matthews/teaching/aapt2016/.

CB04: 4:50-5 p.m. Modern Physics for Engineers, A Flipped Course at Purdue

Contributed – Ronald Reifenberger, Department of Physics and Astronomy, Purdue University, 525 Northwestern Ave., West Lafayette, IN 47907; reifenbr@purdue.edu*

Joseph Cychosz, Rick DeSutter, nanoHUB, Purdue University

Purdue's Department of Physics and Astronomy now offers a flipped modern physics course for engineers. Using a more traditional lecture format in prior course offerings, few if any questions were ever asked, ostensibly because there was insufficient time to process the new information. To address this issue, the course was flipped and students now spend the majority of their time watching video lectures on the web. Utilizing Purdue's nanoHUB, 85 videos have been produced in a format that allows students to pause, navigate, and review the material as often as they choose. A graded multiple choice lecture quiz is available on-line following each video and tracks daily progress. At the end of each calendar week, the class meets for one 50-minute discussion period. The improvements in learning, the marked increase in the pace and scope of the discussion sections, and the students' response to the course will be summarized.

* Sponsored by R. Lindell

CB05: 5-5:10 p.m. Flipping a Modern Physics Class

Contributed – Juliet Wain Brosing, Pacific University, 2043 College Way, Forest Grove, OR 97116; brosingj@pacificu.edu

James J. Butler, Pacific University

We have "flipped" the classroom for our Modern Physics with Health Applications class. As part of their pre-class work, students watch videos of lectures we have prepared and complete "Web Warm-Ups" (a form of Just-in-Time Teaching). We then spend class time on tutorials, Peer Instruction via "clickers," solving homework problems, and other group work. The class also has an intensive lab component in which the students do a few standard labs along with health professions-related projects. The Quantum Mechanics Conceptual Survey (QMCS) developed by the University of Colorado PER group was administered. Results of the survey will be presented as well as the challenges and successes of the class.

Session CC: Writing and Assessing Biology-based Problems in the Introductory Physics Course

Location: Empire C
Sponsor: Committee on Physics in Undergraduate Education
Date: Sunday, January 10
Time: 4–6 p.m.

Presider: Juan Burciaga

CC01: 4-4:20 p.m. Physics for the Life Sciences: Calculus-based Introductory Physics Re-Imagined

Invited – Simon G. Mochrie, Yale University, Sloane Physics Laboratory, New Haven, CT 06520; simon.mochrie@yale.edu

A calculus-based introductory-physics-for-the-life-science (IPLS) sequence, which re-imagines the IPLS syllabus, and which has been taught for the last five years at Yale, will be described. The goals of this course are to: Demonstrate the application of physics and mathematics to the life sciences and the human body via authentic examples; "Introduce biological science majors and future clinicians to a set of mathematical and physical tools, principles, and techniques that will enable a deeper scientific understanding of biological systems, including the human body;" Seed an enduring appreciation of the power of mathematical and physical approaches in biology and medicine;" Satisfy the physics requirements of biological science majors, and satisfy the physics requirement for medical school. I will summarize the syllabus and share student feedback about the course, including how student evaluations compare to those for courses with a traditional syllabus. I will also elaborate on selected topics and homework problems, that seek to infuse the class with biological and medical authenticity.

CC02: 4:20-4:40 p.m. AISS: Assessing Physics Students by Assessing the Pedagogy of Biology

Invited – Scot A.C. Gould, W.M. Keck Science Department, Claremont McKenna, Pitzer, Scripps Colleges, 925 N. Mills Ave., Claremont, CA 91711-5916; sgould@kecksci.claremont.edu

For the past nine years, the W.M. Keck Science Department, the sciences for Claremont McKenna, Pitzer and Scripps colleges, has offered a first-year non-traditional introductory science program for likely majors. The program, the Accelerated Integrated Science Sequence (AISS), covers the content typically found in introductory biology, chemistry, and physics. Topics are examined in an integrated format. Instructors from the three disciplines are present during virtually all of the classroom time and compose exam questions and problem sets together. This format has allowed each instructor to observe and assess multiple teaching methods. As the physicist for this program for more than five years, I have worked with six different biologists and two chemists. The topics and questions of interest to my colleagues has affected how I assess students' skill sets and comprehension of physics principles. The most significant change is a greater emphasis of qualitative comprehension and application.

CC03: 4:40-5 p.m. Making Physical Biology Research Part of the Introductory Physics Course for Life Scientists

Invited – Wolfgang Losert, University of Maryland, Physical Sciences Complex, Rm 1147, College Park, MD 20742-2421; wlosert@umd.edu

I will describe how the NEXUS team at the University of Maryland approaches the challenge to bring authentic biology into the reformed introductory physics course for life scientists. Questions that include physical biology are being developed for all parts of the course from course material and lab material to homework and exam problems. Our goal is to give students tools and experience in how to describe the behavior of living systems from a physics perspective, and to consider physical constraints on the operations of living systems.
In the process of developing and refining problems with a team of biologists, biological physicists, and education researchers something unexpected happened: Our team discovered unexpected principles of living systems, blurring the line between research and education.

CC04: 5-5:20 p.m. Connecting Form and Function: Constructing Biology-based Introductory Physics Problems

Invited – Kenneth Heller, University of Minnesota, School of Physics and Astronomy, Minneapolis, MN 55455; heller@physics.umn.edu

Problem solving is the "sine qua non" of a science course. It is equally valued by the life sciences and physics. In introductory physics, problem solving is both a desired outcome and an important teaching tool. Useful problems are those that develop and foster the use of powerful expert-like problem solving skills that connect fundamental physics to student knowledge. To be effective, problems must engage students by using their knowledge background. Biology majors need problems that use biology to set the scene. Of course, biology is complex. Using physics that accurately describes real biology can reduce a course to employing equations only tenuously connected to the fundamental physics we need to teach the students. However, the act of modeling a biological process can be used as the motivation in effective physics problems that engage students in using fundamental physics. This talk will describe the construction and use of such problems.

CC05: 5:20-6 p.m. A Survey of Biological Topics in Physics Problems

Poster – Juan R. Burciaga, Bowdoin College, Department of Physics & Astronomy, 8800 College Station, Brunswick, ME 04011-8448; jburciag@bowdoin.edu

A number of sources are available that provide biology-based physics problems that can be used to supplement a standard physics curriculum. But what biology topics are used in these problems? How do these topics map onto the suggested biology and physics topics for MCAT preparation? What kinds of biology topics are generally useful for physics faculty to explore? Are there other sources of physics problems that can be used in the IPLS curriculum? The paper presents an analysis of the biology topics from several supplements.

CC06: 5:20-6 p.m. Aligning Introductory Physics Problem Solving to Health Profession Problem-Solving Skills

Poster – Nancy Beverly, Mercy College, 555 Broadway, Dobbs Ferry, NY 10522; nbeverly@mercy.edu

Problem-solving skills in introductory physics can be aligned with the problem-solving skills needed by health professionals, who routinely have to raise questions, determine what information is needed, interpret information, use models of symptoms and their causes, and make diagnosis based on their models and information, then devise and evaluate a treatment plan. Similarly, physics students can be guided to pose their own questions about a physical scenario, construct appropriate models, find and interpret their own needed information and make an inference about the scenario. The main difference is that physics models are mathematical. However the problem-solving process can be made similar, if students ask their own questions and determine their own needed information, instead of the instructor. Students also have to close the loop and use their numerical answer to make a decision or inference. Our experience with guiding students in this kind of problem solving will be discussed.

CC07: 5:20-6 p.m. Kinesthetic Activities to Improve Student Understanding of Multi-concept IPLS Models*

Poster – James P. Vesenka, University of New England, 11 Hills Beach Road, Kennebunkport, ME 04046; jvesenka@une.edu

David Grimm, Bradley Moser, University of New England

Rebecca Lindell, Purdue University

Life science students are, in general, more motivated to analyze and understand problems related to their career interests rather than seemingly unrelated physics concepts. On the other hand authentic biological problems typically encompass multiple physics concepts that require a strong foundation of physics in order to understand the biology. We are developing a number of kinesthetic (hands-on, manipulable) activities that encompass multiple physics concepts in a fashion that makes the biology more understandable through interesting conceptual and quantitative physics-rich presentations. Examples include the development of kinesthetic models of the circulatory system, diffusion and electrophoresis. Our efforts are designed to develop an introductory physics sequence that integrates in parallel with our year long anatomy, physiology and pathophysiology sequence in order to elevate the comprehension of both the underlying biology and physics through authentic and career relevant biological problems.

*Supported by NSF grant DUE 1044154

CC08: 5:20-6 p.m. Physics Curriculum for IPLS Using Multimedia Content

Poster – Ralf Widenhorn, Portland State University, Department of Physics, Portland, OR 97201; ralfw@pdx.edu

Elliot Mylott, Portland State University

There is concern among experts in the physics, biology, and medical communities that undergraduate physics courses are not adequately preparing students for careers in medicine and the life sciences. The rapid development of new instrumentation has made it increasingly useful that students entering these professions have a strong conceptual understanding of the relevant physical principles behind investigative, diagnostic and treatment technologies. In this poster we present the design and assessment of a flipped classroom, algebra-based introductory physics curriculum at Portland State University that utilized in class discussions, original texts, pre-lecture questions, and online homework. The materials are used with laboratory sessions exploring the physics of biomedical instrument and content relevant videos from biomedical researcher and medical professionals.

Session CD: Research on Ethnic Minorities: PER, DBER, and Science Education

Location: Strand 10 B
Sponsor: Committee on Diversity in Physics
Co-Sponsor: Committee on Professional Concerns
Date: Sunday, January 10
Time: 4–5:40 p.m.

Presider: Dan Smith

CD01: 4-4:30 p.m. Values Affirmation as a Buffer Against Impostor Syndrome

Invited – Sarah Ballard, Massachusetts Institute of Technology, 77 Massachusetts Ave. # 3724, Cambridge, MA 02139; sarahba@mit.edu

Physics is only one field of many in which Impostor Syndrome is rampant among students. The syndrome presents as a narrative about one's "impostor" status that resists evidence from authentic achievements and praise, and is most common among underrepresented groups. It's especially challenging to address, since it reflects the internalization of stubborn cultural stereotypes. Values affirmation practices--encouraging individuals to focus upon their personal worth independent of science entirely--have emerged as effective intervention strategies. As two recent studies in science demonstrate, individuals who've suffered most from negative internalized stereotypes stand the most to gain from values affirmation. I'll review the literature about values affirmation and describe not only how it improves student performance, but also bolsters findings about the value of empathy in scientific interactions.

CD02: 4:30-5 p.m. Institutional and Social Barriers that Limit the Success of Marginalized Students (People of Color, Women, and LGBT)

Invited – Ramon Barthelemy, 0000 Washington, DC 20003; ramon.s.barthelemy@gmail.com

Physics degrees give students access to unique problem solving skills and the opportunity for lucrative employment in many degrees. However, this economic gain and intellectual growth is limited to a small fraction of undergraduate and graduate students. Although women represent more than half of all college students and Hispanics and African Americans are pursuing higher education at ever higher rates, they are still underrepresented in physics. Many factors play into this, from the primary school level all the way through graduate education. This talk will outline institutional and social issues for marginalized groups in physics, including people of color, women, and LGBT persons. Topics such as K-12 course access and microaggressions will be discussed.

CD03: 5-5:30 p.m. Using Research Results to Support Inclusive Environments in STEM

Invited – Geraldine L. Cochran, Rochester Institute of Technology, 138 Lomb Memorial Drive, SAU 2312, Rochester, NY 14623; glcsps@rit.edu

Research has been conducted in a variety of fields on how environments can either support or inhibit students from underrepresented groups to pursue and persist in STEM fields. In this talk, I will draw particularly from the literature on diversity and inclusion and science education, with a focus on implications for STEM educators. Further, I will address some apparent gaps in the literature that could further advance our understanding of how to support inclusive environments in STEM.

CD04: 5:30-5:40 p.m. Utilizing Service Learning to Increase Student Enrollment and Engagement

Contributed – Amber D. Strunk, Paradise Valley High School, 3950 E Bell Rd., Phoenix, AZ 85032; astrunk@pvschools.net

Derek Vance, Carl Johnson, Paradise Valley High School

Physics has traditionally been thought of, by students, as a class for the "smart" kids, those kids who are college bound and whizzes at math and science. In addition it is typically perceived as a class with lots of math and no connection to students' everyday life. Many minority students have received the message that physics is not for them. This presentation is about how to integrate service learning and cross curricular topics to work with classes such as Environmental Chemistry, Woods, and Automotives to teach students problem solving techniques, life skills and science content. Our program has increased enrollment and engagement of our minority students while improving our school community.

Session CE: Astronomy Education Research: Current Trends and Future Directions

Location: Bolden 6
Sponsor: Committee on Space Science and Astronomy
Date: Sunday, January 10
Time: 4–6 p.m.

Presider: Doug Lombardi

CE01: 4-4:30 p.m. Student Progress in Gravity and Dynamics Through an Astronomy Curriculum

Invited – Julia Plummer, Pennsylvania State University, 149 Chambers Building, University Park, PA 16802; jdp17@psu.edu*

Chris Palma, Chrysta Ghent, Tim Gleason, Yann Shiou Ong, Alice Flarend, Scott McDonald, Pennsylvania State University

KeriAnn Rubin, St. Ann School

Our team developed a Solar System learning progression that describes how middle and high school students use key physics principles to explain astronomical phenomena (Plummer et al., 2015). We subsequently used this learning progression framework to analyze students' progress in understanding gravity and dynamics during a 6th grade astronomy unit. Data sources included pre/post interviews with a sample of students (N=24) and classroom video. Students made significant progress in discussing gravity's role in the Solar System and explaining orbital motion; the use of a coherent science content storyline and multiple opportunities to engage in scientific argumentation shaped the nature of the students' progress. Also, while students maintained some alternative ideas in their final explanations, the use of the learning progression framework reveals the extent of their movement towards the big idea and suggests ways that future instruction may continue their path towards more sophisticated explanations.

*Sponsor: Doug Lombardi

CE02: 4:30-05 p.m. Cosmological Sense-making: Refocusing on Supporting Student Competence

Invited – Zoe Buck Bracey, BSCS, 5415 Mark Dabling Blvd., Colorado Springs, CO 80918; zbuck@bscs.org

I introduce the constructs of cosmological literacy and cosmological sense-making, and briefly explain how they can be used to refocus our efforts away from what students are getting wrong, and onto supporting student competence. We can tackle this from a pragmatic epistemological perspective following multiple lines of inquiry – both quantitative and qualitative. I will share two examples from my own research around cosmology visualizations. The first uses quantitative, experimental methods to investigate how 122 post-secondary learners rely on color to make sense of dark matter in a cosmology visualization, suggesting ways in which we can better support cosmological sense-making. The second uses qualitative, interpretive methods to investigate how cosmology visualizations are used by small groups of community college students to make sense of content, suggesting a broader view of cosmological sense-making that is more supportive for students from non-dominant linguistic backgrounds.

CE03: 5-5:30 p.m. Investigating Lifelong Learners in an Astronomy Massively Open Online Course

Invited – Sanlyn Buxner, University of Arizona, 1501 E Speedway Blvd., Tucson, AZ 85721-0069; buxner@email.arizona.edu

Chris Impey, Matthew Wenger, Martin Formanek, University of Arizona

We describe a study of learners enrolled in an astronomy-related massively open online course (MOOC). Now, in its third generation of development, students enroll on a rolling basis and complete 11 weeks of content that includes watching videos, completing quizzes, submitting and peer reviewing writing assignments, and participating in citizen science projects. Although tens of thousands of students have signed up for these courses, the level of engagement is much lower. We present demographics and patterns of student use in these courses as a way to understand who signs up for these courses, how they use the resources, and why they complete the courses. Additionally, we compare their basic science knowledge, interest in science, and reported access to science to 25 years of data we have collected from parallel undergraduate non-science major astronomy courses at the University of Arizona. Our analysis has revealed unique characteristics of these learners.

CE04: 5:30-5:40 p.m. K-12 Teachers Scores on the Test of Astronomy STandards TOAST

Contributed – Stephanie J. Slater, CAPER Center for Astronomy & Physics Education Research, 604 S 26th St., Laramie, WY 82070; United States stephanie@caperteam.com

Debra J. Stork, University of Dubuque

Sharon Schleigh, Eastern Carolina University

Timothy F. Slater, University of Wyoming

In an informed effort to better focus and improve professional development, systematic surveys of K-12 teacher' knowledge in the domains of science are conducted periodically. In the context of astronomy education research, we used the 29-item multiple-choice Test Of Astronomy STandards, or TOAST, to survey several samples of teachers. The TOAST is a criterion-referenced instrument constructed upon a solid list of clearly articulated and widely agreed upon learning objectives. The results suggest that K-12 teachers still hold many of the same fundamental misconceptions uncovered by earlier surveys. This includes misconceptions about the size, scale, and structure of the cosmos as well as misconceptions about the nature of physical processes at work in astronomy. This suggests that professional development in astronomy is still needed and that modern curriculum materials are best served if they provide substantial support for implementation.

CE05: 5:40-5:50 p.m. Does the Classroom Matter?

Contributed – Kaisa E. Young, Nicholls State University, PO Box 2022, Thibodaux, LA 70310; kaisa.young@nicholls.edu

Chadwick H. Young, Adam Beyer, Nicholls State University

If you got your choice of classroom for your large introductory science class, what would it look like? We compare student learning and perception data from astronomy, physics, and geology courses taught in traditional classrooms with individual movable desks to the same classes taught in a large auditorium. A survey of our students shows a preference for newer traditional classrooms with large desks and ample space. By comparing our grade books and equalizing as many factors as possible, we report differences between classrooms in measures such as average final exam scores and average final grades. Overall, we find larger percentages of students drop or fail courses taught in a large auditorium than a traditional classroom. The results suggest that the weaker students may get "lost" in an auditorium, but that many students are able to adapt to their learning environment.

CE06: 5:50-6 p.m. Using Online Homework in Introductory Astronomy – Student Engagement Matters

Contributed – Kathy J. Shan, University of Toledo, Department of Physics and Astronomy, 2801 W. Bancroft St., Toledo, OH 43606; Kathy.Shan@utoledo.edu

This study examined the use of online homework in an introductory survey of astronomy course (Astro1010) for non-majors at an open enrollment public university. The study addressed whether student performance depends on the type of online homework assigned. Two sections of Astro1010 were taught by the same instructor during the same semester. Both sections were assigned homework online using Mastering Astronomy, with one section (002) assigned both multiple choice quizzes and interactive homework questions/problems, while the other section (005) was assigned only the multiple choice quizzes (although the more interactive questions were made available for study). All other aspects of instruction were as identical as possible, including lecture notes, in-class peer instruction questions, lecture tutorials, and exams. Preliminary analysis shows that the student success rate (defined as the number of students receiving A, B, or C grades) were significantly higher in section 002 (54 percent) than in section 005 (46 percent).

Session CF: PER: Diverse Investigations

Location: Strand 10 A
Sponsor: Committee on Research in Physics Education
Date: Sunday, January 10
Time: 4–5:50 p.m.

Presider: Gina Passante

CF01: 4-4:10 p.m. Leveraging the Culture and Resources of Urban STEM Students to Create Programmatic Change*

Contributed – Mel S. Sabella, Chicago State University, Department of Chemistry and Physics, Chicago, IL 60628; msabella@csu.edu

Kristy Mardis, Andrea Van Duzor, Chicago State University

Shared experiences, shared culture, and a strong sense of community play an important role in instructional environments in the Chicago State University STEM program. In this presentation we explore how listening to student input and connecting our science education efforts to the culture and community of our population has allowed us, as researchers and instructors that often come from different communities, to develop a more effective program. The CSU Learning Assistant (LA) Program and the CSU S-STEM Program will serve as examples of efforts toward building a welcoming, community-based learning environment.

*Supported by the National Science Foundation (DUE #1356523)

CF02: 4:10-4:20 p.m. The Effects of Grader Assessment Feedback on Student Self-Regulation

Contributed – Annie Chase, San Jose Staté University, One Washington Square, San Jose, CA 95192-0001; annie.chase@sjsu.edu

Cassandra Paul, San José State University

Self-regulation is an internal process where students create an effective environment for constructing knowledge. Constructivist-learning theory suggests that strong self-regulators are efficient learners. Grader assessment feedback (GAF) is a powerful tool instructors can utilize to influence student self-regulation and thus student construction of knowledge. I present results found by applying a qualitative coding scheme, developed in a previous pilot study, in a quasi-experimental investigation. Previously, it was found that students are demonstrating all the aspects of self-regulation defined in this study and different styles of GAF result in different manifestations of student self-regulation. This study presents results from survey data collected in different semesters, different populations, and with a significantly larger sample size. The same coding scheme, along with any open codes that develop, will be used to determine what physics student self-regulation looks like and how different GAF styles affect physics student self-regulation in light of the preliminary data.

CF03: 4:20-4:30 p.m. Web Design for Dissemination of Educational Materials and Tools

Contributed – Mathew A. Martinuk, Cognition Technology, 4088 Welwyn St., Vancouver, BC V5N 3Z2, Canada; martinuk@physics.ubc.ca

I present examples of design for physics educators, based on a user-centered process for designing websites and software. This process includes: interviews with the target audience to determine their needs and expectations; identification of key tasks that the website must enable; design of pages to support those tasks; usability testing to ensure that the site meets users' needs; and design iteration based on the results of usability testing. I summarize lessons learned from the design of several websites that offer educational materials and tools to physics educators, and present examples of how the particular needs of this audience can be best addressed in web design. I offer recommendations for anyone wishing to offer educational research or materials via the web.

CF04: 4:30-4:40 p.m. Professional Development Through an Online Workshop: Lessons Learned*

Contributed – Raina M. Khatri, Western Michigan University, 1903 W. Michigan Ave., Kalamazoo, MI 49008; raina.m.khatri@gmail.com

Charles Henderson, Western Michigan University

Renee Cole, University of Iowa

Jeff Froyd, Texas A&M University

Debra Friedrichsen

Education developers in STEM fields have many ideas on improving undergraduate instruction, but often these ideas fail to propagate to other educators. Our research group has worked to understand best practices in developing educational innovations with sustainable adoption by others in mind. We have run in-person and online workshops in which we train others and have them apply what they learned to their grant proposals. In this talk, we discuss the benefits and limitations of an online setting for professional development and online workshops as a dissemination mechanism.

*This work is supported by NSF grant no. 1122446.

CF05: 4:40-4:50 p.m. Interpreting Self-Reported Data from the Postsecondary Instructional Practices Survey (PIPS)

Contributed – Alexis Knaub, Western Michigan University, 315 Woodward Ave., Apt. 1, Kalamazoo, MI 49007; avknaub@gmail.com

Emily Walter, California State University- Fresno

Charles Henderson, Andrea Beach, Cody Williams, Western Michigan University

The Postsecondary Instructional Practices Survey (PIPS), developed by a team of researchers at Western Michigan University, is a valid and reliable survey instrument to measure teaching practices in higher education. The survey asks respondents to describe how representative a set of statements is of their teaching (e.g., "I provide feedback on student assignments without assigning a formal grade.") One way to analyze the data is using "instructor-centered" and "student-centered" categories. These categories can be graphically represented as a scatterplot with quadrants indicating different levels of instructor- and student-centered practices. In this presentation, we further our understanding of the quantitative survey data through qualitative data. We interviewed survey respondents in each quadrant to learn more about their teaching practices and to be able to better interpret what each quadrant means in terms of teaching practices.

CF06: 4:50-5 p.m. Using Interventions that Change Students' Approach to Learning

Contributed – Calvin S. Kalman, Concordia University, 7141 Sherbrooke St., West Montreal, QC H4B 1R6, Canada; calvin.kalman@concordia.ca

Mandana Sobhanzadeh, Mount Royal University

Robert I Thompson, University of Calgary

It was postulated that if students reflected metacognitively on textual material before coming to class and then had interventions in class that had them examine subjects that produce cognitive dissonance, the students' epistemological beliefs would evolve from those characterizing a novice learning towards those consistent with a more expert learner. This hypothesis was tested through a five-year study involving close to 1000 students at two institutions, in four physics courses. Using student interviews, writing product assessments, and the Discipline-Focused Epistemological Beliefs Questionnaire (DFEBQ) as a pre-and post-test of the students, our results, based on both qualitative and quantitative data, are a strong indication that a combination of an activity that gets students to examine textual material metacognitively (Reflective Writing) with one or more interactive interventions can promote positive change in students' epistemological beliefs.

CF07: 5-5:10 p.m. Designing Strategies to Engage Student Metacognition*

Contributed – Catherine J. Miller, Rhodes College, Department of Physics, Memphis, TN 38112; milcj-16@rhodes.edu

Mila Kryjevskaia, North Dakota State University

MacKenzier R. Stetzer, University of Maine

Research has shown that even after targeted instruction designed to address student conceptual and reasoning difficulties, some introductory physics students still tend to apply intuitive rather than formal reasoning on specific types of questions. In this study, metacognitive interventions were designed and implemented in an effort to encourage the students to reflect on their thought processes. Specifically, students were asked to consider alternative solutions, identify formal and intuitive approaches, and reflect on their own thinking. The impact of these metacognitive interventions on student reasoning was examined. The dual-process theory to reasoning and decision-making was applied in order to interpret the results.

*This work has been supported by the National Science Foundation under Grant Nos. REU DUE-1156974 and DUE-1431857, 1431940

CF08: 5:10-5:20 p.m. Another Look at Multiple-Choice Problems on Tests

Contributed – Dean Richardson, Xavier University of Louisiana, 1 Drexel Drive, New Orleans, LA 70125-1098; drichar7@xula.edu

This project focuses on finding a meaningful way to write multiple-choice questions on exams. One of the most important aspects of a physics exam is to test the students' ability to solve problems, not just answer questions. We have also noticed that when grading free-response problems on physics tests for large classes, it is necessary to use a certain rubric. In other words, it is necessary to be able to quickly look for certain mistakes and take off a certain number of points for that mistake. This process becomes very formulaic. We have substituted a series of multiple-choice questions for each "worked-out" problem. One free-response problem is rotated between versions of the test as a check. So far, this has worked well and doesn't appear to have changed the way the students prepare for exams.

CF09: 5:20-5:30 p.m. Student Interactions with Mastery Inspired Online Activities

Contributed – Tim J. Stelzer, University of Illinois, 1110 W Green St., Urbana, IL 61801; tstelzer@illinois.edu

Noah Schroeder University of Illinois

This fall we have introduced a new type of online homework activity designed to help students become proficient with some fundamental concepts necessary to succeed in introductory physics. For each concept several equivalent sets of questions have been created. Each student is assigned one set of the questions. Instead of being given immediate feedback on the correctness of their answers, they are given help in the form of the solution to a different version of the questions. This talk will summarize results from the student interactions, and implications for improving student learning from online homework activities.

CF10: 5:30-5:40 p.m. What Our Textbooks Tell Students About Problem-Solving

Contributed – Jeffrey A. Phillips, Loyola Marymount University, 1 LMU Drive, MS-8227, Los Angeles, CA 90045; jphillips@lmu.edu

Improved problem-solving is considered one of the primary student learning goals for many physics courses, yet most textbooks do not describe the complexities of problem-solving. To be successful at problem-solving, students must learn to employ metacognitive skills so they can monitor and correct their own work. This process typically yields non-linear solutions that bear little resemblance to the worked examples in textbooks. A survey of how popular introductory physics texts describe and illustrate the problem-solving process will be presented. Most portray problem-solving as a linear process devoid of any metacognition. Rather than showing examples of how one can identify and correct errors within a solution with monitoring, they show only correct and optimized solutions. Implications for teachers and students will be discussed.

CF11: 5:40-5:50 p.m. Becoming a Physicist: Identity Trajectories in Undergraduate Research Experiences

Contributed – Gina M. Quan, University of Maryland, 082 Regents Drive, College Park, MD 20740; gina.m.quan@gmail.com

Andrew Elby, University of Maryland

In this talk, we analyze students' identity trajectories as undergraduate physics majors participating in physics research. Students in the study participated in an elective seminar in which they were paired with graduate students and faculty mentors on physics research projects and participated in a weekly discussions about research. In one-on-one interviews and classroom discussions, students described changes in their participation in the broader physics community, as well as more sophisticated ideas about what constitutes participation in that community. Using their narrative accounts, we discuss students' trajectories of their participation in the community, highlighting relational dynamics between themselves and other members of the physics community. Finally, we draw out connections between these trajectories, which have implications for future research and programmatic design.

Session CG: International Programs and Teaching Experiences

Location: Bolden 4
Sponsor: Committee on International Physics Education
Co-Sponsor: Committee on Physics in High Schools
Date: Sunday, January 10
Time: 4–5:30 p.m.

Presider: Carolina Alvarado

CG01: 4-4:30 p.m. An American Instructor in an Upper-Level Italian Physics Class

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

In spring 2014, I taught an upper-level Nuclear Experimental Techniques class in Italy, utilizing an active-learning pedagogical approach that was undoubtedly novel for the students. The class was an elective for third-year undergraduates, so their enrollment was optional, and a balance had to be established between trying these interactive methods in class and "testing the tolerance" of the students who had mostly been raised in a more passive classroom environment. In addition, the class was taught in English, which is not the norm for Italian undergraduate classes, so the language issue became an important factor to consider. Questions to address included: (1) Did students like the interactive environment? (2) Did they participate fully in the classroom activities? (3) Did they perceive any educational benefit from the higher level of engagement? I will present the details of this experiment and a summary of the outcome, along with student feedback on their perceptions of the active-learning experience in this class.

CG02: 4:30-5 p.m. Taking U.S. Students to a German University Lab*

Invited – Evangeline J. Downie, George Washington University, 725 21st St. NW, Washington, DC 20052-0002; edownie@gwu.edu

Raluca Teodorescu, Montgomery College

William J. Briscoe, George Washington University

For many years the George Washington University has taken summer research students to Mainz, Germany, to gain experience at the Mainzer Microtron (MAMI). With the award in 2014 of an NSF IRES grant, it was decided to add more structure to the program and use PER techniques to investigate the student experience and establish some best-practice guidelines for such experiences. We will report on the procedures we have implemented and their effect on the student outcomes. We will share the initial experiences and the gains we have found from local, pre-travel training and regular meeting and monitoring structures throughout the summer.

*This material is based upon work supported by the National Science Foundation under Grant No. IIA-1358175.

CG03: 5-5:10 p.m. Teaching Physics in Afghanistan and Math in the D.P.R.K.

Contributed – Marek J. Radzikowski, American University of Afghanistan, Darul-aman Road, Kabul, 00000, Afghanistan; mradzikowski@auaf.edu.af

I discuss some of my experiences teaching Introductory Physics I and II at the American University of Afghanistan 2011–2015, and teaching Advanced Calculus to graduate students at Pyongyang University of Science and Technology, D.P.R.K., for three weeks in the summer of 2012.

CG04: 5:10-5:20 p.m. Teaching Physics in Refugee Camps

Contributed – Mary L. Lowe, Loyola University, Maryland, 4501 N. Charles St., Baltimore, MD 21210; mlowe@loyola.edu

Harry Lee, Ben Doyle, JesuitNET Global

In 2015, in collaboration with the academic program led by Jesuit Commons: Higher Education at the Margins, an online physical science course was developed and administered to 115 students at six refugee sites in Kakuma Camp, Kenya; Dzaleka Camp, Malawi; Amman, Jordan; and Taunggyi, Myanmar. The course was constructed in two modules: physics and chemistry. The latter was taught by Dr. Patrick Daubenmire, Loyola University Chicago. The physics portion covered Newton's laws, thermodynamics, gravity, and electricity. Online review questions and onsite activities (in electrical circuits) were incorporated. We will describe the infrastructure needed to conduct this course, the choice and delivery of physics course materials prepared by the professor, and the resulting online course developed by the JesuitNET Global production team. Despite having no prior knowledge of the subject matter, some students achieved the highest possible letter grade. Evaluations by the students and facilitators at the sites will be provided.

CG05: 5:20-5:30 p.m. Real Experimentation Across the Internet and Across Borders, Ampère's Law

Contributed – Jeremiah O. Bechtold, Southwest Baptist University, 1600 University Ave., Bolivar, MO 65613; jeremiahbechtold@gmail.com

Perry A. Tompkins, Southwest Baptist University

Virtual instrumentation allows the formation of real experiments that are served to remote locations, even across international borders. This is especially useful in international contexts that often are trying to educate physics students in resource-limited environments. In these environments, often physics theory is prevalent, but experimentation can be lacking. This presentation outlines a project that makes the measurement of the magnetic field of a long straight wire, served across the internet using National Instrument's LabVIEW software. This experiment is available to anyone that can reasonably access the internet. The measurement is an actual measurement that combines video, control of the position of a hall-probe and a high current power-supply. Measurement of the permeability of free space is typically made within errors less than 10%. This overall strategy is envisioned as a way that national universities can provide local high-schools and regional universities access to experimentation that would otherwise be unavailable.

Session CH: Panel – Electronic Physics Education Resources for Teachers and Teacher Educators

Location: Bolden 5
Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on Research in Physics Education
Date: Sunday, January 10
Time: 4–6 p.m.

Presider: John Stewart

The panel members form a spectrum of experts who have successfully delivered educational resources and materials to teachers and teacher educators. The panel will discuss their successes in and the challenges of delivering resources for teachers and teacher educators over the internet. Multiple delivery methods including digital libraries, open online courses, and targeted websites will be discussed. Each panel member will introduce their online resources and the efforts taken to make the teacher education community aware of these resources. The panel will talk about their most successful products and some that did not reach a broad audience.

Speakers:

– **Bruce Mason**, *Department of Physics and Astronomy; The University of Oklahoma, Norman, OK*

– **Wendy Adams**, *University of Northern Colorado, Department of Physics and Astronomy, Greeley, CO*

– **Colleen Megowan-Romanowicz**, *Executive Officer, American Modeling Teachers Association, Sacramento, CA*

– **Manher Jariwala**, *Boston University, Department of Physics, Boston, MA*

Session CI: Effective Practices in Educational Technologies

Location: Bolden 2
Sponsor: Committee on Educational Technologies
Date: Sunday, January 10
Time: 4–5:50 p.m.

Presider: Andrew Duffy

CI01: 4-4:10 p.m. Interaction Effects of Video Vignettes on Student Understanding*

Contributed – Kathleen M. Koenig, University of Cincinnati, 3758 Hubble Road, Cincinnati, OH 45247; kathy.koenig@uc.edu

Robert Teese, Rochester Institute of Technology

Priscilla Laws, David Jackson, Maxine Willis, Dickinson College

Multiple short, single topic interactive video vignettes (IVVs) have now been developed and tested by the LivePhoto Physics Group (www.compadre.org/IVV). As part of an evaluation to determine the impact of each IVV on student understanding of certain concepts, studies have been conducted that compared two groups of students; those completing the IVVs as homework assignments in college level introductory courses to those who did not complete them. Both groups were pre- and post-tested using the Force Concept Inventory. Past presentations of our research findings focused on the impact on student understanding for single IVVs. This presentation will focus on how multiple IVVs, when used in combination, better target student learning of certain concepts.

* Supported by NSF TUES (DUE 1123118 & 1122828).

CI02: 4:10-4:20 p.m. Use of a Curriculum App in Teaching and Learning

Contributed – Meera Chandrasekhar, University of Missouri, Department of Physics, Columbia, MO 65211; meerac@missouri.edu

Deepika Menon, Towson University

Dorina Kosztin, Douglas Steinhoff, University of Missouri

Mobile devices are replacing textbooks in classrooms. We describe a conceptual physics curriculum app and its use in a college-level class for elementary education majors. The Exploring Physics curriculum app, based on inquiry and modeling pedagogies, is a combination textbook, workbook and lab-book. Students can enter text, drawings, graphs, tables, or data in the app. They submit their work for grading and receive feedback through the app. Two studies have been conducted on the use of this app in the classroom. The first study compared the technology self-efficacy of two sections of the class; in one that used a traditional workbook, and the other that used the app. In the second study students' growth in physical science content knowledge was measured as they used the app. Results of the studies will be presented. Findings have implications for pre-service teacher preparation for future use of technology in science teaching.

CI03: 4:20-4:30 p.m. Teaching Computational Modeling: The Basics

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

Bruce A. Sherwood, North Carolina State University

Most students in introductory physics courses have never written a computer program. This is true for many instructors as well. As interest in incorporating computational modeling into physics instruction increases, many novices, both students and instructors, are encountering computational ideas for the first time. There's a lot to learn. What should be omitted, what should be included, and how should it be taught? We'll describe one functional model, based on nearly two decades of experience in integrating computation into introductory physics.

CI04: 4:30-4:40 p.m. The Maxima CAS as a Tool for Teaching Physics

Contributed – Todd K. Timberlake, Berry College, PO Box 495004, Mount Berry, GA 30149-5004; ttimberlake@berry.edu

Maxima is an open-source computer algebra system (CAS) that runs on all major platforms. It can serve as a free alternative to commercial CAS programs like Mathematica or Maple. The combination of Maxima and a tool for building interactive simulations (like Easy Java Simulations) provides a free but powerful set of tools for introducing students to computational physics. I will briefly discuss the advantages of using open-source software before describing some features of Maxima and how they can be used for teaching computational physics, with particular emphasis on topics in classical mechanics. A list of resources (both online and in print) for learning and using Maxima is available at sites.berry.edu/ttimberlake/cm_maxima/.

CI05: 4:40-4:50 p.m. Using IPython Electronic Notebooks in the Introductory Physics Laboratories

Contributed – Tatiana A. Krivosheev, Clayton State University, 3791 River Mansion Drive Duluth, GA 30096 tatianakrivosheev@clayton.edu

We present our experience with conversion of the traditional laboratory manuals used in the Introductory Physics courses into an integrated IPython notebook: a web-based interactive computational environment to combine code execution, text, mathematics, plots, and rich media into a single document. The electronic notebooks are provided to students as a free of charge, electronically shareable file, which amounts to an average savings of $25 per student per semester. The IPython environment also generates additional student learning opportunities such as numerical simulations and programming.

CI06: 4:50-5 p.m. FormScanner: An Open-Source Solution for Grading Multiple Choice Exams

Contributed – Chadwick H. Young, Nicholls State University, P.O. Box 2022, Thibodaux, LA 70301; chad.young@nicholls.edu

Alberto Borsetta

Glenn V. Lo, Kaisa E, Young, Nicholls State University

We present software for grading multiple choice exams. FormScanner allows the instructor greater flexibility in grading and is much preferred over the "scantron" machines on campus for several reasons. 1) The software provides detailed item analysis, so instructors can better assess the effectiveness of questions. 2) Grading is considerably faster with FormScanner than on a scanner because one uses a photocopier machine to scan; these can scan hundreds of forms in a matter of seconds. 3) Faculty can create their own custom forms for a particular test; also, researchers can administer and analyze surveys with FormScanner. 4) Finally, FormScanner is open-source, free, and without in-software advertising. Similar commercial products cost thousands of dollars and do not provide the same quality of results. We show how to use FormScanner, analyze a set of student papers, and share faculty experiences with this software. More information about the process is at www.formscanner.org

CI07: 5-5:10 p.m. Using Python and pdfLaTex to Generate Customized Physics Problems

Contributed – William G. Nettles, Union University, 1050 Union University Drive, Jackson, TN 38305; bnettles@uu.edu

Geoffrey M. Poore, Union University

Physics teaching routinely utilizes drill problems to teach physics concepts, problem-solving skills, and mathematical techniques. Answers for end-of-chapter problems are being published and accessed by students. Generating new initial conditions and their answers for individual students is laborious. pdfLaTeX is a free typesetting system and PythonTex[1] is a package that allows a pdfLaTeX document to execute code in Python and then typeset output from the code under user control. Using random numbers, we generate randomized initial conditions for standard physics problems and present these problems in typeset form. We also program Python to generate the answers and write them, along with a student name, to a file; we don't need to hand-calculate each student's answer. A custom Python class and a custom script automatically handle batch generation of problems for students. One or several student(s) can have multiple instances of a standard problem, each instance with a different answer. Emphasis can be placed on conceptual understanding of the problem. This approach also enhances peer instruction.

1. Geoffrey M Poore, "PythonTeX: reproducible documents with LaTeX, Python, and more," *Computational Science & Discovery* **8** (2015) 014010.

CI08: 5:10-5:20 p.m. Using Spreadsheets for Self-Assessment

Contributed – Stephen Robinson, Belmont University, Whites Creek, TN 37189-9139; steve.robinson@belmont.edu

"Am I fair to students?" "What external factors influence my teaching effectiveness?" "Am I getting any better at teaching?" These are questions most teachers ask themselves, but it can be difficult to reach clear conclusions. This discussion will introduce a few simple statistical tools (e.g., t-tests, regressions, and standard errors) in spreadsheets to help teachers gather data about themselves for self-assessment.

CI09: 5:20-5:30 p.m. Integrating Computation: It's Time to Start!*

Contributed – Larry Engelhardt, Francis Marion University, PO Box 100547, Florence, SC 29501-0547; lengelhardt@fmarion.edu

Marie Lopez del Puerto, University of St. Thomas

Kelly Roos, Bradley University

Danny Caballero, Michigan State University

Norman Chonacky, Yale University

In physics classes, we should expect our students to use computers to solve problems, just as we expect them to use algebra and calculus. That is the goal of the PICUP organization -- the "Partnership for Integration of Computation into Undergraduate Physics." One of PICUP's current projects involves offering a series of faculty-development workshops and building a national community of faculty to support one another in realizing this goal. Come find out how you can be a part of this project, and how you can help your students develop computational skills that will help them in their future jobs and education.

*This work is supported by the National Science Foundation under DUE IUSE grants 1524128, 1524493, 1524963, 1525062, and 1525525.

CI10: 5:30-5:40 p.m. Results from Applying Two Learning Sequences with Simulations, Intelligent Tutoring Systems and Low-Cost Experiments for the Learning of Electric Circuits' Concepts in High School Students

Contributed – Daniel Sanchez Guzman, Instituto Politecnico Nacional Legaria, No. 694 Mexico City, 09760 México; dsanchezgzm@gmail.com

Ricarco Garcia Salcedo, Diana Berenice Lopez Tavares, Instituto Politecnico Nacional

Active learning and technology have demonstrated to be an effective group of methodologies and tools for the learning process. Based on all the help that teachers can use and the results in a useful impact on students, we can formulate the next question: which tools and learning sequences can be more effective to learn electric circuits' concepts in high school students? To answer this question we design and compare two active learning sequences, both involve a similar approach supported by the active learning, but they used different learning strategies like interactive simulations using PhET, demonstrative experiments realized by students and intelligent tutoring systems for the problem-solving process. The experiment was applied to four groups of students with ages between 15 and 17 years old. We analyze normalized gain, concentration factor and a semantic differential test in both groups for measuring the impact of the different learning sequences and to comprehend that both approaches were effective in the learning process with students.

CI11: 5:40-5:50 p.m. Video Analysis for Science & Physics Classrooms

Contributed – Kerem Ekinci, Harmony School of Science High, 13522 W. Airport Blvd., Sugar Land, TX 77478; kekinci@harmonytx.org

Capture, Analyze, and Share with Video Analysis: Video Physics app brings automated object tracking and video analysis to iPhone, iPod touch, and iPad. Capture video of an object in motion, then tap to track the object automatically. Video Physics app instantly creates trajectory, position, and velocity graphs for the object. Video Physics app is perfect for science students and instructors. Perform on-the-go analysis of interesting motion. Measure the velocity of a child's swing, a roller-coaster, or a car. Or, take a video of a basketball free throw shot. Video Physics app will display the path of the ball and provide graphs of y vs. x as well as the x and y position and velocity as a function of time. Video Physics app is intended for use in science education.

Session TOP1A: iOS and Android App Show

Location: Strand 11 A
Sponsor: Committee on Educational Technologies
Co-Sponsor: Committee on Physics in High Schools
Date: Sunday, January 10
Time: 6–7:30 p.m.

Presider: Lee Trampleasure

Do you have a favorite app for your physics classroom? Do you want to see others' favorite apps? Come to this "Show and Tell" for a cavalcade of apps—both "student" and "teacher" apps are welcome. Each presenter will get five minutes to show their app. You can sign up at the show or, to ensure you get time, you can sign up in advance at http://ncnaapt.org/appshow (this will also help us to avoid duplication). We'll have dongles to connect iPad/iPhones to the projector, and maybe some Android devices, but since devices have different connectors we suggest bringing your own (if you have one), and may also have a document camera to project any device that we can't connect. A list of all apps presented will be available to those who attend and those who can't.

TOP1A01: 6-7:30 p.m. Introducing SMASH*: Modern Physics

Contributed – Rebecca Lindell, Department of Physics and Astronomy, Purdue University, 525 Northwestern Ave., West Lafayette, IN 47907; rlindell@purdue.edu

Ronald Reigenberger, Tianwei Liu Joseph Cychosz, Purdue University

SMASH (Scientific Multiple-choice Assessments for Student Handhelds) is a cell-phone based app designed to deliver researcher-based multiple-choice questions to student handhelds. The current implementation of SMASH focuses on questions relevant to an introductory course in modern physics. The easy-to-use app is designed to supplement lectures, reinforce relevant concepts, and review appropriate vocabulary. Of most importance, the SMASH app format has been designed for adoption in any course. A web-based version of the app can be viewed at http://cychosz.com/SMASHphysics/modern/. Downloadable Android and iPhone based versions of the app are nearing completion.

*Scientific Multiple-choice Assessments for Student Handhelds

TOP1A02: 6-7:30 p.m. Quantum Sandbox – A Playground for 1D and 2D Quantum Wavefunctions

Contributed – John Di Bartolo, NYU Polytechnic, School of Engineering, 6 Metrotech Center, Brooklyn, NY 11201; john.dibartolo@nyu.edu

The goal of this app is to provide a "playground" for students to manipulate quantum mechanical wavefunctions in one- and two-dimensions. The focus is on providing qualitative, not quantitative, understanding. In one dimension, the user draws the potential energy function as well as the initial wavefunction. The one-dimensional time-dependent Schrödinger equation is then solved using the leapfrog method, and the resulting behavior of the wavefunction is shown. The device can be tilted along the x-axis to influence the evolution of the wavefunction via gravitational force. In two dimensions, the user draws potential energy barriers as well as the initial wavefunction. The two-dimensional time-dependent Schrödinger equation is then solved using the leapfrog method, and the resulting behavior of the wavefunction is shown. The device can be tilted along the x- and y-axes to influence the evolution of the wavefunction via gravitational force.

Session TOP2B: Forum on Teaching Pre-Service and In-Service Teachers

Location: Bolden 3
Sponsor: Committee on Physics in Pre-High School Education
Co-Sponsor: Committee on Teacher Preparation
Date: Sunday, January 10
Time: 6–7:30 p.m.

Presider: Beth Marchant

Do you work with in-service or pre-service teachers? Teach elementary education majors or conduct professional development? Come to this forum to discuss your ideas, ask questions and learn from others. Prior to this session think about what is most important to you, as we will spend the first five minutes self-organizing around those topics. We will break at the 30- and 60-minute marks to quickly summarize and reorganize in an effort to accommodate those who may not be able to attend the entire session and those who want to focus on more than one topic.

Session TOP6F: Identifying the Needs of Early Career TYC and 4YR Physics Faculty

Location: Strand 11 B
Sponsor: AAPT
Date: Sunday, January 10
Time: 6–7:30 p.m.

Presider: Janelle Bailey

Help AAPT help you! If you are an early career physics instructor in higher education—or are about to become one—come share your thoughts with AAPT leadership and help guide the direction of future efforts. Beyond the New Faculty Workshop, how can we best support you and your colleagues as you begin your career teaching physics or astronomy? Mentors of new faculty, we welcome your input as well!

2016 Winter Meeting Plenary

Location: Celestin A-C
Date: Sunday, January 10
Time: 7:30–8:30 p.m.

Presider: George Amann

Dr. Benjamin D. Santer

Evidence for Human Effects on Global Climate

by Benjamin D. Santer, Lawrence Livermore National Laboratory

My talk covers information provided to an American Physical Society subcommittee charged with updating the APS's position statement on climate change. The first part shows that satellite data and the model-predicted response to human influence have a common latitude/altitude pattern of atmospheric temperature change. Key features of this pattern are global-scale tropospheric warming and stratospheric cooling. Current climate models are unlikely to produce this distinctive signal pattern by internal variability alone, or in response to naturally forced changes in solar output and volcanic aerosol loadings. Despite continuing increases in atmospheric levels of greenhouse gases, global-mean temperatures have showed relatively little warming since 1998. This so-called "hiatus" has received considerable attention. The second part of my talk examines the contribution of early 21st century volcanic activity to the "hiatus" in global warming. Neglect of these eruptions in climate model simulations partly explains why current climate models overestimate the muted warming observed since 1998.

NOTE: Meeting of the Members follows at 8:30 p.m.

Early Career Professionals Speed Networking Event

Career development and networking can be time consuming, so AAPT is spearheading a fun and exciting way to get connected to a large number of early career and seasoned physics professionals in a short amount of time. Speed-networking provides the opportunity to discuss career goals and challenges with a new contact for five minutes, exchange information, and then move on to the next person. By the end of the event each participant will have meaningful interactions with over half a dozen colleagues and the opportunity to meet many more. If you think you made a good contact, follow up with the person and schedule a time to meet for coffee. It's that simple! By the end of the first day of the conference you would have already made several personal connections with other attendees. If you have business cards, don't forget to bring them.

Sunday, January 10, 12–1:30 p.m.
Empire B

Monday, January 11 Highlights

AAPT French Quarter Jogging/Walking Tour
7–8 a.m.
Offsite

High School Resource Lounge
10 a.m.–7 p.m.
Imperial 11

Two-Year College Breakfast
7–8 a.m.
8 Block Kitchen and Bar

AAPT Richtmyer Memorial Lecture Award presented to Derek Muller
9:30–11 a.m.
Celestin A-C

Exhibit Hall (open 10 a.m.–4 p.m.): Roku 3 Streaming Media Player Raffle Drawing
10:45 a.m., Storyville Hall, 3rd Floor

Multicultural Luncheon
12:30–2 p.m.
Q Smokery and Café

Retired Physicists Luncheon
12:30–2 p.m.
8 Block Kitchen and Bar

Committees, 12:30–2 p.m.

Educational Technologies	Bolden 4
Graduate Education in Physics	Strand 10 A
Diversity in Physics	Strand 2
Science Education for the Public	Bolden 2

Free Commercial Workshop
CW04: PASCO: Come See What's New
12:30–1:30 p.m. – Strand 5

PLENARY: Dr. Kimberly Ennico, NASA
2–3 p.m.
Celestin A-C

Exhibit Hall: Kindle Fire HD 6 Raffle Drawing
3:15 p.m.
Storyville Hall, 3rd Floor

Exhibit Hall: Great Book Giveaway
4–4:30 p.m.
Storyville Hall, 3rd Floor

Committees, 5:30–6:30 (or 7 p.m.)

Apparatus	Strand 3
International Physics Education	Bolden 4
Pre-High School Education	Bolden 2
Professional Concerns	Strand 2
Space Science and Astronomy	Bolden 3
Membership and Benefits	Imperial 12
SI Units and Metric Education	Strand 6

AIP Science Communication Awards Celebration
5:30–7 p.m., Foster 1

SPS Undergraduate Awards Reception
6–7:30 p.m., Foster 2

Session TOP4D: Physics and Society

Location: Strand 10 A
Sponsor: Committee on Science Education for the Public
Date: Monday, January 11
Time: 8–9:30 a.m.

Presider: *Stanley Micklavzina*

Join your colleagues to discuss how AAPT members can contribute and coordinate efforts to teaching physics related societal issues such as science literacy, energy use and production, pseudoscience, and other topics bound to raise interesting conversations in the classroom, public venues, and even the dinner table with friends and relatives!

Session TOP5E: Graduate Student Topical Discussion

Location: Strand 10 B
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Graduate Education in Physics
Date: Monday, January 11
Time: 8–9:30 a.m.

Presider: *Gina Quan*

This session is the primary opportunity for members of the PER graduate students community to meet and discuss common issues.

Session TOP3C: Identifying the Needs of Pre-service and Early Career HS Physics Teachers

Location: Strand 11 B
Sponsor: AAPT
Date: Monday, January 11
Time: 8–9:30 a.m.

Presider: *Janelle Bailey*

Are you an early career or pre-service physics teacher, or someone who works closely with one? If so, AAPT needs your help! How can we best support you and your colleagues as you begin your career teaching physics or physical science? Are there new ideas that we should pursue, improvements for existing programs, additional opportunities to consider? Please come share your thoughts with AAPT leadership and help guide the direction of future efforts.

Session PST1: Poster Session 1

Location: Storyville Hall, 3rd floor
Sponsor: AAPT
Date: Monday, January 11
Time: 8–9:30 a.m.

Persons with odd-numbered posters will present their posters from 8–8:45 a.m.; even-numbered will present 8:45–9:30 a.m.

A - Physics Education Research

PST1A01: 8-8:45 a.m. A Cohort Model for a Discipline-based Education Research REU Program

Poster – Warren M. Christensen, North Dakota State University, 513 9th Ave., N Fargo, ND 58102; Warren.Christensen@ndsu.edu

Jennifer L Momsen, North Dakota State University

Growing up STEM at North Dakota State University is one of the first REU programs in the nation to focus on discipline-based education research (DBER). For the past three years, the goal of our program has been to foster retention and recruitment of talented students to graduate programs in DBER. The program features 10 weeks of immersive research, and through a number of social and professional development activities, students build a cohort of like-minded peers and develop as scholars. Results from our first three years indicate participants were deeply engaged, motivated, and committed to their research while on campus. Several participants are matriculating into graduate programs in DBER and nearly all of our remaining participants plan to continue on to graduate programs in STEM. As the program matures, we seek to increase the diversity of our applicants and will track these students as they progress in their graduate careers and beyond.

PST1A02: 8:45-9:30 a.m. Development of a Fluid Dynamics Conceptual Assessment II: Questions and Test Specifications

Poster – Dawn Meredith, University of New Hampshire, 9 Library Way, Durham, NH 03824; dawn.meredith@unh.edu

Rebecca Lindell, Purdue University

James Vesenka, University of New England

We are in the process of developing a fluid dynamics Conceptual Learning Assessment Instruments (CLAIs) designed specifically to assess students' understanding of basic fluid dynamics concepts before and after their IPLS course. In the first stage of development, we utilized a Delphi process to identify the concept domain for this CLAI. After this stage, we determined the test specifications for our CLAI. Based on the concept domain and the test specifications, we crafted a large number of open-ended questions. These open-ended questions were then distributed to a diverse population of ILPS students. These results were used to develop a series of multiple-choice questions to be part of the Fluid Dynamics CLAI. We will present the Beta version of the Fluid Dynamics CLAI. The next stage in development is field testing at a variety of institutions' IPLS courses. If interested in participating in the national field test please contact one of the authors.

PST1A03: 8-8:45 a.m. Diagnoser.com: Assessment to Serve Students, Teachers, Researchers and Professional Developers

Poster – James A. Minstrell, Facet Innovations, 1314 NE 43rd St., Suite 207, Seattle, WA 98105; jimminstrell@facetinnovations.com

Wouldn't you like to have an assistant that would help you diagnose the problematic conceptual ideas of your students and suggest instructional activities to promote concept development? High school physics teachers in an NSF-funded MSP are using Diagnoser.com for diagnostic, formative and summative assessment and using the data to inform their decisions about addressing specific research-based misconceptions used by their students and to suggest next activities identified through research and best practice teaching. This poster will briefly describe the components of a partnership between several Alabama universities, the state of Alabama, and 70+ Alabama high school physics teachers to improve learning by students. Session participants will have access to free online assessment and instruction tools that have been shared with teacher participants. Participants will also learn about the effects teachers are having by using Diagnoser.com for formative and summative assessment.

PST1A04: 8:45-9:30 a.m. Effects of the IMPRESS Program on Student Metacognition

Poster – Annie Chase, San José State University, One ' San Jose, CA 95192-0001; annie.chase@sjsu.edu

Eleanor Sayre, Kansas State University

Mary Bridget Kustusch, DePaul University

Scott Franklin, Rochester Institute of Technology

IMPRESS (Integrating Metacognitive Practices and Research to Ensure Student Success) is an intensive two-week program for incoming first generation or deaf / hard-of-hearing college students at Rochester Institute of Technology. The purpose of IMPRESS is to help students develop the necessary metacognitive skills needed to be successful students. Metacognition is often defined simply as "thinking about thinking." However a more complete definition includes awareness of one's own understanding as well as the ability to regulate one's own thought processes. The IMPRESS program used strategies for developing metacognitive skills including small group research activities focused around the theme of climate change followed by whole class discussions. Students were encouraged to reflect on their own thought process through activities including journaling and silent reflection. In this poster, I discuss the qualitative methods I used, including developing and refining a narrative, to investigate how students' metacognition changed over a two-week period.

PST1A05: 8-8:45 a.m. Epistemological Beliefs, Scientific Reasoning Ability and Practicing Science

Poster – Shannon D. Willoughby, Montana State University, EPS 264 Bozeman, MT 59717; willoughby@physics.montana.edu

Keith Johnson, Montana State University

We administered the Epistemological Beliefs about the Physical Sciences (EBAPS) survey as a pre-test and a post-test in Astronomy 110 for four semesters to collect baseline data, then we made reforms to the course and have continued to collect EBAPS data for three more semesters. To date we have not been able to affect students' views about whether or not learning science is a fixed trait or something anybody can do if they practice. During the fall 2015 semester we implemented an online homework system for the first time in order to give students further opportunities to practice doing Astronomy. We also gave Lawson's test of scientific learning during the second week of class to determine if there are correlations between scientific reasoning ability and epistemological beliefs. We will report on correlations between changes in students' epistemological beliefs, online homework implementation, and Lawson's test of scientific reasoning.

PST1A06: 8:45-9:30 a.m. Exploring Questioning Patterns in High School Physics Classrooms

Poster – Brianna Santangelo, The College of New Jersey, 16 Maryland Ave., West Long Branch, NJ 07764; santanb1@apps.tcnj.edu

AJ Richards, The College of New Jersey

The use of higher level questioning in classrooms helps students develop a deeper understanding of concepts and an ability to apply these concepts. However, the use of higher level questioning in high school physics classroom has yet to be explored in detail. We have applied Bloom's revised taxonomy to categorize the type of questions asked in several high school physics classrooms. We plan to use this information and students' scores from the Force Concept Inventory (FCI) to find a correlation between higher level questions and students' conceptual understanding of Newtonian physics.

PST1A07: 8-8:45 a.m. How Students Use Prior Knowledge While Constructing Understanding

Poster – AJ Richards, The College of New Jersey, 2000 Pennington Rd., Ewing, NJ 08628; aj.richards@tcnj.edu

Darrick C. Jones, Eugenia Etkina, Rutgers University

We recorded pre-service physics teachers learning about the physics of solar cells. Using a knowledge-in-pieces theoretical framework, we analyze their interactions in order to make inferences about the elements of prior knowledge they call upon as they build understanding of how these devices function. Of special interest are the instances when a student makes a significant conceptual breakthrough. We find that students who combine different aspects of their prior knowledge in specific ways may be more likely to make breakthroughs. We will discuss what instructors can do to prime learners to combine knowledge in productive ways so they are better able to achieve these breakthroughs.

PST1A08: 8:45-9:30 a.m. Implementing Inquiry Labs in the Introductory Physics Classroom

Poster – Erin Combs, Sutherland Kennesaw State University, 4206 Rockpoint Drive, Kennesaw, GA 30152-7726; esutherl@kennesaw.edu

David Rosengrant, Kennesaw State University

This study investigates the impact of an Inquiry physics I lab on student attitudes and conceptual change. The labs were changed from "cookbook" format to inquiry labs that used the same equipment as the traditional labs. This study involves algebra-based physics I labs taught by different professors during the fall of 2015. The first set of classes was taught using the standard lab book and equipment. The other classes were taught using the reformatted labs. Both labs taught the same physics concepts. We theorized that students would understand the physics behind the labs more clearly if they had to spend more time thinking about how the labs were performed and how they related to the content of the classroom lessons and less time simply plugging in numbers and filling in the blanks. We pre and post tested both groups of students using the CLASS and a misconceptions test that was designed to focus on the material covered by the labs.

PST1A09: 8-8:45 a.m. Increasing Student Confidence and Conceptual Change with Demonstrations

Poster – Jeremy Tomaszewski, Temple University, 2001 Fairwood Lane, Wilmington, DE 19810; jeremy.tomaszewski@gmail.com

Doug Lombardi, Temple University

The study of conceptual change in science education, specifically in the realm of physics, continues to be an area of active research. Although researchers have given an appreciable amount of attention to conceptual change, there is still much that is not understood. This study seeks to explore one such area: the role confidence plays in helping or hindering conceptual change. Additionally, feedback given in the form of a classroom demonstration, rather than simply providing oral feedback, may increase students' cognitive engagement with the material and increase learning and retention. In this study, students will be asked to pair a series of short multiple-choice questions on five Newtonian mechanics topics with a Certainty of Response Index (CRI; i.e., as a measure of confidence). Following each survey, students will be provided feedback on the correct answers. For one group of classes, written feedback of correct answers will be paired with a teacher/researcher lead discussion focused on one of the questions in the survey. The other group will receive written feedback of correct answers paired with a live demonstration mirroring the same survey question. Posttests will be given 1 day, 1 week, and 6 weeks after initial test to track confidence and conceptual change.

PST1A10: 8:45-9:30 a.m. Investigating Novice-Like Reasoning Patterns via Eye-Tracking and Interviews*

Poster – Catherine J. Miller, Rhodes College, Department of Physics, Memphis, TN 38112; milcj-16@rhodes.edu

Mila Kryjevskaia, Erika G. Offerdahl, Robert D. Gordon, North Dakota State University

MacKenzie R. Stetzer, University of Maine

Evidence suggests that many undergraduate physics students fail to build reasoning chains from fundamental principles. Instead, they often rely on intuitive reasoning strategies or they reach a quick intuitive conclusion and attempt to assemble an argument that appears to support that conclusion. In this study, we focus on the examination of novice-like reasoning patterns and on the identification of circumstances under which novices' reasoning paths have greater potential for merging with those of experts. Multiple data streams were used. Both novices and experts were asked to answer a series of questions using an eye-tracking device. The eye-tracking session was then immediately followed by interviews in which participants were asked to articulate the reasoning approaches they used to answer the presented physics questions. Student written responses to analogous exam questions were also considered in order to gain further insight into student reasoning.

*This work has been supported by the National Science Foundation under Grant Nos. REU DUE-1156974 and DUE-1431857, 1431940

PST1A11: 8-8:45 a.m. Noticing, Valuing and Using Physics Outside of the Classroom: Understanding TE in Physics*

Poster – Leslie Atkins, 400 W. 1st St., Chico, CA 95926-0535; ljatkins@csuchico.edu

The author of this poster has been drawing on work by Pugh (2012) on "Transformative Experiences" (TE) -- a construct that seeks to capture whether or not students notice, value, and use science ideas outside of science class. This poster describes how TE manifests for students in a physics course that shows high instances of TE. In particular, I outline the ways in which students notice, value and use physics ideas in their everyday lives, and how curriculum might be better designed to support such experiences.

*Supported in part by NSF #1140785

PST1A12: 8:45-9:30 a.m. Professional Development Through an Online Workshop*

Poster – Raina M. Khatri, Western Michigan University,1903 W. Michigan Ave., Kalamazoo, MI 49008; raina.m.khatri@gmail.com

Charles Henderson, Western Michigan University

Renee Cole, University of Iowa

Jeff Froyd, Texas A&M University

Courtney Stanford, University of Iowa

STEM education developers have many ideas on improving undergraduate instruction, but often these ideas fail to propagate to other educators. Our research group has worked to understand best practices in developing educational innovations with sustainable adoption by others in mind. We created resources for developers and have run in-person and online workshops to train others in our research framework. What setting worked better, and what can be improved upon? We reflect on whether our ideas have propagated to others through our dissemination efforts.

*This work is supported by NSF grant no. 1122446.

PST1A13: 8:45-9:30 a.m. Revisiting the Five-Block Problem: Conceptual vs. Reasoning Difficulties*

Poster – Cody Gette, North Dakota State University, NDSU Dept. 2755, P.O Box 6050, Fargo, ND 58103; cody.gette@ndsu.edu

Mila Kryjevskaia, North Dakota State University

MacKenzie R. Stetzer, University of Maine

Andrew Boudreaux, Western Washington University

Paula Heron, University of Washington

As part of an ongoing investigation of the development of student reasoning in physics, we have been applying the dual-process theory of reasoning in order to disentangle students' conceptual understanding from their reasoning approaches. Previously, research on student understanding of Archimedes' principle suggested the students did not possess the requisite conceptual understanding of hydrostatics to reason through the Five-Block Problem correctly (Loverude et al 2003). In the current study, we revisited the Five-Block Problem by applying a paired-question methodology. Specifically, a set of screening questions was designed to identify those students who possessed a robust conceptual understanding relevant to the task and those who did not. Student performance on the screening questions was then juxtaposed with that on Five-Block Problem in order to gain insight into the nature of the underlying student difficulties. Preliminary results will be presented and implications for instruction will be discussed.

*This work has been supported by the National Science Foundation under Grant Nos. DUE-1431857, 1431940, 1432052, and 1432765.

PST1A14: 8-8:45 a.m. Situated Belonging and Self-Efficacy of Physics Students

Poster – John C. Stewart, West Virginia University, 235 White Hall, Morgantown, WV 26506; jcstewart1@mail.wvu.edu

Seth DeVore, Rachel Henderson, West Virginia University

A survey measuring students' feelings of self-efficacy and belonging within multiple environments within Science, Technology, Engineering, and Mathematics (STEM) and the campus community was administered to introductory, calculus-based physics classes at a large public land-grant university. The sense of belonging and self-efficacy varied significantly between broader environments such as the institution and major to more narrow environments such as the physics class or lab group. Student self-efficacy increased significantly as one moved from the physics class to the major to the profession. Belonging was less strongly coupled to environment. Strong gender effects ($p<.001$) were identified; however, these were highly class and environment dependent.

PST1A15: 8:45-9:30 a.m. Spinning Wheel: Reinventing and Re-visioning Rotational Kinematics

Poster – Warren A. Turner, Westfield State University, 577 Western Ave., Westfield, MA 01086-1630; wturner@westfield.ma.edu

Over the past several decades a great deal of thought and energy has been expended attempting to transform the way in which physics is taught. Active learning strategies making use of computer/calculator/tablet based probes have been shown to be effective across a wide range of topics. One area where this approach has been particularly fruitful is linear kinematics. Student-centered activities involving ultra-sonic motion sensors have resulted in significant achievement advances as measured using the Test of Understanding Graphs-Kinematics when compared to more traditional teaching approaches. This paper describes a parallel approach to the teaching of rotational kinematics which makes use of a rotational motion sensor. Student assessment, done using the recently developed Test of Understanding Graphs-Rotational Kinematics, will be presented. Additionally, in the activity-based version of the course material, rotational topics are interwoven throughout the discussion of kinematics, typically being introduced immediately following their linear counterpart.

PST1A16: 8-8:45 a.m. Student Thinking Regarding Coordinate Systems in the Upper Division

Poster – Brian D. Farlow, North Dakota State University, NDSU Dept. 2755 P.O. Box 6050, Fargo, ND 58108; brian.farlow@ndsu.edu

Marlene Vega, Mike Loverude, Warren Christensen, North Dakota State University

As part of a broader study on the content of and student thinking within mathematics in the undergraduate physics curriculum, we report on student thinking about coordinate systems in the upper division. Early evidence suggests that upper-division physics students struggle to solve problems and answer conceptual questions requiring the use of Cartesian and non-Cartesian coordinate systems. Specifically, students have difficulty identifying the direction of unit vectors and constructing symbolic expressions for position and velocity in the plane polar coordinates. Additionally, students struggle to recognize appropriate units associated with these quantities. We report findings from one-on-one interviews that used a think aloud protocol designed to shed light on student thinking within this domain. We investigate the potential connection between student reasoning regarding Cartesian and non-Cartesian coordinates with emphasis on polar and spherical coordinate systems, and students' ability to answer conceptual questions and solve problems requiring the use of those coordinate systems.

PST1A17: 8-8:45 a.m. Using Metacognitive Interventions to Impact Student Problem Solving Approaches*

Poster – Nathaniel Grosz, Department of Physics, NDSU, Dept. 2755 P.O. Box 6050, Fargo, ND 58102-6050; Nathaniel.C.Grosz@ndsu.edu

Mila Kryjevskaia, Department of Physics, NDSU

MacKenzie Stetzer, University of Maine

Andrew Boudreaux, Western Washington University

It is notoriously difficult to address persistent student difficulties that stem from intuitive ideas that are inconsistent with the formal application of physics knowledge. In many cases, students do not attempt to apply formal reasoning, and instead they rely on their "gut feelings" or intuition. Moreover, on specific types of physics tasks, students find confirmation of their intuitive ideas in formal relationships that are misinterpreted and/or misapplied. In such cases, students are particularly unlikely to question their intuition-driven responses. In this study, we designed and administered a set of metacognitive interventions in an effort to engage students more productively in formal reasoning. The impact of such interventions on student learning will be described, and the associated implications for instruction will be discussed.

*This work has been supported by the National Science Foundation under Grant Nos. DUE-DUE-1245999, 1245313, and 1245993.

PST1A18: 8:45-9:30 a.m. Using RIOT Data to Understand Interactive Classroom Pedagogy

Poster – Cassandra Paul, San Jose State University, One Washington Square, San Jose, CA 95192-0001; cassandra.paul@sjsu.edu

Research has previously shown that instructors teaching the same course use extremely varied instructor-student interaction techniques. For example, some instructors may spend a significant time explaining, while others might spend more time observing and listening. How much and of what sort of this variation can we attribute to the instructor and their training, the individual student demands, and/or the curriculum? The investigation of this question could hold meaning for both instructor professional development and curriculum design experts. With data from a quasi-experimental study I examine the influence of these three factors in the context of a classroom culture model.

PST1A19: 8-8:45 a.m. What Does Active Learning Look Like? Characterizing Reform through Observations

Poster – Adrienne L. Traxler, Wright State University, 3640 Colonel Glenn Hwy., Dayton, OH 45435-0001; adrienne.traxler@wright.edu

Beth Basista, Wright State University

The term "active learning" encompasses a diverse collection of classroom environments. However, for research purposes, courses have often been coded using a traditional/interactive binary. Distinctions between active learning strategies, or varying implementations of the same technique, give important context for interpreting results. Learning environments may provide better or worse support for different outcomes—e.g., conceptual understanding, problem-solving skills, communicating experimental results, or formation of classroom community. At Wright State University, some sections of the introductory physics sequence have transferred to SCALE-UP classrooms, where instructors use a range of active learning strategies. Assessing this reform at a department level requires a framework of common language to describe multiple classrooms. Simultaneously, such a framework allows for a more fine-grained examination of measured conceptual gains, attitudinal shifts, and participation in classroom community. We present preliminary results using the COPUS instrument to characterize introductory physics courses at Wright State University.

PST1A20: 8:45-9:30 a.m. Writing Narratives to Document and Interpret "Thinking Like a Physicist"*

Poster – Emily H. Van Zee, Oregon State University, 3324 NW Elmwood Drive, Corvallis, OR 97330; Emily.vanZee@science.oregonstate.edu

Corinne Manogue, Tevian Dray, Oregon State University

What does it mean to "think like a physicist"? How does one learn "to think like a physicist"? How does one learn to engage students in "thinking like a physicist"? The purpose of narratives is to provide examples of facilitating "thinking like a physicist" so that interested instructors can talk and think about specific instances in which students succeed in thinking in effective ways. The data consist of videos obtained with consent of the students and instructors for ongoing recording of instruction. The writing process includes identifying incidents of interest, transcribing what the students and instructors said and did, and interviewing participants about their perceptions of what happened. A narrative includes a summary of the physics involved, an interpretation of the dialogue and actions as these occurred, and a reflection on the students' thinking and the instructor's ways of eliciting that thinking through engaging interactions in class and other settings.

*Supported by NSF DUE 1323800

PST1A21: 8-8:45 a.m. An Exploratory Case Study of Factors that Influenced Women Persisting in an Undergraduate Physics Program

Poster – Nelda P. Hislop, Loyola University, Chicago, 1032 W. Sheridan Road, Chicago, IL 60660; nhislop@luc.edu

The purpose of this study was to determine what factors influence women's decision to persist in physics through their Bachelor's degree. The representation of women in undergraduate physics remains the lowest of any scientific field, slightly ahead of engineering. The largest withdrawal of women in physics occurs by the end of the freshman year in college. Surveying women who had successfully completed the physics degree at Loyola, we identified four common factors that attract and retain women in undergraduate physics programs. All of these can be implemented in physics departments. They include creating a supportive atmosphere, cultivation of a strong sense of community with faculty and students, encouraging peer interactions in and out of the classroom, and participating in physics social events to encourage faculty-student interaction. Details of the study and its implications will be presented.

B Lecture/Classroom

PST1B01: 8-8:45 a.m. A College-Wide Program for Active-Learning in STEM (PALS)*

Poster – Kristine Lui, Montgomery College, 20200 Observation Drive, Germantown, MD 20876; kristine.lui@montgomerycollege.edu

Faculty members may feel isolated from their colleagues when trying new strategies to engage students in the classroom. Sustaining active-learning strategies in spite of complaints from students (and sometimes other faculty and administrators) requires a supportive and dynamic community. Faculty PALS creates a cohort of faculty to share ideas, approaches, and experiences in student-oriented STEM classrooms, where participants from multiple campuses are committed to participate for one year. In this poster, I describe the structure and implementation of Faculty PALS, and share lessons learned thus far. Faculty PALS was inspired by the Two-Year-College New Faculty Experience. Sample activities developed by past participants may be shared.

*This project, now in its fourth year, is supported by NSF DUE-1161231.

PST1B02: 8:45-9:30 a.m. Diffusion, Drug Elimination, Radioactive Decay and Osmosis for Introductory Courses

Poster – Peter Hugo Nelson, Benedictine University, 6601 Fernwood Drive, Lisle, IL 60532; pete@circle4.com

Teaching materials have been developed for introductory physics for the life sciences. They are written as self-contained self-study guides. The first chapter introduces students to using Excel using an authentic computational model of diffusion that introduces students to equilibrium as a dynamic stochastic process in the context of the oxygen cascade. Students discover that Fick's law is a consequence of Brownian motion in an active learning exercise using a kinetic Monte Carlo simulation of their own construction. Subsequent chapters introduce students to: algorithms and computational thinking; exponential decay in drug elimination and radioactive decay; half-life and semi-log plots; finite difference methods (and calculus); the principles of scientific modeling; model validation and residual analysis; and osmosis. Analysis of published clinical data and Nobel Prize winning research is featured. Because the materials are self-contained they can be used in a flipped-classroom approach. The chapters are available for free at http://circle4.com/biophysics/chapters/

PST1B03: 8-8:45 a.m. Field Day at the Rec: Working Out with Physics of the Human Body

Poster – Chadwick Young, Nicholls State University, PO Box 2022, Thibodaux, LA 70301; chad.young@nicholls.edu

Kaisa Young, Nicholls State University

Gavin Buxton, Armand Buzzelli, Robert Morris University

Students in allied health fields often are required to take an introductory survey of physics. These courses cover all major areas and focus on applications of physics in the function and care of the human body. As a final field trip, students in the course may complete activities at the university's recreation center. These activities—e.g., torques for the plate-loaded inclined bench press or the hack squat as an inclined plane—highlight particular topics covered in the course and show how these principles are involved in the various exercises and equipment at the recreation center.

PST1B04: 8:45-9:30 a.m. Using the Careers Toolbox for Undergraduate Physics Students as a Curricular Enhancement

Poster – Toni Sauncy, Texas Lutheran University, 1000 West Court Street Seguin, TX 78155; tsauncy@tlu.edu

On average, 40% of physics undergraduate degree recipients enter the workforce with a baccalaureate degree, despite the fact that many undergraduate physics programs do not include career development as a departmental priority. Several useful career development resources aimed specifically at undergraduate physics students and faculty mentors have resulted from an NSF-funded project carried out by the Society of Physics Students and the Statistical Research Center at the American Institute of Physics. At TLU, we have used these resources to develop an introductory-level seminar course, modify advanced courses, and develop purposeful extracurricular activities. Our goal is to enhance the overall undergraduate physics experience, while empowering the significant fraction of students who will seek employment when they graduate. Strategies for using the SPS Careers Toolbox for Undergraduate Physics Students along with the guidance in the report for physics faculty (Equipping Physics Majors for the STEM workforce) are the focus of this presentation.

Acknowledgements: Kendra Redmond (AIP), Roman Czujko (AIP) and Tom Olsen (formerly of AIP) http://www.spsnational.org/cup/careerpathways/

PST1B05: 8-8:45 a.m. Formative Evaluation of the Conversion to SCALE-UP at Miami University

Poster – Jennifer Blue, Miami University, Department of Physics, Oxford, OH 45056; bluejm@muohio.edu

The Department of Physics at Miami University moved to a new building in the fall of 2014. We seized this opportunity and designed ourselves large, flat classrooms. This means we can teach our algebra-based and calculus-based introductory courses in the SCALE-UP (Student-Centered Activities for Large-Enrollment Undergraduate Programs) model. These courses had, before our move, been taught in a traditional way, as separate lecture (in an auditorium) and lab courses. Students have not all been successful. We had known that we should incorporate active learning into these courses to help the students learn better, but it was hard to do so in our tiered lecture classrooms. After years of preparation, we started teaching SCALE-UP physics. I will present preliminary results – how was our transition?

PST1B06: 8:45-9:30 a.m. Lessons from Three Semesters of a Physics for Humanities Course

Poster – Deepak Iyer, Bucknell University, 53 Olin Science Building, Lewisburg, PA 17837; deepak.g.iyer@gmail.com

Mary Emenike, Rutgers University

We report on three installations of a "Physics for humanities and social sciences" course. This was a moderate enrollment course (about 100 students) at a large public university. We will describe these three versions, the motivations, and present CLASS data (with both pre and post for two of them). We see variation in gains and losses across the three courses, and while causality is hard to establish, we speculate on the reasons based on other surveys done in the class.

PST1B07: 8-8:45 a.m. Ortmann and the Physical Forms of Sound

Poster – Jeffrey R. Groff, Shepherd University, PO Box 5000, Shepherdstown, WV 25443-5000; jgroff@shepherd.edu

David J. Gonzol, Shepherd University

The work of former Peabody Conservatory of Music Director Otto Rudolph Ortmann is little known among physicists. However, his theory of the nature of music (1922) advanced our understanding of the physics of sound and deserves wider appreciation in the physics community. Ortmann's theory described three attributes of sound, namely primary, secondary, and tertiary. He called the primary attribute extensity, which in turn had three forms called transtensity, intensity, and protensity that correspond to the physical characteristics of frequency, amplitude, and duration, respectively. Before Ortmann, others, including Hermann von Helmholtz, recognized the importance of frequency and amplitude to the perception of sound but none so clearly emphasized the important role duration and temporal structure play. By highlighting the important role temporal envelope has on musical sound, Ortmann was helping to lay the groundwork for the emergence of electronic synthesizers in the early 1960s in which physicists such as Robert Moog played pioneering roles. By striving to delineate more clearly and fully the primary physical attributes of musical sound from the secondary and tertiary attributes that reflect physiological responses and higher-order mental processing, Ortmann was demonstrating an objective physicist-like approach to understanding musical sound that both students of physics and music should be taught.

PST1B08: 8:45-9:30 a.m. Surface Charge in Electrostatics and Circuits

Poster – Bruce A. Sherwood, North Carolina State University, 515 E. Coronado Road, Santa Fe, NM 87505; bruce_sherwood@ncsu.edu

Ruth W. Chabay, North Carolina State University

In electrostatics and in circuits, charge buildups on the surfaces of conductors contribute to the electric field inside and outside of the conductors. A relaxation method based on field[1] was used to compute the surface charge distributions in 3D for a number of interesting configurations. These distributions and the associated fields can be explored interactively with a GlowScript VPython program at tinyurl.com/SurfaceCharge. The poster will highlight some of the interesting features of these charge distributions. In the calculus-based intro E&M course this interactive program can help students to acquire a deeper sense of mechanism of circuit behavior, and to unify the explanations of electrostatic and circuit phenomena.

1. Preyer, Norris W. (2000). Surface charges and fields of simple circuits. *Am. J. Phys.* **68**(11), 1002-1006.

PST1B09: 8:-8:45 a.m. The Art and Science of Photography at UW - Fox Valley

Poster – John E. Beaver, University of Wisconsin - Fox Valley, 1478 Midway Road, Menasha, WI 54952; john.beaver@uwc.edu

We describe an interdisciplinary course, The Art and Science of Photography (ASP), and its accompanying textbook, offered at the University of Wisconsin - Fox Valley in Menasha, WI. ASP uses photography as a point of departure to inspire students to ask fundamental questions about the nature of art, and to consider physics as part of the study of nature. In turn, fundamental aspects of art and physics are chosen in part for their direct relevance to the fundamentals of photography. ASP is offered as a 4-credit lecture/lab/studio course, and the students have a choice of registration for either art or natural-science credit. A large majority of students register for natural-science credit, and we suggest that ASP may be particularly useful as an entry point for students who view themselves as lacking ability in the sciences.

PST1B10: 8:45-9:30 a.m. Two-Stage Exams: An Effective Learning Tool?

Poster – Kristi D. Concannon, King's College, 133 North River St., Wilkes Barre, PA 18711; kristiconcannon@kings.edu

The process of peer instruction is crucial in helping students to identify and confront their misconceptions and to critically apply the fundamental principles learned in lecture to different and more complex situations. In most cases, though, peer learning ends at exam time. I have recently begun implementing two-stage exams in my courses under the premise that learning can and should take place throughout the entire semester, not just in compartmentalized chunks; hence, exams can both be an opportunity for students to demonstrate what they have learned and an opportunity for students to continue to increase their understanding of the course material. In this poster, I will examine the effectiveness of the two-stage exam process for two populations: students enrolled in a physics for the life sciences course and students enrolled in a general education course.

PST1B11: 8-8:45 a.m. Flipping Over Physics: Hybrid Courses for Majors and Nonmajors

Poster – Sharon Price Schleigh, East Carolina University, Center for Astronomy & Physics Education Research, 7214 West Wood St., Phoenix, AZ 85043; schleighs@yahoo.com

As university classrooms increase in student enrollment, and the calls to engage learners beyond the traditional lecture format become more prominent, instructors in undergraduate courses struggle to find effective ways to teach basic concepts. Although the flip classroom has been offered as a means of addressing these stresses in the undergraduate courses, faculty continue to concern themselves with the ability to adequately instruct for conceptual understanding, and revert back to the traditional lecture format. The hybrid classroom with an emphasis on the flip format can address these needs and stresses. This presentation offers examples of how the hybrid flip classroom looks in a large lecture hall and provides evidence that the flip course format does support student learning, can increase an interest in physics related degrees and careers, and is effective in developing conceptual understanding for both majors and non-majors.

Other Posters

PST1C01: 8-8:45 a.m. A Continuing List of Climate Myths V

Poster – Gordon J. Aubrecht, Ohio State University, Marion, 193 N. Washington St., Delaware, OH 43015-1609; aubrecht.1@osu.edu

This continues my series of posters on climate myths.

PST1C02: 8:45-9:30 a.m. Astrobiology at the Edge of Space Sparks Undergraduate Student Engagement

Poster – Barbra K. Maher Sobhani, Red Rocks Community College, 13300 W. Sixth Ave., Lakewood, CO 80228; barbra.sobhani@rrcc.edu

Undergraduate research has sparked student engagement, creativity, and persistence in STEM at Red Rocks Community College (RRCC) though the Colorado Space Grant Consortium (COSGC). The NASA-sponsored program provides high-altitude balloon launch research opportunities (DemoSat). Our student DemoSat team designed an astrobiology project, investigating an extremophile response to edge of space conditions as analog of possible Martian biosignatures in similar exposure conditions. The team designed a unique flight package, obtained permission from the National Park Service for collection of microbial mats from Bad Water, CA, and devised an approach for studying the viability of the microbial community response to edge of space conditions using XRD, Baclight and CellRox testing. In addition to the research, they formed a student club, produced a video documenting their experience and pursued additional funding. Several team members stayed on for a second launch opportunity this summer and are now participating in RockSat-C.

PST1C03: 8-8:45 a.m. Computational Models in Introductory Electromagnetism and Quantum Physics

Poster - Jessie A. Petricka, Gustavus Adolphus College, 800 W College Ave., Saint Peter, MN 56082-1498; petrickj@gmail.com

Presented are a computational modules used in introductory Electromagnetism and Quantum Physics. The modules introduce different computational platforms through use of varied programs, (code/Python, symbolic/Mathematica, and LabView) and to teach concepts where those tools can be brought to bear. The concepts covered here are numerical integration via Mathematica, electrical circuit problems in Python, and the use and understanding of an oscilloscope in LabVIEW.

PST1C04: 8:45-9:30 a.m. Teaching Intermediate Electricity and Magnetism Using Differential Forms

Poster– Dominique Mckenzie, Wellesley College, 21 Wellesley College Road, Unit 6320, Wellesley, MA 02481-8203; dmckenzi@wellesley.edu*

Jelena Begovic, Kaca Bradonjic, Wellesley College

Electricity and magnetism is traditionally taught using vector calculus, which involves complicated mathematical identities of divergence, gradient, and curl, and leaves some elements of the theory, such as the difference between electric field D and electric induction E, and the magnetic field H and the magnetic induction B, obscure. The alternative mathematical formalism of differential forms simplifies the relevant mathematics and clarifies the distinction between E and D fields, and B and H fields as different types of differential forms represent them. Furthermore, differential forms allow for illuminating visual representations of these fields. We present resources for undergraduate learning of intermediate electromagnetism with differential forms, which include a more pedagogical exposition of the existing literature and worked-out additional examples. We used 3D printing to create models of fields for various electric charge and current distributions. These resources will be available online.

*Sponsored by Kaca Bradonjic

PST1C05: 8-8:45 a.m. Newton Iteration-based Pi Calculation

Poster – Jason Cannon-Silber, Socrates Preparatory School, 3955 Red Bug Lake Road, Casselberry, FL 32707; nealcg@gmail.com*

Neal C. Gallagher, III, Joshua M. Fair, Maura F. Gallagher, Brandon W. Mayle, and Samual J. Konkol, Socrates Preparatory School

Nicolas M. Fair, Valencia Community College

Detailed analysis of Newton's method for finding a zero of $\sin(x)$ located at $x = \pi$, has led to our discovery of a highly efficient recursive method for computing π based on the convergent expression $x_{n+1} = x_n + \sin(x_n)$. This recursion is derived using a geometric analysis of Newton's method. In addition this geometric analysis proves the surprising result that for *any* value of x such that $\frac{\pi}{2} \le x \le \frac{3\pi}{2}$, it is true that $\pi = x + \arcsin(\sin(x))$.

* Sponsored by Neal C. Gallagher, II,

PST1C06: 8:45-9:30 a.m. Simulating Infrared Transmission Through a Porous Dielectric Foam

Poster – Maxfield T. Torke, Sonoma State University, 1701 E Cotati Ave., Rohnert Park, CA 94928-3609; maxtorke@gmail.com

Edward Wollack, NASA Goddard Space Flight Center

Infrared radiation can interfere with satellite measurements by changing the temperature and thus the responsivity of sensitive components. For millimeter wavelength sensors, a simple solution to this challenge is to reject thermal infrared radiation with a thin layer of dielectric foam. The transmission of infrared radiation through a dielectric window made from porous Teflon foam was simulated and compared to experimentally measured data. This simulator serves as a tool to determine dielectric window thickness to filter by diffusely reflecting or scattering incident infrared radiation. The simulator was implemented in MATLAB using a transformation matrix method. A series of rotational lines were used in the dielectric function to fit measured absorption peaks. This program can accurately predict transmission spectra given easily measurable inputs. Once the material parameters are in hand optimization of the window geometry by simulation provides an efficient means of optimizing the desired instrument response.

PST1C07: 8-8:45 a.m. Energy and Climate in Physics Education

Poster – Barbra K. Maher Sobhani, Red Rocks Community College, 13300 W. Sixth Ave., Lakewood, CO 80228; barbra.sobhani@rrcc.edu

Energy and climate are hot topics and physics courses should be offered that inspire students to action. At the community college level, many freshmen students do not have the math background necessary for physics classes. A course featuring energy is a great introduction to science and physics. Red Rocks Community College developed three new physics course offerings to fill these needs. Energy Science and Technology is an introductory level, lab-based course exploring many aspects of energy and climate. Students complete a passive solar home project as well as investigate the physics of renewable energy technology. Energy for Engineers is intended to be an in-depth look at renewable energy technology for those on the engineering track. Field Studies in Energy provides opportunity for students to travel and investigate energy systems and climate issues. These courses help connect physics students with the energy and climate issues so crucial to society today.

PST1C08: 8:45-9:30 a.m. Modified Archimedes Pi Calculation

Poster – Maura F. Gallagher, Socrates Preparatory School, 3955 Red Bug Lake Road, Casselberry, FL 32707; nealcg@gmail.com*

Brandon W. Mayle, Joshua C. Fair, Jason Cannon-Silber, Neal C. Gallagher III, Samuel J. Konkol, Socrates Preparatory School

Nicolas M. Fair, Valencia Community College

The earliest known algorithm for computing Pi is the Archimedes method.[1] The circumference of a circle is estimated by the perimeter of a regular polygon. The number of sides of the polygon is recursively doubled to obtain an increasingly better estimate. We propose inscribing a circle with irregular polygons whose vertices have x-coordinates that occur at regularly spaced interval. A clever application of (30-60-90) triangle geometry permits us to compute Pi to a greater accuracy than that of Archimedes for polygons with the same number of sides. A simple Java program demonstrates our results.

* Sponsored by Neal C. Gallagher, II, Ph.D.

1. Heath, T.L., *The works of Archimedes* (Dover edition), pp 93-98, 1953.

PST1C09: 8-8:45 a.m. Successful Research and Retention Programs in a Small Department*

Poster – Peter A. Sheldon, Randolph College, 2500 Rivermont Ave., Lynchburg, VA 24503; psheldon@randolphcollege.edu

Sarah Sojka, Katrin Schenk ,Randolph College

Randolph College has instituted a recruitment and retention program that has significantly increased the number of physical science majors. While the college has a total enrollment of 700 students, and a physics department with 2.5 faculty, we have recently consistently had 8-10 physics majors each year, and increases in all the other sciences. The number of students served by our physics classes has gone from traditionally less than 200 to nearly 400 each year. The program includes a number of recruitment and retention initiatives, and for two class years included an NSF S-STEM grant. While the grant provides scholarships to two cohorts of 12 students, we have exceeded our goal to recruit 24 students each year and to retain them at a higher rate than the college as a whole. We will discuss the initiatives and the planned changes to continue the improvements.

*This project is supported by the National Science Foundation under Grant No. DUE- 1153997. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

PST1C10: 8:45-9:30 a.m. Student Difficulties in Synthesizing Information in Scientific Inquiry*

Poster – Kathleen M. Koenig, University of Cincinnati, 3758 Hubble Road, Cincinnati, OH 45247; kathy.koenig@uc.edu

Lei Bao, The Ohio State University

A windmill engineering design project, implemented in an 8th grade classroom, led students through activities focused on the cyclic process of scientific inquiry. Experiments built upon one another such that results of initial experiments were to inform the design of subsequent experiments; enabling students practice in the scientific thinking and decision making promoted in 21st Century Learning. Our research found, however, that most students treated the inquiry explorations as fragmented steps and struggled in synthesizing information to guide necessary decisions in the experimental process. Students were quick to resort to "trial and error" and appeared to have a narrow vision for addressing only those questions on the page rather than stepping back and focusing on the larger task. This presentation will include what was learned about student habits as well as their deficiencies in scientific thinking, and how curriculum might be designed to better support student learning and performance.

*Supported by NSF DRK-12 Grant #1417983.

AAPT PHYSICS EDUCATION

2016 Richtmyer Memorial Lecture Award

Location: Celestin A-C
Date: Monday, January 11
Time: 9:30–11 a.m.

Presider: Steven Iona

Why Some Confusion is Good – Evidence for How to Make Learners Think

by Derek Muller, Veritasium

Derek Muller
creator of YouTube channel *Veritasium*

Every physics teacher wants engaged, active learners, but how do you get them engaged? Video content, now more widely available than ever, appears only to perpetuate the transmissionist model of education. I researched how changing the content of a video affects can change how learners view it. I found that direct expository summaries were least helpful for novices, despite the fact learners enjoyed and felt they learned from them. What was more effective were videos involving alternative conceptions, which viewers perceived as more confusing but from which they learned much more. Now I apply these insights to create online videos for a mass audience. I think the lessons I've learned apply not only to educational video but to all teaching and learning environments.

Outstanding SPS Chapter Advisor Award

presented to:
Kiril Streletsky, Associate Professor of Physics at Cleveland State University.

Kiril Streletsky

Session DA: SPS Contributed Talks

Location: Strand 10 B
Sponsor: AAPT/ SPS
Date: Monday, January 11
Time: 11 a.m.–12:50 p.m.

Presider: Sean Bentley

Monday morning

DA01: 11-11:10 a.m. Musical Physics: The 2015 Science Outreach Catalyst Kit

Contributed – Hannah E. Pell, Lebanon Valley College, 205A Marquette Hall, Annville, PA 17003-1400; hannahepell@comcast.net

What is the science behind how we make music? The 2015 Society of Physics Students' Science Outreach Catalyst Kit (SOCK) attempts to answer this question through a collection of demonstrations, activities, and physics lessons! The SOCK is an annual product of the Society of Physics Students and is full of activities based around a particular theme in physics, and is then sent to approximately 25 collegiate chapters to be used in science outreach events. In this year's SOCK, our theme was Acoustics; we've explored the characteristics and behavior of sound waves, acoustical properties of various types of instruments, and how we can use sound to communicate. The SOCK contains interactive activities allowing students to build their own instruments, visualize properties of waves, construct their own 'telephones' to understand amplification and communication from a distance, and much more. In this presentation, I will discuss the process of planning, designing, and putting together the SOCK, as well as my overall summer experience in Washington, D.C. as a Society of Physics Students national intern.

DA02: 11:10-11:20 a.m. Teaching a Diverse History of Physics: African Americans in the Physical Sciences

Contributed – Brean E. Prefontaine, 3311 Baring St., Apt. B, Philadelphia, PA 19104; brean_prefontaine@yahoo.com

Those in the STEM fields are often concerned about lack of diversity across the various disciplines and much discussion revolves around improving the situation. One aspect that is commonly overlooked is the place of women and minorities in the history of the physical sciences. In an effort to bring forth these stories, the American Institute of Physics Center for the History of Physics established the Women and Minorities Project in 2012 to encourage educators to incorporate these men and women into existing curriculum. The project has developed to encompass a variety of materials including a set of lesson plans and educational games that pertain to African Americans in the history of physical sciences. During the summer of 2015, as a Society of Physics Student intern I expanded upon the materials pertaining to African Americans in order to provide more information to the student and to create an easier format for the instructor. I will introduce the Women and Minorities Project, discuss strategies used to develop the materials related to African Americans in the history of physical science, and share our vision for how the project will increase diversity in the physical sciences.

DA03: 11:20-11:30 a.m. Women in the History of the Physical Sciences

Contributed – Connor Day, 1800 Stokes St., #54 San Jose, CA 95126; cday624@gmail.com

Diversity in STEM fields continues to be an issue of great concern to the scientific community. While greater numbers of women are entering STEM careers than in the past, many important female faces are missing from common discussions of the history of physical science. To uncover and promote these stories, the American Center for Physics Center for History of Physics established the Women and Minorities Project in 2012 to encourage educators to incorporate underrepresented and minority scientists into their classrooms. During the summer of 2015, I worked with the Center as a Society of Physics Students summer intern to improve the educational materials available within this project. By featuring historical actors who challenge societal conceptions of who is a scientist, the teaching guides create role models for young scientists that reflect their own diverse backgrounds. I will discuss the goals and motivation of this project further, explain my contributions to its development, and future steps to be taken.

DA04: 11:30-11:40 a.m. Physics and Engineering, in Harmony from Research to Development

Contributed – Amandeep Gill, San Jose State University, 1800 Stokes St. #54, San Jose, CA 95126; agill.1409@gmail.com

As a National Society of Physics Student's intern with the American Physical Society's Public Outreach department, I chose to highlight the relation between physics and engineering. Physics and engineering are interwoven disciplines and their relation is beneficial in research and industry. Showcasing the relation is important for high school or college-level students or the general public who is curious about either or both fields. To best reach out with this information, I wrote a desktop application using Kivy, a game design library of Python. An application enables the information to be accessible on any web-enabled device and adds an interactive element. This application, titled "Physics and Engineering, in Harmony from Research to Development," highlights the relation between physics and engineering through interviews and with examples how each discipline has contributed to some real-world applications. My talk will go further into the application design and content development process.

DA05: 11:40-11:50 a.m. HPU's Chip 'n' Ship and NASA Micro-g NExT Program Experience

Contributed – Hallie Stidham, High Point University, 920 Main St., Dennis, MA 02638; stidhh12@highpoint.edu

Matthew Iczkowski, High Point University

The High Point University Panther CLAWS Team designed and constructed a rock chip sampling device for microgravity bodies. The design incorporated a commercially available, unmodified pneumatic air hammer that was mounted inside of an aluminum housing. The device also featured three interchangeable collection cartridges that were made specifically to mitigate cross-contamination between rock chip samples. The final product was tested in the Neutral Buoyancy Laboratory at the Johnson Space Center in Houston, Texas. We are sharing our story with our fellow students and local media outlets. In addition, we created related activities for children at an annual outreach event called HPUniverse Day, where hundreds of local children and their families engage in hands-on activities and demonstrations.

DA06: 11:50 a.m.-12 p.m. The Effect of Impurities on the Superconductivity of BSCCO

Contributed – John J. Vastola, University of Central Florida, 1190 Lake Rogers Circle, Orlando, FL 32816; johnvastola@knights.ucf.edu

Richard A. Klemm, University of Central Florida

BSCCO is a high-temperature cuprate superconductor whose electronic structure is currently poorly understood. In particular, it is unclear whether its order parameter is consistent with s-wave or d-wave behavior. Leggett has suggested that its order parameter might take a certain form that is consistent with d-wave behavior. While some experiments on the surface of BSCCO seem to support this conclusion, other experiments have suggested that its order parameter is instead s-wave in the bulk. We present some quantum field theoretic calculations in the spirit of Abrikosov and Gorkov that suggest such an order parameter cannot be correct. We will demonstrate that having such an order parameter would mean that BSCCO's critical temperature would go to zero if it is sufficiently impure, contradicting experimental evidence otherwise. These calculations lend support to the hypothesis that BSCCO is an s-wave rather than a d-wave superconductor.

DA07: 12-12:10 p.m. Effects of Combined Chemotherapy Drugs and Radiation on Cancer Cells

Contributed – Catherine J. Kuhnheim, Mercyhurst University, 501 East 38th St., Erie, PA 16546-0001; ckuhnh32@lakers.mercyhurst.edu

Autumn E. Walter, Christopher E. Taylor, Dyan L. Jones, Mercyhurst University

Radiation therapy is often utilized as a primary method for the treatment of cancerous cells, but it comes with its limits. The use of radiation often has adverse effects on healthy tissues in the body. To minimize the effects radiation can have on otherwise healthy cells, this method can be used in combination with a chemical reagent. The chemical reagent will act as an inhibitor in the cell in order to increase the sensitivity of the cell to the radiation dosage. In this study the combination of Canertinib, a chemotherapy drug, and lose-dose radiation is examined. There is a focus on the erbB pathway, which is composed of a family tyrosine kinases that have been shown to be associated with cell growth, cell cycle control, and apoptosis (programmed cell death). The effectiveness of the combination and isolation of each treatment is measured on SKBR3 cancer cells through current mathematical models of synergy.

DA08: 12:10-12:20 p.m. Exploring Electrical Stimulus Parameters for Targeted Osmotic Lysis of Cancer Cells

Contributed – Autumn E. Walter, 501 E 38th St., Box 0228, Erie, PA 16546-0001; awalte54@lakers.mercyhurst.edu

Kenneth (Kip) L. Matthews, Paul Maggi, Department of Physics and Astronomy, Louisiana State University

Targeted osmotic lysis (TOL) has recently been proposed as a method of selectively killing certain cancers that overexpress sodium pumps and channels on the cell membranes. For TOL to be achieved, chemical inhibitors block or paralyze the sodium pumps while the channels are electrically stimulated open. This then causes water to flow into the cell which results in the cell swelling and bursting. Electrical stimulus is an essential component of inducing TOL, so having the appropriate stimulus is essential. In this study, the electrical stimulus parameters needed to induce TOL in MDA breast cancer cells were explored. Stimulation was applied across MDA and MCF-12A (healthy tissue) cells that were seeded in 24-well plates. The stimulation was provided via a function generator, and the voltage and current were monitored using a custom made interface box and oscilloscope.

DA09: 12:20-12:30 p.m. The Potential Impact of Seat Position

Contributed – Russell H. Burt, Randolph College, 2112 Burnt Bridge Road, Lynchburg, VA 24503; rhburt@randolphcollege.edu

Zach Vernon, Peter A. Sheldon, Sarah Sojka, Randolph College

The past two decades have seen an acceleration of improvements to safety systems in passenger vehicles. These improvements have greatly reduced the risk of severe injury or death of occupants in motor vehicle collisions. However, many of these improvements have focused solely on the front seats of the vehicles with little to no emphasis on rear seat safety. We used data from the National Highway Traffic Safety Administration (NHTSA) to look at motor vehicle collisions involving front and rear seat occupants. We examined factors that influenced the likelihood of severe injury or death of rear seat passengers. Those factors included vehicle type, impact direction and speed, and points of contact. In this presentation, we will discuss our findings which can be used to guide future innovations and developments in rear occupant safety systems.

DA10: 12:30-12:40 p.m. Latitude Dependence of the Primary Stellar Wind of eta Carinae

Contributed – Rachel Odessey, Scripps College, 420 Mansfield Rd., Silver Spring, MD 20910; rachel.odessey@gmail.com

The binary star Eta Carinae underwent a massive eruption in the 1840s, resulting in a huge nebula of ejected material, called the Homunculus. Despite preventing us from the direct view from the central source, the Homunculus acts like a mirror, allowing us to see the spectrum of the central binary system from different stellar latitudes. By mapping the spectrum along the nebula we are actually probing the dependence of the spectrum with stellar latitude. Our project focuses on the P Cyg absorption component of H lines mostly in the optical and near-infrared wavelengths. in order to investigate the structure of the primary stellar wind. A full spectral mapping of the entire nebula was constructed by combining multiple dithered long slit observations using the ESO/X-Shooter high-resolution spectrograph. Such mapping allowed us to assemble a data cube containing the spectrum of each position along the nebula. Preliminary analysis confirms that the primary wind indeed has a deeper absorption component at high stellar latitudes (polar region). Also, contrary to our expectations, our analysis indicates that the polar region does not seem entirely radially symmetric in terms of density, which invites further investigation into the source of these discrepancies.

DA11: 12:40-12:50 p.m. Simulating Infrared Transmission Through a Porous Dielectric Foam

Contributed – Maxfield T. Torke, Sonoma State University, 1701 E Cotati Ave., Rohnert Park, CA 94928-3609; maxtorke@gmail.com

Edward Wollack, NASA Goddard Space Flight Center

Infrared radiation can interfere with satellite measurements by changing the temperature and thus the responsivity of sensitive components. For millimeter wavelength sensors, a simple solution to this challenge is to reject thermal infrared radiation with a thin layer of dielectric foam. The transmission of infrared radiation through a dielectric window made from porous Teflon foam was simulated and compared to experimentally measured data. This simulator serves as a tool to determine dielectric window thickness to filter by diffusely reflecting or scattering incident infrared radiation. The simulator was implemented in MATLAB using a transformation matrix method. A series of rotational lines were used in the dielectric function to fit measured absorption peaks. This program can accurately predict transmission spectra given easily measurable inputs. Once the material parameters are in hand optimization of the window geometry by simulation provides an efficient means of optimizing the desired instrument response.

Session DB: Outcomes from the 2015 Conference on Laboratory Instruction Beyond the First Year

Location: Empire C
Sponsor: Committee on Laboratories
Co-Sponsor: Committee on Apparatus
Date: Monday, January 11
Time: 11 a.m.–12:30 p.m.

Presider: Randy Peterson

DB01: 11-11:30 a.m. Laboratory Instruction Beyond the First Year: New Approaches and Initiatives

Invited – Elizabeth George, Wittenberg University, PO Box 720, Springfield, OH 45501; egeorge@wittenberg.edu

Many of the themes of the 2015 Conference on Laboratory Instruction Beyond the First Year (BFYII) underscore the recent AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum, which recognize the vital role of laboratory instruction in developing students' physics knowledge and experimental skills as well as many transferable skills such as design, troubleshooting, innovation, and communication. Plenary talks, workshops, breakout sessions, and posters at the conference highlighted a variety of creative and exciting efforts to rethink and revise the content and structure of the BFY laboratory curriculum, including contemporary experiments from new research fields (including interdisciplinary research); student-guided open-ended projects; flipped classroom techniques; and new approaches to assessment. I will discuss takeaway messages

from the conference, including challenges and opportunities for constructing robust experimental physics curricula that support student mastery of these important skills, and current and future initiatives to build community and enhance advanced laboratory instruction.
http://advlabs.aapt.org/conferences/2015/

DB02: 11:30 a.m.-12 p.m. Report on the BFY II Workshop Program

Invited – John Essick, Reed College, 3203 SE Woodstock Blvd., Portland, OR 97202; jessick@reed.edu

The BFY II conference program included a slate of 53 small-group workshops, with each workshop focusing on an innovative "beyond the first year" instructional laboratory experiments. Over the course of the conference, every BFY II attendee had the opportunity to participate in 12 workshops of his or her choosing, providing hands-on experience with a broad selection of contemporary instructional labs. Roughly half of the workshops were led by the college laboratory instructors who had developed the experiments being presented, while the other workshops were based on interesting "beyond the first year" experiments available from commercial vendors. In this talk, the process of creating the workshop program will be briefly reviewed and then a few of the workshops will be highlighted. Finally, a report of the feedback obtained from BFY II attendees about their workshop experience will be given.

Session DC: K-12 PER

Location: Strand 11 B
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Physics in High Schools
Date: Monday, January 11
Time: 11 a.m.–12:10 p.m.

Presider: Dan Crowe

DC01: 11-11:30 a.m. Forgetting History and Other Reasons Change Is Hard: Structural Barriers*

Invited – David E. Meltzer, Arizona State University, 7271 E. Sonoran Arroyo Mall, Mesa, AZ 85212; david.meltzer@asu.edu

Physics educators have been working since the 1880s to revise and improve the high school physics course, yet change has come quite slowly.[1] To some extent, the slow pace of change can be traced to the ways in which science courses first became part of U.S. high schools, and to how the U.S. physics teacher education system developed.[2] Another key factor has been the inconsistent role played by physicists in the evolution of K-12 education: at certain times, physicists' involvement has been intense and productive; at other times, it has been distant and neglectful. (For example, in the 1880s, early 1900s, and 1960s, physicists were among the leaders in high school curriculum development and instructional reform.) I will review the evolution of physics teaching in the high schools and examine some of the various forces that have both driven and impeded change.

*Supported in part by NSF DUE #1256333

1. D. Meltzer and V. Otero, *AJP* **83**, 447 (2015).
2. D. Meltzer and V. Otero, *AJP* **82**, 633 (2014).

DC02: 11:30 a.m.-12 p.m. Forgetting History and Other Reasons Change Is Hard: Clashing Perspectives*

Invited – Valerie K. Otero, University of Colorado Boulder, 249 UCB, Boulder, CO 80309-0249; valerie.otero@colorado.edu

Since the 1880s, physics education reformers have been calling for increased engagement by physics students in the inductive method (called "inquiry" or a "scientific practice" in more recent times). This theme was repeatedly "rediscovered" in each era, as the intense and passionate debates of previous times were largely forgotten, overlooked, or misinterpreted[1]. I will describe differences in how physics reform movements (such as the project method, the inductive method, and physics for everyday life) have been interpreted by science education reformers with different educational backgrounds and commitments. By highlighting debates originating from diverse objectives, I conjecture that these differences have served to impede educational change and continue to do so today. I will also discuss how certain perspectives held by well-meaning scholars may serve to exclude, rather than include, students from physics and other sciences. Based on this analysis, I will provide recommendations for physics teacher preparation and physics instruction.

*Supported in part by NSF grant #DUE-0934921

1. D. Meltzer and V. Otero, *AJP* **83**, 447 (2015).

DC03: 12-12:10 p.m. Quantification of School Students' Reasoning Abilities Updated

Contributed – Gordon J. Aubrecht, Ohio State University, Marion, 193 N. Washington St., Delaware, OH 43015-1609; aubrecht.1@osu.edu

Jessica G. Creamer, Education Specialist

Jennifer L. Esswein, Evaluation Specialist

Bill Schmitt, Science Center of Inquiry

Middle school teachers in our program give students pre- and post-common formative assessments (CFAs) and analyze them. We recruited teachers in the same district's middle school as controls. We created a rubric to assess student communication, correctness, use of evidence, and reasoning on the CFAs. We presented preliminary results in College Park,[1] and will present final results of our analysis of samples of students of control and treatment teachers.

1. G. J. Aubrecht, J. L. Esswein, J. G. Creamer, and B. Schmitt, "Quantifying school students' reasoning abilities," CH08, Summer 2015. This work supported in part by grants from the Ohio Department of Education C1457-OSCI-09-49 (2008-2009), C1667-MSP-10-410 (2009-2010), EDU01-0000006141 (2010-2011), EDU01-0000007902 (2011-2012), GRT00029161 (2012-2013), ODE-MSP-10673 (2013-2014), EDU01-0000013704 (2014-15), and (2015-16).

Session DD: Climate Change

Location: Bolden 6
Sponsor: Committee on Physics in Undergraduate Education
Date: Monday, January 11
Time: 11 a.m.–12:30 p.m.

Presider: Toby Dittrich

DD01: 11-11:30 a.m. Volcanic Effects on Climate in the Late 20th and Early 21st Centuries

Invited – Benjamin D. Santer, Program for Climate Model Diagnosis and Intercomparison, Lawrence Livermore National Laboratory, 7000 East Ave., Livermore, CA 94551; santer1@llnl.gov

The relatively muted warming of the surface and lower troposphere since 1998 has attracted considerable attention. One contributory factor to this "warming hiatus" is an increase in volcanic cooling over the early 21st century. Our recent research has identified the signals of late 20th and early 21st century volcanic activity in multiple observed climate variables. Volcanic signals are statistically discernible in spatial averages of tropical and near-global sea-surface temperature, tropospheric temperature, net clear-sky short-wave radiation, and atmospheric water vapor. Signals of late 20th and early 21st century volcanic eruptions are also detectable in near-global averages of rainfall. Successful volcanic signal detection is critically dependent on removal of variability induced by the El Nino–Southern Oscillation. Prospects for improved quantification of volcanic effects on climate are discussed at the end of the talk.

DD02: 11:30 a.m.-12 p.m. Understanding Climate Change: Challenges and Opportunities for Teaching and Learning*

Invited – Doug Lombardi, Temple University, 1301 Cecil B. Moore Ave., Philadelphia, PA 19122; doug.lombardi@temple.edu

Climate change is a topic that is not easy to understand. Deepening students' understanding of climate change may be difficult both because the underlying scientific principles are complex and because students have difficulty understanding why scientists think that Earth's global climate is changing. Many assume that students' difficulties are caused by a lack of coherence and clarity when explaining the topic (i.e., students have an information deficit). However, my research, and the research of my colleagues, reveals a broad array of challenges that must be overcome for students and the public to understand why Earth's climate is changing. These include overcoming prior misconceptions, negative attitudes, cognitive biases, and motivated reasoning. This presentation will highlight areas of challenge and discuss the implications of these for teaching and learning about climate change.

*Some of the analyses in this presentation were supported by the National Science Foundation (NSF) under Grant No. DRL-131605. Any opinions, findings, conclusions, or recommendations expressed are those of the authors and do not necessarily reflect the NSF's views.

DD03: 12-12:10 p.m. Engaging Prospective Elementary Teachers in Learning about Global Climate Change

Contributed – Emily H. Van Zee, Oregon State University, 3324 NW Elmwood Drive, Corvallis, OR 97330; Emily.vanZee@science.oregonstate.edu

As the instructor of a physics course for prospective elementary teachers, I have been pondering the following questions: What aspects of the physics of global climate change are accessible for students with little preparation in science and mathematics, especially for those with high anxiety about enrolling in a physics course now required for entry into my university's teacher education program? What resources are available to instructors contemplating adding the topic of global climate change to a physics course? How does one decide what to include as well as what to cut when redesigning an already full course? How have prospective teachers responded to explorations, discussions, readings, homework assignments, and field experiences designed to raise awareness and understanding of some of the science underlying claims about climate change? How can I encourage my students to share their knowledge with friends and families? What next steps am I contemplating for this course?

DD04: 12:10-12:20 p.m. Connecting Racism, Climate Change, and Justice with a Teach-in

Contributed – Madeleine E. Msall, Bowdoin College, 8800 College Station, Brunswick, ME 04011-8448; mmsall@bowdoin.edu

Mark Battle, Bowdoin College

Strong student activism on our campus calls for divestment from fossil fuels and for broader engagement in the fight against racism. In response, a faculty and student coalition named Intersections: People, Planet and Power proposed a day long Teach-in that would use campus expertise to explore the intersections of these issues. As physicists working on a general education course, Energy, Physics and Technology, we joined students and colleagues from all college divisions on the core leadership team. This was a unique opportunity to engage deeply with issues across the college and to develop interdisciplinary partnerships. Our focus was an educational conversation promoting awareness of structural inequity, the impacts of climate change, and the connections between these threats. We will report on our success in promoting campus-wide dialogue, the many lessons learned and the patience required to make that dialogue inclusive and substantial.

DD05: 12:20-12:30 p.m. Communicating the Radiation Physics of Global Warming

Contributed – Wolfgang Bauer, Hannah Administration Building, 426 Auditorium Road, Room 412 East Lansing, MI 48824; bauer@pa.msu.edu

Climate change skeptics find it hard to believe that parts-per-million level changes to our atmospheric composition can make a difference in the global temperature. However, fairly straightforward application of concepts of radiation physics can make communication of these concepts much easier and more understandable. The present talk will give examples, which were derived from NIMBUS satellite data.

Session DE: 30 Demos in 60 Minutes

Location: Strand 10 A
Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on Physics in High Schools
Date: Monday, January 11
Time: 11 a.m.–12 p.m.

Presider: Wendy Adams

Our panel of physics teachers will present at least 30 dynamic demonstrations that will engage students in the wonder of science. Presenters will share tips on the setup, materials, procedure, and underlying science concepts so the audience can integrate these demos into their own classrooms.

Speakers:

- **James Lincoln,** *Tarbut V'Torah*
- **Bill Reitz**
- **Gene Easter,** *Streetsboro High School*

Session DG: At Home Labs

Location: Bolden 5
Sponsor: Committee on Educational Technologies
Co-Sponsor: Committee on Physics in Two-Year Colleges
Date: Monday, January 11
Time: 11 a.m.–12:30 p.m.

Presider: Andrew Duffy

DG01: 11-11:30 a.m. Using Mobile Devices for Home Laboratories

Invited – Kyle Forinash, Indiana University, Southeast School of Natural Sciences, New Albany, IN 47150; kforinas@ius.edu

Raymond Wisman, Indiana University Southeast

We will present ideas for several introductory physics laboratory exercises using smart phones and tablets as data collection devices. Example exercises include the use of the accelerometer, magnetometer, and microphone. We also describe simple external headset circuits that extend the smart phone capabilities for photo gate timing, voltage measurements and the collection of other types of real data. We will present a list of apps (some written by us, all free) that can be adapted for various laboratory exercises involving real data collection that students can preform at home. A sneak preview of some of our ideas can be seen at http://mobilescience.wikispaces.com/home.

DG02: 11:30-11:40 a.m. Take Home Labs for Struggling Learners

Contributed – Stephanie C. Hawkins, Barrington High School 201 Lakewood Dr. Oakwood Hills, IL 60013 smarry@barrington220.org

At Barrington High School I teach a co-taught physics class. The students in this course lack academic confidence and study skills. One of the ways we help these students understand the content is through take-home labs. First, we do a lab or activity in class. Then, students go home recreate the lab and teach it to a friend or family member. Finally, students submit a video of their at-home experience. Students appreciate the low-stress atmosphere of teaching someone who doesn't know the content and restarting the videos until they are happy with their performance. I will share examples of take-home activities and student videos.

DG03: 11:40-11:50 a.m. Take-Out Labs Chicago Style: Inertia & Waves

Contributed – Diane M. Riendeau, 1959 Waukegan Road, Deerfield, IL 60015; driendeau@dist113.org

Using readily available equipment (CDs, water bottles, candles) students perform actual investigations with their families. I'll share a few of the take-home labs and share a bit of the pedagogy and reasoning behind providing such experiences for our students.

DG04: 11:50-12 p.m. Take-Out Labs, Chicago Style: Electricity & Magnetism

Contributed – John P. Lewis, Glenbrook South High School, 4000 W. Lake Ave., Glenview, IL 60026; jlewis@glenbrook225.org

Using readily available equipment (compass, festive lights, batteries, and bulbs) students perform actual investigations with their families. This is not a "show and tell" experience for the kids but rather a gathering of large amounts of data which will later be analyzed in class. I'll share a few of the take-home labs and share a bit of the pedagogy and reasoning behind providing such experiences for our students.

DG05: 12-12:10 p.m. Take-Out Labs, Chicago Style: Physics Phun for Parents!

Contributed – Scott C. Beutlich, 525 Juanita Vista, Crystal Lake, IL 60014 scottbeutlich@rocketmail.com

PPP, Physics Phun for Parents is a way to get your students to learn and teach activities at home with their parents and family. Using readily available equipment (mirrors, rulers, balloons, dollar bills) I will share the handouts and related demos for preparing the students and reviewing their discoveries.

DG06: 12:10-12:20 p.m. The Power of the Video in the Physics Home Lab

Contributed – Farook Al-Shamali, Athabasca University, 16260 - 132 St., Edmonton, AB T6V 1X5, Canada; farooka@athabascau.ca

Martin Connors, Athabasca University

Video production for educational purposes is currently within the reach of most instructors and students. The widespread use of smartphones makes this task easy and affordable. We share our experience in using this great tool in the design of home labs at Athabasca University. Instructional videos are embedded in the e-lab manual to explain and demonstrate experimental setup and procedure. Students shoot and analyze videos to study the kinematics and dynamics of moving objects. Students can also submit (for assessment) properly edited videos as a replacement of traditional lab reports.

DG07: 12:20-12:30 p.m. Labs at Home for Distance and Classroom Education

Contributed – Martin G. Connors, Athabasca University, 11560 80 Ave., NW Edmonton, AB T6G 0R9, Canada; martinc@athabascau.ca

Farook Al-Shamali, Rafael Hakobyan, Elaine Goth-Birkigt, Athabasca University

Freshman courses value the lab experience since it exposes students to the real world that physics studies, and develops skills and critical thinking. Traditionally, such labs have been done in an on-campus setting. In distance education, students enroll specifically because they do not wish to come to a campus, so having a comparable lab experience had been a challenge. Almost 20 years ago, Athabasca University solved this problem with home lab kits based mostly on instruments attached to calculators, sent to students on loan by the university library. Meshing student needs with academic requirements caused an enrollment boom, and similar technologies were adopted in other subject areas. Improvements in technology have allowed us to update our home labs and reduce kit costs. They are so successful that we can advocate use of home lab kits even in classroom-based teaching, as supplements or even to completely replace the on-campus lab experience.

Session DH: Undergraduate Research at Two Year Colleges

Location: Bolden 1
Sponsor: Committee on Physics in Two-Year Colleges
Date: Monday, January 11
Time: 11 a.m.–12:20 p.m.

Presider: Michael Butros

DH01: 11-11:30 a.m. Undergraduate Research and Other Collaborations between TYCs and 4yr+ Universities*

Invited – Timothy D. Usher, California State University, San Bernardino, CA 92407; tusher@csusb.edu

Alec M. Sim, Irvine Community College

Joseph C. Farmer, College of the Desert

Michael S. Butros, Victor Valley College

As part of a NASA-CIPAIR grant and a NSF-CREST grant, we initiated several innovative activates that have greatly strengthened the ties between three two-year colleges (TYC), three 4yr+ universities and a NASA Center. One of the innovations has been given the moniker, "winternships." These are three to four week research "boot camps" conducted at TYCs during the winter break. The students work in teams on research projects. The timing of the winternship corresponds with the open application timeframe for summer research internships at, NASA, National Labs, and REU programs. Students are required to apply for at least three of these internships. Furthermore, having worked with the students closely TYC faculty can provide letters of recommendation that speak to more than just a student's performance in the classroom. However, by far the most important aspect of the winternship is that it builds student confidence. Other collaborative activities will be presented.

*Funded by NASA-CIPAIR grant number: NNX11AQ99G and NSF-CREST award number: 1345163.

DH02: 11:30-12 p.m. CURE – A Unique REU at L.A. City College

Invited – Paul McCudden, 855 N. Vermont Ave., Los Angeles, CA 90029; mccuddpj@lacitycollege.edu

CURE (Consortium for Undergraduate Research Experiences) is an NSF funded REU based at Los Angeles City College, in collaboration with NASA's Jet Propulsion Laboratory (JPL) and six Los Angeles area community colleges. CURE uses faculty at the colleges to help recruit approximately 10 community college students per year, with an emphasis on minority, female and older "second chance" students, for year-round (but summer-focused) research internships in cutting-edge projects in astronomy, astrophysics, and planetary science at JPL. CURE students overwhelmingly transfer to and graduate from universities with STEM majors. CURE is distinctive in both its year-round nature and its careful selection and mentoring component. Community college students have unique circumstances and needs, and CURE works with them before, during and after their internships to help guide them through a successful internship and transfer to a university. CURE gives two-year college students access to opportunities usually available only to their four-year colleagues.

DH03: 12-12:10 p.m. Undergraduate Research Experience for Physics Students at Valencia College

Contributed – Irina Struganova, Valencia College, 1800 S Kirkman St., Orlando, FL 32811; istruganova@valenciacollege.edu

I will talk about three models of offering introductory undergraduate research experience to physics students at Valencia College: 1) Mini-projects as a part of honor class curriculum, 2) Independent study, and 3) NASA Challenge – joined with engineering students. I will emphasize benefits and specific of each approach and highlight student achievements.

2016 Winter Meeting Plenary

Location: Celestin A-C
Date: Monday, January 11
Time: 2–3 p.m.

Presider: George Amann

Pluto Revealed: First Results From The Historic 1st Fly-By Space Mission

Dr. Kimberly Ennico Smith, NASA's Ames Research Center

Dr. Kimberly Ennico Smith

On July 14, 2015, after a 9.5-year trek across the solar system, NASA's New Horizons spacecraft successfully flew by the dwarf planet Pluto and its system of moons, taking imagery, spectra and in-situ particle data. In this internet-information age, this historic first fly-by was shared across planet Earth, everyone witnessing first-hand the transformation of distant point of lights into real worlds. The New Horizons' dataset has become an invaluable first glimpse into the outer Third Zone of the Solar System. Pluto has revealed itself to be a complex, beautiful place, with a variety of geophysical and surface-atmosphere interactions. Charon has been unmasked; its surface features implying a complicated, enigmatic history. The smaller moons, origins still unknown, are uniquely different in their own right. This presentation summarizes NASA's New Horizons mission and its early science results, and touches on the future of further exploring the outer Third Zone.

DH04: 12:10-12:20 p.m. Diversity and Retention Through STEM Student Research Opportunities

Contributed – Barbra K. Maher, Sobhani Red Rocks Community College 13300 W. Sixth Ave Lakewood, CO 80228 United States barbra.sobhani@rrcc.edu

Liz Cox Red Rocks Community College

Community colleges are ideally placed to provide STEM career access to a diverse population. Red Rocks Community College (RRCC) has built a robust transfer pathway through diligent development of articulation agreements, course alignments and recruiting. Our next step is to increase our retention of diverse populations. RRCC has begun a multi-pronged effort to address this, including faculty cultural competency training, developing a student STEM Scholar Program (SSP) and increasing access to student research and internships. The SSP provides community building, mentoring, training, and research opportunity through career workshops, outreach activities, and competitive research positions. STEM Summer Scholars Research Program is a paid internship for RRCC students, placing them in research projects on either the Colorado School of Mines or CU-Boulder campus. With seven successful placements in 2015, we are looking to expand the research program to include experiential learning field classes, and climate, atmospheric and aerospace related internships.

Session EA: Climate Change B

Location: Empire D
Sponsor: AAPT
Date: Monday, January 11
Time: 3:30–5:10 p.m..

Presider: Toby Dittrich

EA01: 3:30-4 p.m. Climate Impact of Energy Production from Nuclear Sources

Invited – Jack F. Higginbotham, Oregon State University, 92 Kerr Administration Bldg., Corvallis, OR 97331; jack.higginbotham@oregonstate.edu

The use of nuclear heat sources for production of the energy necessary to drive global economies has the potential to minimize society's impact on the climate. The primary advantage of the nuclear option is the reaction products are fully contained and do not constitute gases that have been identified as contributors to global climate change. No energy production method is fully carbon free when consideration is given to the entire life cycle of the technology. The carbon production values for the fuel or energy cycles of the primary energy production sources - nuclear, coal, hydro, solar, wind and natural gas – are presented. International projections for building of new electricity production facilities will be used to calculate the percentage of green house gas released from the use of each technology and examine the specific contribution of nuclear energy.

EA02: 4-4:30 p.m. Climate Physics in the Classroom

Invited – Michael Wiescher, University of Notre Dame, 225 Nieuwland Hall, Department of Physics, Notre Dame, IN 46556; mwiesche@nd.edu

The question of climate and climate change is dominated by emotional discussion and by ideological agendas. A new course was developed to investigate the science conditions that determine climate and that instigate climate change. The presentation will provide an overview on motivation and content of the course that includes topics such as energy physics of climate, the microphysics of climate, the atmospheric and hydrospheric physics of climate, climate history, climate proxies and signatures, closing with possible methods for climate stabilization.

EA03: 4:30-4:40 p.m. Climate Change and Non-Science Majors: Non-believing to Understanding

Contributed – Paul Ashcraft, Mercyhurst University, 501 E. 38th St., Erie, PA 16546; pashcraft@mercyhurst.edu

Pedagogical methods used in an Energy Science course are examined, relating global energy use to the historical increase in greenhouse gasses in the atmosphere and, using models, examine how changes in climatological variables can change global temperature and precipitation patterns. Non-science majors examine their beliefs about global climate change and the basis for those beliefs at the start of class. Physical concepts, used to examine historical and current research on global climate change, are used with models/simulations to look at feedback mechanisms.

EA04: 4:40-4:50 P.M. Ideas and Resources for Teaching Environmental Physics

Contributed – Kyle Forinash, Indiana University Southeast, School of Natural Sciences, New Albany, IN 47150; kforinas@ius.edu

Beginning physics students often need concrete examples in order to comprehend abstract physical concepts. The environment is a significant source of interesting examples where the principles of physics can be applied to the real world. Fossil fuels, energy conversion processes, renewable energy, and climate are all fertile topics for the introduction of basic concepts of physics such as conservation of energy, the first and second laws of thermodynamics, electromagnetic radiation and many more. This talk will present classroom presentation ideas and several online resources for using environmental processes, including climate as starting points for introducing fundamental concepts in physics. The material, drawn from 15 years experience teaching environmental physics courses, can be introduced into existing courses or used to teach a stand alone environmental course.

EA05: 4:50-5 p.m. Climate Change in the Introductory Course

Contributed – Thomas A. Moore, Pomona College, Physics Department / 610 N College Ave., Claremont, CA 91711; tmoore@pomona.edu

In this talk, I will describe a simple but surprisingly accurate climate change model suitable for presentation in an introductory physics course. This model shows students how global warming is linked to basic physical principles and how even they can generate some basic quantitative predictions from those principles, while at the same time illustrating some important aspects the modeling process itself.

EA06: 5-5:10 p.m. Time for 'Climate Change' on Climate Change

Contributed – Michael J. Ponnambalam, Nellai Mano University, 7-40 Sannathi St., Vadakkankulam, Tirunelvely Dt. Tamil Nadu, T.N. 627116 India; michael.ponnambalam@gmail.com

"Climate Change" has been talked about for many years now. Discussions have been done by various groups, yielding many reports. Yet, the amount of contribution to revert the harmful effects of "Climate Change" is negligible. It seems the time has come for a 'climate change' in addressing the problem of "Climate Change." Instead of depending solely on Science and Technology, a holistic approach is recommended for better results. When Rome was burning, Emperor Nero was playing his fiddle. When our Home (planet Earth) is burning, what are we doing?

Session EB: Outreach Physics Courses for Non-Science Majors

Location: Imperial 5
Sponsor: Committee on the Interests of Senior Physicists
Co-Sponsor: Committee on Physics in Two-Year Colleges
Date: Monday, January 11
Time: 3:30–5:10 p.m.

Presider: David Cook

EB01: 3:30-4 p.m. What to Teach Non-Science Students

Invited – Paul G. Hewitt, City College of San Francisco, 300 Beach Drive NE, #1103, St. Petersburg, FL 33701; pghewitt@aol.com

What to teach in an introductory course for non-science students? Lightweight problem solving, perhaps preceded by a bit of remedial algebra? Or elicit class discussions of current physics-related topics via the Internet? Or follow the textbook and minimize or avoid equations? My suggestion is none of the above, but rather teach what cannot be learned elsewhere: the laws of physics! Since most laws are in equation form, teach the meaning of their symbols and how they connect to one another. Learning to see equations as guides to thinking about nature's rules can be a stimulating and delightful educational experience—one that students won't experience elsewhere. To prevent your course from swerving into a less-welcome one of applied mathematics, minimize number crunching. When a learner's first course in physics is a delightful experience, a more rigorous second course will be welcomed.

EB02: 4-4:30 p.m. Courses for Non-Science Majors at Kenyon College

Invited – Thomas B. Greenslade, Jr., Kenyon College, Department of Physics, Gambier, OH 43022; greenslade@kenyon.edu

John T. Giblin, Paula C. Turner, Benjamin W. Schumacher, Timothy S. Sullivan, Kenyon College

Only a small fraction of students at liberal arts colleges take the introductory physics courses for physics and engineering majors and for pre-medical students. That leaves us with an opportunity to create courses for the rest of the undergraduate population. Courses in Astronomy are very popular for this group, but what else can we teach? At Kenyon we have offered a wide range of courses for the non-science students, with titles ranging from "Natural Philosophy" to Creating with Gadgets" to "Good Nukes, Bad Nukes." In this talk I will talk about our experiences over the past 50 years. Perhaps the audience can suggest a better name that "Non-Science Majors."

EB03: 4:30-4:40 p.m. Lessons from Three Semesters of a Physics for Humanities Course

Contributed – Deepak Iyer, Bucknell University, 153 Olin Science building, Lewisburg, PA 17837; deepak.g.iyer@gmail.com

Mary Emenike, Rutgers University

We report on three installations of a "Physics for humanities and social sciences" course. This was a moderate enrollment course (about 100 students) at a large public university. We will describe these three versions, the motivations, and present CLASS data (with both pre and post for two of them). We see variation in gains and losses across the three courses, and while causality is hard to establish, we speculate on the reasons based on other surveys done in the class.

EB04: 4:40-4:50 p.m. Science & Culture: Physical Sciences for a Sustainable Future

Contributed – Philip J. Carlson, Belhaven University, 1500 Peachtree St., CMB 277, Jackson, MS 39202; pcarlson@belhaven.edu

Reid Bishop, Belhaven University

Recent efforts to improve student perceptions and performance in the physical sciences have resulted in the design and implementation of a new general science education course series. We will present a course entitled "Science & Culture: Physical Sciences for a Sustainable Future" that attempts to bridge the gap between professional and citizen science. Evidence-based methods that involve teaching science through civic engagement and societal sustainability and developed in part with the assistance of the National Center for Science and Civic Engagement (ncsce.net) will be discussed along with successes and challenges. Results from specific learning modules and activities are used together in the context of partnerships with local entities including the US Army Corps of Engineers, the US Geological Survey, a local natural history museum and a local zoological park. Together, these efforts connect students to problems of local, regional, and global importance and also build inter-connectivity between the disciplines.

EB05: 4:50-5 p.m. Electronics for Business Students

Contributed – Chuck Winrich, Babson College, Kriebel 203, Babson Park, MA 02457-0310; cwinrich@babson.edu

Babson College is a small college specializing in business and entrepreneurship education. Traditional science courses that provide a foundation for further study within a discipline are of little value or interest to this student population. This presentation will focus on the physics course (one option for students to fill their science requirement) which is organized around the theory and operation semiconductor devices. The topic lends itself to discussion of fundamental topics in physics (e.g. modeling & experimentation, semiconductor physics), common technology (e.g. integrated circuits), and current events (e.g. raw materials and recycling for electronics). To gain practical experience, the students also build Arduino-based prototypes of a device of their choosing. Both the topics discussed and the prototype project lend themselves to the incorporation of relevant business and ethical issues of interest to the students.

EB06: 5-5:10 p.m. Expanding Ideas of Time: Relativity as a Discussion-based Course

Contributed – Louise O. V. Edwards, Yale University, 52 Hillhouse Ave., New Haven, CT 06511; louise.edwards@yale.edu

Astronomy 040: Expanding Ideas of Time and Space is a seminar-style course for university freshmen of all academic backgrounds. The objective of this course is to introduce Cosmology to students in the context of Einstein's Theory of Relativity without any algebra, yet to provide enough conceptual physics knowledge with assigned articles that students can critique information found online and in the news. To do this, popular science articles are discussed, as are technical articles about astrophysical research and in class fundamental physics concepts are provided in an interactive setting. The nature of time and light are taught as a foundation to special relativity; from there we delve into general relativity, which gives a theoretical context in which to explore the shape, contents and fate of the universe. The most important observational discoveries of the last hundred years are examined and put together to describe the big bang, the accelerating universe and dark energy. In this talk, the course format is outlined as well as a timeline. A list of student readings are provided.

Session EC: Focused Collection on Upper-Division PER

Location: Empire C
Sponsor: Committee on Research in Physics Education
Date: Monday, January 11
Time: 3:30–5:30 p.m.

Presider: Michael Loverude

EC01: 3:30-4 p.m. Becoming a Physicist: The Roles of Research, Mindsets, and Milestones

Invited – Paul W. Irving, Michigan State University, and CREATE for STEM Institute (MSU), 1310A Biomedical and Physical Sciences Building, East Lansing, MI 48824-2320; paul.w.irving@gmail.com

Eleanor C. Sayre, Kansas State University

As part of a longitudinal study into identity development in upper-level physics students, we used a phenomenographic research method to examine students' perceptions of what it means to be a physicist. Analysis revealed six different categories of perception of what it means to be a physicist with an importance placed on the following themes: research and its association with being a physicist; differences in mindset, and exclusivity of accomplishments. The paper highlights how these perceptions relate to two communities of practice that the students are members of, and highlights the importance of undergraduate research for students to transition from the physics undergraduate community of practice to the community of practicing physicists.

EC02: 4-4:30 p.m. Evolution of Student Ideas in Quantum Mechanics

Invited – Gina Passante, California State University, Fullerton, Department of Physics, Fullerton, CA 92831-3547; gpassante@fullerton.edu

Energy measurements and time dependence play a fundamental role in the theory of quantum mechanics, yet there is evidence that these ideas are difficult for many students, even after all undergraduate instruction. As part of the process of developing curriculum to address these difficulties we have analyzed student responses to open-ended questions given after lecture instruction. In this talk I will describe some results that show how students' ideas evolve (or fail to evolve) throughout instruction from sophomore modern physics to graduate quantum mechanics. This work has been done in collaboration with Paul J. Emigh (University of Washington) and Peter S. Shaffer (University of Washington).

EC03: 4:30-5 p.m. Identifying and Addressing Student Difficulties in Advanced Thermal Physics Courses*

Invited – Trevor I. Smith, Rowan University, 201 Mullica Hill Road, Glassboro, NJ 08028-1701; smithtr@rowan.edu

Warren M. Christensen, North Dakota State University

Donald B. Mountcastle, John R. Thompson, University of Maine

We present results from a multi-year investigation of student understanding of advanced undergraduate thermal physics. We focus on identifying specific student difficulties with classical thermodynamics and statistical mechanics, and addressing these difficulties by designing guided-inquiry tutorial activities for students to complete either in additional to or in place of traditional lecture instruction. We find evidence that many of the difficulties identified at the introductory level persist into the upper division. However, we also find evidence of more sophisticated difficulties that are indicative of the more advanced thinking required of students at the upper division. Their developing knowledge and understanding give rise to questions and struggles that are inaccessible to novices. Difficulties often stem from needing to synthesize various pieces of information and lines of reasoning into a coherent whole. We preset specific examples in the context of students reasoning about the density of states function and the Boltzmann factor.

*Supported by the National Science Foundation (DUE-0817282 and PHY-0406764) and the Maine Academic Prominence Initiative.

EC04: 5-5:30 p.m. Development and Uses of Upper-division Conceptual Assessments

Invited – Bethany R. Wilcox, University of Colorado at Boulder, 2510 Taft Dr., Unit 213, Boulder, CO 80302; Bethany.Wilcox@colorado.edu

Marcos D. Caballero, Michigan State University

Charles Baily, University of St. Andrews

Homeyra Sadagiani, California State Polytechnic University

Steven J. Pollock, University of Colorado at Boulder

The use of validated conceptual assessments alongside conventional course exams as a measure of student learning in introductory courses has become common practice in many physics departments. These assessments provide a more standard measure of certain learning goals, thus allowing for comparisons of student learning across instructors, semesters, institutions, and pedagogies. Researchers at the University of Colorado Boulder (CU) have developed several assessments designed to target the more advanced physics of upper-division classical mechanics, electrostatics, quantum mechanics, and electrodynamics courses. Here, we synthesize the existing research on CU's upper-division assessments and discuss some of the barriers and challenges associated with their development, validation, and implementation as well as some of the strategies we have used to overcome these barriers.

Session ED: History of Physics and Astronomy

Location: Strand 10 A
Sponsor: Committee on History and Philosophy in Physics
Co-Sponsor: Committee on Space Science and Astronomy
Date: Monday, January 11
Time: 3:30–5:30 p.m.

Presider: Todd Timberlake

ED01: 3:30-4 p.m. Hooke and Newton

Invited – Robert D. Purrington, Tulane University, Department of Physics, New Orleans, LA 70118; danny@tulane.edu

Robert Hooke and Isaac Newton had an antagonistic relationship that deeply affected each other's lives. Newton triumphed not only because of his greater genius and especially his mathematical knowledge, but also by refusing to acknowledge Hooke's very important contributions and in particular his statement of universal gravitation in 1665, as well as the key he gave Newton to understanding "attraction toward the center and motion by the tangent" which led to the Principia. We attempt to show just what Newton's debt to Hooke was why the two were continually at odds. "Everything you Thought You Knew About the History of Quantum Mechanics is Wrong" [tougher] While we all understand the formalism of quantum mechanics, as developed in 1925-32 by Heisenberg, Born, Jordan, Dirac, and von Neumann, often the history of that "heroic era" is bowdlerized if taught at all. We highlight a few episodes which are typically distorted or misunderstood, with a view toward setting the record straight.

ED02: 4-4:30 p.m. Augustin Fresnel and the Lighthouse Revolution

Invited – Theresa Levitt, University of Mississippi, Bishop Hall University, MS 38677-9999; tlevitt@olemiss.edu*

Augustin Fresnel was one of the most important physicists of the 19th century, responsible for a wave theory of light that served as a model for mathematical physics. But he is best known by many as the inventor of the Fresnel lens, the lighthouse lens that is now a staple of museum displays. The invention of the lens in the 1820s made lighthouses reliably visible from a great distance for the first time, and signaled the transition from harbor lights to genuine coastal lights. A study of Fresnel's career reveals interesting relations between the pursuit of theoretical physics and engineering practice. Although employed as an engineer, Fresnel's ambitions lay primarily in physical theory. As the social consequences of his lighthouse work became clearer, however, he devoted himself more to the practical elements.

*Sponsor: Todd Timberlake

ED03: 4:30-5 p.m. The Physicist Robert H. Dicke and Experiments in Gravitation

Invited – Martin P. McHugh, Loyola University, New Orleans, 6363 St. Charles Ave., New Orleans, LA 70118-6195; mmchugh@loyno.edu

Robert Dicke was one of the late 20th century's most influential physicists. After a PhD thesis in nuclear physics, and wartime work on microwave radar, Dicke made his early impact in the area of atomic physics. But by the mid 1950's his interests had shifted towards gravitation and Einstein's theory of General Relativity. Dicke was a primary force behind the then nascent field of experimental relativity. His approach to precision measurements has remained extremely influential.

ED04: 5-5:10 p.m. Magic, Science, and Religion: Lessons Learned from Interdisciplinary Team-Teaching

Contributed – Donald Andrew Smith, Guilford College, 5800 W. Friendly Ave., Greensboro, NC 27410; dsmith4@guilford.edu

Religious Studies Professor Eric Mortensen and I have developed an interdisciplinary course we call "Magic, Science, and Religion." This course represents a general education capstone experience and can be taken by any senior at Guilford College. We establish an aggressive reading schedule and guide the students through some of the best writers in human thought on the question of how we make sense of the world. We grapple with history, philosophy, anthropology, quantum mechanics, neurobiology, folklore, and Tibetan Buddhism, among other topics. The students must digest readings from authors as diverse as Annie Dillard, Ibn Tufayl, and J. Z. Smith. In this talk, I will present highlights from the three times we have taught the course, I will introduce some of the readings I think might be most useful or provocative for physics teachers, and I will describe some of the ways interdisciplinary team-teaching has informed my physics teaching.

ED05: 5:10-5:20 p.m. Reacting to History: Role-Playing Science for Non-Majors

Contributed – Shawn A. Weatherford, MC 2188, 33701 SR 52, Saint Leo, FL 33574; shawn.weatherford@saintleo.edu

The "Reacting to the Past" immersive role-playing curriculum is gaining popularity among historians as a vehicle for analyzing the positions of major participants during moments of radical change. The curriculum emphasizes how factions of common thinkers build consensus by convincing those who are indeterminate of the merits of new ideas. Students engage background readings and original sourced documents to prepare for a series of debates, while personifying historical figures. This presentation will focus on and explore the author's experience utilizing "The Trial of Galileo," a science-themed game used to explore the consequences of Galileo's discoveries during a course called "Scientific Revolutions" at Saint Leo University. During the game, students are responsible for learning and teaching the arguments for and against heliocentricity, while considering the nature of knowledge and the role of the Catholic Church in the 17th century.

Session EE: Educational Applications of Arduino Microcontrollers

Location: Strand 10 B
Sponsor: Committee on Apparatus
Co-Sponsor: Committee on Educational Technologies
Date: Monday, January 11
Time: 3:30–5 p.m.

Presider: Samuel Sampere

EE01: 3:30-4 p.m. Beyond Blinking Lights: Real-world Lab Solutions Using Arduinos

Invited – Eric Ayars, California State University, Chico, Campus Box 202, Chico, CA 95929-0202; eayars@csuchico.edu

The usual reaction people have on first being introduced to the Arduino microcontroller development board is something like "Wow! I'm going to use this for x" without much thought as to whether an Arduino is the most effective solution to x. Physics teachers are not immune to this "Arduino effect." In this talk I would like to address a few areas in lab for which a microcontroller may be the best solution; areas such as faking data, acting as a communications bridge, and creating new instruments. I will also address a few more areas for which an Arduino is probably not the best solution, such as analog data collection. Finally, I'll discuss alternatives to the "real" Arduino and when and why you should consider using those alternatives.

EE02: 4-4:30 p.m. A Quick Introduction to Arduino and Sensors

Invited – Philip C. Fulmer, Francis Marion University, Department of Physics and Astronomy, PO Box 100547, Florence, SC 29502-0547; pfulmer@fmarion.edu

The Arduino microcontroller board has celebrated its 10th birthday in the commercial world and has opened up electronics prototyping for non-technical hobbyists. The power of the Arduino board has made possible a wide variety of applications; a designer could envision a project and within a matter of a few minutes or hours have a working prototype. Arduino finds its greatest success in the world of physical computing whereby a sensor provides input to the Arduino, which then causes some other action to occur based on the measurement. In the classroom, students can quickly learn how to assemble a working circuit and have a satisfying learning experience that helps remove much of the mystery of scientific measurement. This presentation will give an overview of some quick projects that teach basic physics of measurements and discuss the available sensors that can be used with Arduino.

EE03: 4:30-4:40 p.m. Generating Audio-Frequency Analog Signals with Arduino

Contributed – Jeffrey R. Groff, Shepherd University, PO Box 5000, Shepherdstown, WV 25443-5000; jgroff@shepherd.edu

The microcontrollers onboard Arduino hardware are capable of natively generating digital pulse-width-modulated signals. However, analog signals such as sine, sawtooth, and triangle waves are often more useful for teaching the physics of sound, resonance, standing waves, and harmonics. This talk will discuss a method for generating audio-frequency analog signals with an Arduino Uno by rapidly varying the duty-cycle of a pulse-width-modulated waveform and applying a low-pass filter to the output. A low-cost open-source Arduino Uno-compatible function generator utilizing this method of subtractive synthesis will be shared. The function generator can be used to drive a small speaker for resonance experiments, to provide a signal for teaching the electronics of filter design, or as a voltage-controlled oscillator for a modular synthesizer. The act of building the function generator itself can be used to teach students about 3D printing, electronics, and Arduino programming.

EE04: 4:40-4:50 p.m. Arduino-based Digital/Optical Communication System

Contributed – Neal C. Gallagher III, Socrates Preparatory School, 3955 Red Bug Lake Road, Casselberry, FL 32707; nealcg@gmail.com*

Joshua C. and Nicholas M. Fair, Brandon W. Mayle, Maura F. Gallagher, Samuel J. Konkol, Socrates Preparatory School

Jason Cannon-Silber, Valencia Community College

Using a clear flexible PVC tube filled with mineral oil as an optical fiber, a laser diode is submerged in one tube side with a photo-resistor in the other side. A transmitter and a receiver Arduino are connected to the laser and resistor respectively. A message typed into a laptop is passed to the transmitter Arduino that converts a text message into binary ASCII, one character at a time. It transmits each character as a packet with a leading sync pulse to align timing for the transmitter and the receiver. Each received packet is converted back to a character by the receiver Arduino and then displayed on a connected laptop.

*Sponsor: Neal C. Gallagher, Ph.D.

EE05: 4:50-5 p.m. Learning Through Tinkering in Engineering Class

Contributed – Yusuf Dogan, Harmony School of Excellence, 2100 E St Elmo Road, Austin, TX 78744; ydogan@harmonytx.org

In this presentation, I would like to share how a regular engineering class (CTE) turned into a tinkering workshop and which projects that we have utilized and what was different from other regular classes. I will show the Arduino projects that we have been working on. Everything is evolving for each second, and we should consider that this progress affects education--especially if your are bringing technology to your classroom, you will see this change faster than other classrooms. In Engineering class, we heavily rely on technology. As a result, tools, curriculum, perspective, and understanding of engineering education is changing, and it evolves into the something different than the past. In these days, it looks like a next step is learning though tinkering. Last two years I have been trying to implement tinkering in engineering and physics classes. I would like to share Arduino projects and some ideas about how we can turn any regular project to the tinkering based education. I would also like to share some details about effects of tinkering in students such as it increases independent work and making.

Session EF: Other Papers

Location: Strand 11 B
Sponsor: AAPT
Date: Monday, January 11
Time: 3:30–5 p.m.

Presider: Frank Lock

EF01: 3:30-3:40 p.m. A Unique Optics Teaching Laboratory*

Contributed – John Noe, Stony Brook University, Department of Physics and Astronomy, Stony Brook, NY 11794-3800; johnnoe@gmail.com

The Laser Teaching Center at Stony Brook University is a unique educational environment in which young students (over half female) are introduced to research by creating and documenting hands-on optics-related projects in collaboration with a mentor. Students experience the excitement, challenges and satisfaction of real-world research by developing novel projects with an uncertain outcome. Optics is ideal for this educational approach for a variety of reasons. Our poster at this meeting describes one such project by a freshman undergraduate. Other recent projects by full-time summer high school students have involved the mode structure of HeNe lasers, the creation of Airy beams, and trapping forces in optical tweezers. The tweezers project was recognized by an Intel Finalist award, our third in 15 years. None of these projects involved expensive or advanced equipment.

*See our web page at http://laser.physics.sunysb.edu for more information.

EF02: 3:40-3:50 p.m. Challenges of Room Temperature Scanning Tunneling Microscopy Investigation of Carbon Nanotubes on a HOPG Substrate

Contributed – Morewell Gasseller, Xavier University, New Orleans, LA 70152-1098; mgassell@xula.edu

Jessica Ritchie, Mercyhurst University

Highly oriented pyrolytic graphite (HOPG) is a common substrate for STM studies of carbon nanotubes. It is an ideal surface for STM because it is easily cleavable by adhesive tape, resulting in large, atomically flat planes that are relatively inert and electrically conducting. Despite these attractive attributes, the cleavage of HOPG surfaces also generates a variety of artifacts, some of which are elongated structures similar to the carbon nanotubes being investigated. Some even exhibit periodicities that mimic the atomic structures expected in the carbon nanotubes. In our investigation of SWCNT deposited on a graphite substrate, we observed and catalogued many of these commonly known filament-like artifacts. The data presented here serve as a demonstration for how we differentiated SWCNT from filament-like graphite artifacts in STM experiments.

EF03: 3:50-4 p.m. Corrosion Engineering in Chemistry

Contributed – Evelyn Restivo, 144 Creekview Circle, Maypearl, TX 76064; erestivo2001@yahoo.com

Jan Mader, Great Falls High SChool

Karen Jo Matsler, UT Arlington

Integrating the physics of metallurgy with environmental and corrosion chemistry is a transition into engineering and technology that is critical to produce more resilient, lighter, less expensive materials for future electronic products and safe, sturdy infrastructure. Using relationships for physical properties of metals and single replacement reactions the prediction and development of a metallic activity series provides a basis for oxidation-reduction showing practical applications such as properties to protect structures from vulnerability to corrosion, oxidation and rust in humid conditions. Many of the challenges associated with saving priceless treasures, bridges, buildings, and in general protecting our economy and way of life must be developed through a combination of engineering processes employing techniques designed through sharing partnerships in the sciences.

EF04: 4-4:10 p.m. Fourier Series-based Methods for Computing the Value for π

Contributed – Joshua C. Fair, Socrates Preparatory School, 3955 Red Bug Lake Road, Casselberry, FL 32707; nealcg@gmail.com*

Samuel J. Konkol, Maura F. Gallagher, Brandon W. Mayle, Neal C. Gallagher, III, Jason Cannon-Silber, Socrates Preparatory School

Nicolas M. Fair, Valencia Community College

The function g(x) = arcsin(sin(x)) is a periodic function of triangular shape, having a Fourier series expansion:

$$g(x) = \frac{4}{\pi}(\sin(x) - \frac{\sin(3x)}{9} + \frac{\sin(5x)}{25} - \dots \frac{(-1)^n \sin(2n+1)x}{(2n+1)^2}$$

+ ..., for all *x*.

The triangle shaped function *g*(*x*) is easy to differentiate and integrate due to its trivial geometry. By evaluating the expression g(x) over different intervals on the x-axis and by performing differentiation and integration for g(x) as well as its term by term Fourier series, a number of series expansions related to π can be obtained.

*Sponsor: Neal C. Gallaher, II

EF05: 4:10-4:20 p.m. Modeling, Making and Physics Experimental Techniques to Understand Neuroscience

Contributed – James H. Dann, Menlo School, 3921 Orinda Dr., San Mateo, CA 94403-3639; jamdann@gmail.com

I will be describing a new kind of class that combines making, physics, and biology. Students make functioning body parts to deepen their understanding of neuroscience and the human body. In addition, students will conduct physics type experiments on insects using probes and Op-Amp circuit board constructed by Spiker Box to conduct experiments on insects and their nervous system. Here is our course description. In this course you will explore one of mankind's greatest unknowns… the brain and nervous system. You will take an adventure that is thought only possible in fictional writing like Frankenstein and along the way you will learn electronics, experimental techniques and neurobiology. This is a hands-on class, where you explore the fascinating topic of how the brain and peripheral nervous system work by studying the electrical signals in grasshoppers as you touch different parts of its body and submit it to different odors. From these experiments, articles and classroom discussions you will learn intimately how the nervous system works and as much as we can infer about the brain. In addition, you will learn enough electronics to build your own circuit that will enable to you to make the live grasshopper move based on your commands!

EF06: 4:20-4:30 p.m. Physics of the Cardiovascular System – NSF Funded Curriculum:

Contributed – Nancy L. Donaldson, Rockhurst University, Kansas City, MO 64110; nancy.donaldson@rockhurst.edu

This NSF-funded curriculum is a hands-on, active learning module covering mechanics of the cardiovascular system and pressure differences in the body that guide blood flow in the cardiovascular system in health and disease. The target learning audience is intermediate-level undergraduates, i.e., students who have already had a one-year introductory-level physics course; however, with the appropriate student background, it could be used in an Introductory Physics for the Life Sciences course. The module activities address Pre-Health Competency E3 (Demonstrate knowledge of basic physical principles and their applications to the understanding of living systems) and Foundational Concept 4B (Importance of fluids for the circulation of blood, gas movement, and gas exchange) and are directed toward an application of physics to medicine. Students particularly interested in these activities may be those pursuing graduate school/careers in medicine, health care, or medical physics or those interested in broadening their understanding of applications of physics.

EF07: 4:30-4:40 p.m. Study of the Mechanical Properties of Biomaterials with Simulink

Contributed – Bernard Drouin, Laval University and Garneau College, 304-2854 RUE WILFRID-LEGARE, Quebec, QC G1V 2H2 Canada; bernard.drouin@sympatico.ca

Diego Mantovani, Laval University and Hospital research center

To assess the mechanical properties of biomaterials, visco-elastic models such as Maxwell or the standard linear solid constitute the most adopted approaches. However, young scientists, including non-engineering students, have not always been educated and are not all familiar with these models. A simple and easy-to-use simulation tool is required to perform investigations and comparisons between experiments and theory. Matlab Simulink, a graphical simulation tool can be used to achieve this goal. This paper presents the basic features of Simulink. Tests on vascular tissues and hydrogels will be exposed and discussed as well as the simulation techniques used to reproduce these experimental results. Considering that neither the *American Journal of Physics* nor *The Physics Teacher* have introduced Simulink in their pages, this presentation is a good opportunity for physics teachers to evaluate this highly versatile simulation software.

EF08: 4:40-4:50 p.m. Integrating a Learning Community of Learning Assistants and Teaching Assistants

Contributed – Manher Jariwala, Boston University, 590 Commonwealth Ave., Boston, MA 02215; manher@bu.edu

At Boston University, the physics department supports both a robust undergraduate Learning Assistant (LA) program as well as the formal professional and pedagogical development of graduate students through participation in the CIRTL (Center for the Integration of Research, Teaching, and Learning) Network. We describe our recent efforts to integrate the training of undergraduate LA's and graduate student TA's and to promote partnership in teaching between LA's and TA's, leveraging best practices from both the LA and CIRTL programs. We also provide examples of change agents that have emerged from each group and discuss the common elements and shared values between undergraduate and graduate student efforts.

EF09: 4:50-5 p.m. The Sun's Orbit Radius and Period

Contributed – Vic Dannon, Gauge-Institute, 619 8th St., SE, Minneapolis, MN 55414; vic@gauge-institute.org

We assume that the Gravitational Power Radiation of a moving mass is proportional to that mass acceleration squared. Then, at Radiation Power Equilibrium between the Sun and its nine Planets, the Sun's Orbit Radius is about 2,067,000 km, about three times the Sun's Radius of 696,000 km. And the Sun's year is about 0.937188048 Earth years. http://www.gauge-institute.org/Gravitation/SunOrbitRadius-Evanston2015.pdf.

Session EG: Graduate International Experiences

Location: Bolden 5
Sponsor: Committee on International Physics Education
Co-Sponsor: Committee on Graduate Education in Physics
Date: Monday, January 11
Time: 3:30–5:30 p.m.

Presider: Claudia Fracchiolla

In this session we will discuss mechanisms to strengthen the bonds between the PER community in the U.S. and abroad. We will also explore ways in which we can foster opportunities for collaboration, in particular for graduate students. Finally, how is the journey different for a typical graduate student abroad as compared to one in the U.S.?

EG01: 3:30-4 p.m. High Speed Cameras in Physics Education

Invited – Michael Vollmer, University of Applied Sciences Brandenburg, Magdeburgerstr. 50 Brandenburg, 14770 Germany; vollmer@fh-brandenburg.de

Video analysis is an important tool to investigate the dynamics of transient physics phenomena. Although there are processes that may be studied using available simple and inexpensive cameras with 25 or 30 Hz frame rate, there is also a very large number of phenomena in all fields of physics which happen too fast for regular video analysis. Fortunately, enormous progress has been made recently in the fields of microsystems, microelectronics, and computer science leading to many new products including also affordable high-speed cameras. Nowadays high-speed imaging with subsequent analysis can support physics teaching at all levels and dozens of relevant refs are available. The presentation introduces the topic, discusses specifics of high-speed imaging compared to regular video analysis and gives selected examples from all fields of physics. The author is interested in cooperating with U.S. teachers and physicists sharing interest in High Speed Imaging in physics education.

EG02: 4-4:30 p.m. Possibilities for Strengthening the U.S. and International PER Community

Invited – Florian Genz, Universitat Zu Koln, GronewaldStr. 2, Köln, 50931[Florian.Genz@uni-koeln.de

André Bresges, University of Cologne

Daniel MacIsaac, Buffalo State College

Jeremias Weber

As mandatory part of the Physics Teacher Training of University of Cologne, Germany, students learn how to use tablets to capture short science movies. This idea was adapted to two teacher preparation courses at the Buffalo State College, NY. This was done in two cycles, in accordance with the methods of Design and Action Based Research. The results show that the adaption is fruitful for both the two teacher preparation courses and the Teacher Training Programme of Cologne, but also highlights the rewards and challenges in adapting new teaching methods from other learning cultures. In the presentation both the underlying idea as well as the implementation will be described. The outcomes of this adaption will be described in detail, with examples from the students. Finally, further possibilities for cooperation in the international learning and teaching community will be brought up and discussed.

EG03: 4:30-5 p.m. How to Broaden Your Horizons with International PER

Invited – Christine Lindstrøm, Oslo and Akershus University College, PB 4 St Olavs Plass Oslo, NO-0475 Norway; christine.lindstrom@hioa.no

I am an international PER person: I grew up in Norway, went to university in Australia for eight years, subsequently worked in Norway for four years, during which time I also taught a graduate course at a university in Thailand and had three month-long visits to South Africa. I am currently a Fulbright Visiting Scholar at the University of Colorado Boulder, and will spend the next year in South Africa. In my talk, I will elaborate on how these opportunities arose, share some of the benefits and challenges of such an international focus, and discuss how graduate students may seek out similar experiences and opportunities for collaboration with PER people around the world.

EG04: 5-5:30 p.m. Crossing Borders as Part of your Graduate Studies Development Process

Invited – Carolina Alvarado, University of Maine, 62 Main St., Apt A, Bangor, ME 04401; carolina.alvarado@maine.edu

We live in a world that tends to set borders, so you can be aware of where you are in a certain moment. I want to share with you how crossing borders is a crucial way to improve your experience as a graduate student while shaping yourself as future researchers. Borders can be defined in several ways; in my personal experience, I had an opportunity to do a research visit for six months as a graduate student that pushed several borders: geographical, institutional, changing research group, exploring new theoretical framework, working with a completely different population, using someone else's data, among others. The interesting part of this change, it was not deviating me from my personal research plan, but strengthening it from new unexplored areas. Getting out of your comfort zone and expanding your horizons as a graduate student allows you to explore new dimensions of Physics Education Research areas that you might not have been able to explore if you don't push yourself beyond your current borders. I share my personal journey as a graduate student having a redefining visiting scholar experience.

Session EH: The PhysTEC 5+ Club

Location: Bolden 6
Sponsor: Committee on on Teacher Preparation
Date: Monday, January 11
Time: 3:30–5:30 p.m.

Presider: Erin Sutherland

This session will start with a poster session followed by a panel discussion by various recipients of PhysTEC's 5+ club award winners. The 5+ club is given to institutions who graduate 5 or more physics teachers in a given year. All presenters will give an overview of their program and how they are able to be recognized into this club.

EH01: 3:30-5:30 p.m. Kennesaw State University and Our 5+ Club Program

Invited – David Rosengrant, Kennesaw State University, 1000 Chastain Road, Kennesaw, GA 30144; drosengr@kennesaw.edu

Kennesaw State University's physics educator program prides itself on content specific training for our physics teachers. Our program started out with the help of two different Robert Noyce Scholarship Programs for our Masters of Arts and Teaching degree. We recently underwent a major program overhaul for a multitude of reasons. Kennesaw State University (KSU) and Southern Polytechnic University consolidated to form a new, bigger and better Kennesaw State University. This included a new undergraduate degree and with an adoption of UTeach now called OwlTeach we have a physics education track. KSU also became a Woodrow Wilson Fellowship site which allowed us to completely overhaul our MAT program. This presentation highlights courses, program of study, and recruitment methods.

EH02: 3:30-5:30 p.m. Physics Teacher Preparation at the University of Arkansas

Invited – John Stewart, West Virginia University, Department of Physics and Astronomy, Morgantown, WV 26506; jcstewart1@mail.wvu.edu

Gay Stewart, West Virginia University

The University of Arkansas implemented changes in its undergraduate physics program beginning in 1994 that dramatically increased the number of students graduating with a physics major from one to two students per year for most of the years from 1990-1998 to 27 graduates in 2012. With the selection of the department as a PhysTEC program in 2001, the number of physics students entering high school teaching also began to dramatically increase. The features that led to the increase in physics graduates were important to increasing the number of teachers graduated, but each feature required refinement to support future teachers. Modifications to a thriving physics program necessary to allow students to enter the teaching profession will be discussed. With the refinements in place, the University of Arkansas has consistently graduated five or more physics teachers per year since 2005 and was proudly awarded membership in the PhysTEC 5+ club in 2014.

EH03: 3:30-5:30 p.m. Physics Teachers from UTeach

Invited – Michael Marder, Department of Physics, UT Austin, Austin, TX 78712; marder@mail.utexas.edu

UTeach prepares STEM teachers at 44 universities across the U.S. All of the UTeach partner universities prepare physics teachers. However given the need for physics teachers and the scale of UTeach, the numbers should be larger. I will discuss features of UTeach, our record in preparing physics teachers, and discuss possible steps to prepare even more.

EH04: 3:30-5:30 p.m. Recruiting Engineering Students into High School Physics Teaching

Invited – Kathleen Koenig, University of Cincinnati, 3758 Hubble Road, Cincinnati, OH 45247; kathy.koenig@uc.edu

We have created multiple pathways into our high school physics teaching license program, with several explicitly targeting engineering majors. This presentation will focus on some of the strategies that have been successful in recruiting both current and past engineering students into possible careers in teaching.

EH05: 3:30-5:30 p.m. The 5+ Club: An Update from PhysTEC

Invited – Monica Plisch, 1 Physics Ellipse, College Park, MD 20740; plisch@aps.org

"The 5+ Club" is designed to recognize institutions that graduate five or more physics teachers in a given year. The great majority of institutions graduate less than two physics teachers a year, and the most common number of graduates is zero. Thus, graduating 5 or more physics teachers a year is a significant achievement, helping to address the severe national shortage of high school physics teachers. A total of 19 institutions have been inducted into The 5+ Club. The 5+ Club is an award of the Physics Teacher Education Coalition (PhysTEC) project, which is led by the American Physical Society and the American Association of Physics Teachers.

EH06: 3:30-5:30 p.m. PTEC 5+ Club, Brigham Young University, Provo

Invited – Duane B. Merrell, Brigham Young University, N-143 Eyring Science Center, Provo, UT 84602; duane_merrell@byu.edu

Since 2004 Brigham Young University in Provo has been fortunate to be able to have the physics teacher preparation program in the physics department. With the guidance and support of many at the university the physics teacher program has thrived in the number of physics certified teachers that have teacher licenses. Organizations such as AAPT and PTEC have held conferences and workshops that have helped form the BYU physics teaching program and we have taken these ideas to help students become physics teachers. With over 130 students certified to teach physics at this time we still wish we had more but are pleased to share what we have learned and why it can be replicated anywhere at any other university. We have borrowed and patterned our physics teacher programs from others and are willing to share what we do with others.

EH07: 3:30-5:30 p.m. Physics Teacher Preparation at BYU-Idaho

Invited – Brian A. Pyper, BYU-Idaho, BYUI Physics, Rexburg, ID 83460-0520; pyperb@byui.edu

Although some of the things happening at BYUI in the physics education area are both modeled on and exemplary of the sorts of things encouraged by the Physics Teacher Education Coalition, and may (already) be replicated elsewhere, there are some things happening that are interesting and peculiar to the BYUI community and culture.

EH08: 3:30-5:30 p.m. Physics Teacher Preparation at Buffalo State College

Invited – Kathleen Falconer, Buffalo State College, 27 East Girard Blvd., Buffalo, NY 14217; falconka@buffalostate.edu

At Buffalo State College, the physics department runs several courses for prospective and practicing physics teachers, collectively called the Physics Teachers Summer Academy. The Summer Academy serves practicing non-physics teachers seeking certification in physics (cross certification) and prospective teachers with backgrounds in physics seeking initial certification (alternative certification), including Noyce scholarship recipients. I will discuss the current state of the program and the challenges we face.

Session EI: Quadcopters, Drones and High Altitude Balloons

Location: Bolden 2
Sponsor: Committee on Educational Technologies
Date: Monday, January 11
Time: 3:30–5:10 p.m.

Presider: Aaron Titus

EI01: 3:30-4 p.m. Teaching Physics with Radio-controlled Helicopters and Multicopters

Invited – Martin A. DeWitt, High Point University, One University Parkway, High Point, NC 27268; mdewitt@highpoint.edu

With the recent proliferation of inexpensive radio-controlled miniature helicopters and multicopters, it is more feasible than ever to purchase these devices for educational use. They can be invaluable motivational tools for teaching a variety of topics in an introductory physics course. In this talk, I will discuss the physics underlying the operation of both helicopters and multicopters, as well as present examples of how to use them in the classroom and laboratory. I will also briefly discuss ways to use slightly larger model aircraft in undergraduate research projects.

EI02: 4-4:30 p.m. Blueprints for Accessible and Affordable High-Altitude Ballooning

Invited – Geoffrey Schmit, Naperville North High School, 304 S River Road, Naperville, IL 60540; gcschmit@gmail.com

Mark Rowzee, Naperville North High School

We'll provide you with the blueprints for success since the moment you release your first high-altitude balloon, you are stricken with an unsettling combination of joy and terror. It is relativity easy to launch a high-altitude balloon; it requires much more planning, resources, and luck to get it back. We will share our experiences designing, launching, and recovering high-altitude balloons over the past six years. We will share the science that can be done with a variety of student age groups (elementary, junior high, and high school). We will share the materials necessary for a successful launch and recovery for a variety of budgets. We will share the safety precautions that are required. Finally, we have photos, videos, resources, and stories that we hope will inspire you to conduct your own launch.

EI03: 4:30-4:40 p.m. First High Altitude Balloon Experience at RCTC; What We Learned

Contributed – Rod Milbrandt, Rochester Community and Technical College, 952 28th St. NW, Rochester, MN 55901-6904; rod.milbrandt@rctc.edu

Andrea Walker, Nathan Brown, Eric Thoreson, Rochester Community and Technical College

Steve Keidl

Three community college students prepared and successfully launched a high altitude balloon (HAB) this spring for a team project in our calculus-based physics class. This talk will discuss our experience: preparation, materials, cost, troubleshooting and other details along with data and video acquired. The key role of retired engineers who volunteered their time and expertise to help the students will also be discussed. The project generated a lot of excitement and interesting data and we highly recommend HAB experiments for other colleges and high schools.

EI04: 4:40-4:50 p.m. Stratospheric Ballooning – Temperature Measurement Challenges

Contributed – Erick Agrimson, St. Catherine University, 2004 Randolph Ave., St. Paul, MN 55105; epagrimson@stkate.edu

Kaye Smith, Brittany Craig, Rachel Newman, St. Catherine University

James Flaten, University of Minnesota

Measuring air temperature from high altitude balloon payloads is a straightforward process– or so we thought. But problems encountered and observation have caused us to rethink how we measure and interpret temperature data collected in a partial vacuum and at temperatures well below -50º Celsius. As a result, our High Altitude Balloon (HAB) program at St. Catherine University took a detour this past summer and focused on increasing our understanding of what it means and how to best measure temperature. In this talk, we present some of the challenges we encountered as we conducted temperature-based research in near space conditions. Testing, calibrating and comparing temperature sensors in this extreme environment has proven to be a worthwhile endeavor for our undergraduate research team, and we share learning experiences and outcomes of this process.

EI05: 4:50 -5 p.m. Service Learning and High Altitude Balloons

Contributed – Joel C. Berlinghieri, The Citadel, Physics Department, Grimsley Hall, Charleston, SC 29409; berlinghieri@citadel.edu

Russell O. Hilleke, Luke S. Sollitt, The Citadel

The Citadel Physics Department, with support from Space Grants, Google Corporation, and the STEM Center for Excellence is leading an outreach program which involves high school teams, undergraduate physics and engineering students, and department faculty. High school teachers attend a workshop in which they learn about project design for high-altitude ballooning. They in turn select high school student teams to design experiments, write proposals, and submit these to a team of undergraduate and faculty reviewers. With an approved project teams are given financial support and then construct the experiment instrumentation. Projects are tested using a tethered balloon (1000 ft.) test protocol. Approved projects are then flown (launched and retrieved) by participants.

EI06: 5-5:10 p.m. Harmony Near Space Project

Contributed – Mehmet Gokcek, Harmony School of Innovation, 3521 Mike Godwin Drive, El Paso, TX 79936; mgokcek@harmonytx.org

In secondary education physics students learn about various concepts of science such as thermodynamics, kinematics and much more. Most schools offer great hands-on activities where students obtain a chance to form a deeper appreciation of physics. However, there seems to be a lack of advanced level projects where various topics of physics can be brought together giving members of physics class an opportunity to apply their recently acquired knowledge. Most schools strive for such advanced projects that can create a higher level of understanding of physical concepts. High altitude balloons introduces students to basics of space exploration by making it possible to collect data and footage at an altitude of 100,000 ft, where temperature drops down to -50 F degree and pressure to an extreme value plummeting from 12.04 psi on the ground to 0.02 psi. For more https://www.facebook.com/Harmonynearspace

Session FA: Physics Outside the Classroom: After School Clubs, Summer Camps and Other Enrichment Programs

Location: Bolden 1
Sponsor: Committee on Physics in Pre-High School Education
Date: Monday, January 11
Time: 7–8:10 p.m.

Presider: Peggy Norris

FA01: 7-7:30 p.m. Next Generation STEM Preparation Through LIGO Science Education at Southern University*

Invited – Stephen C. McGuire, Southern University and A&M College, LIGO Livingston Observatory, P.O. Box 940, Livingston, LA 70754; smcguire1@cox.net

Luria Young; Southern University and A&M College

This talk focuses on our 10-year local partnership with the LIGO Science Education Center (SEC) in science education through in-service and pre-service programs that primarily impact K-16 teacher preparation. Principal on-campus components of our science educational outreach effort include the SUBR-LIGO Inquiry Laboratory and the LIGO Docent Training Program. Both support teacher pre-service and in-service activities by introducing classical LIGO science concepts to a broad spectrum of undergraduate majors, practicing teachers, and the public through the use of interactive exhibits and in doing so enhance science literacy throughout the region. Further, the Inquiry laboratory and Docent Training Program serve as sources for graduate student projects for the university's doctoral program in Science and Mathematics Education (SMED). Details of the partnership, a summary of recent outcomes, and future plans will be presented.

*Work supported by National Science Foundation Grant No. PHY-0917543.

FA02: 7:30-7:40 p.m. Saturday Morning Astrophysics at Purdue: Sharing Astrophysics with ndiana Community

Contributed – Matthew Wiesner, Purdue University, 525 Northwestern Ave., West Lafayette, IN 47907; matthewwiesner@aol.com

David Sederberg

In this paper we describe Saturday Morning Astrophysics at Purdue (SMAP), a new program at Purdue University for local students in grades 6-12. On the second Saturday of every month, we present a lesson that introduces the students to a topic in current astrophysics. Each one-hour lesson includes a brief introduction and a hands-on exploration of the topic. In the past year we have measured the Hubble constant, identified star types using spectroscopy, built telescopes, created model meteor craters and more. In this talk we describe our goals for SMAP, we present concepts we have taught and we consider students' progress in learning about astrophysics and getting comfortable with science as a whole.

FA03: 7:40-7:50 p.m. Randolph College Science Festival and Science Saturdays: Outreach for All

Contributed – Peter A. Sheldon, Randolph College, 2500 Rivermont Ave., Lynchburg, VA 24503; psheldon@randolphcollege.edu

Randolph College is a small, liberal arts college with 700 students. More than 10 years ago, our Society of Physics Students started an annual outreach for elementary school children which has now grown into a weekend-long regional Science Festival for all ages and a fall laboratory series for high school students. This is all done on no regular budget and in a department with 2.5 faculty members. An incredible 25% of the entire student body volunteers to help with the festival each year. I will share what we do and how we do it, our successes, and our struggles.

FA04: 7:50-8 p.m. Physics for Five-year-olds

Contributed – Jessica Graber, Xavier University of Louisiana, Department of Physics, 1 Drexel Dr., New Orleans, LA 70125; jgraber@xula.edu

After searching for physics experiments suitable for my own kindergarten-aged children, I came to the conclusion that science for five-year-olds comprises dinosaurs and growing seeds. Physics-oriented projects were generally for older children, and concentrated on solar power or water conservation. In terms of cognitive development, concepts of weight, length, shape, and volume are being molded at around age five, but I could find no lessons introducing vocabulary, nor kinesthetic activities helping them intuitively develop these concepts. So I wrote my own. My college students helped lead the activities during eight weeks of after-school enrichment at a nearby elementary school. The kids and I had a good time, though no formal evaluation or assessment was done of the outcomes of the program. I would appreciate feedback on the content and approach of my lessons, as well as suggestions for evaluation and dissemination.

FA05: 8-8:10 p.m. Outreach and Engagement – Seizing and Leveraging Opportunity

Contributed – David Sederberg, Purdue University, 525 Northwestern Ave., West Lafayette, IN 47907; dsederbe@purdue.edu

Matthew Wiesner, Purdue University

The design of educational outreach can take myriad directions, depending on the expectations and philosophies of those engaged in and conducting programs, the selection of and anticipated benefits to target audiences, levels of engagement, and the availability of volunteers and material resources. In this presentation, we will briefly outline both time-honored and emerging physics and astronomy Outreach Programs at Purdue and illustrate models of new directions we are pursuing. We will highlight some of our successes, our challenges, and present ways in which Physics Outreach is positioned to serve the department, maintain our responsibility to the College of Science, and seek and effectively reach target audiences, in ways that we believe will most effectively accomplish common goals.

Session FB: Recovery of New Orleans Physics Post-Katrina

Location: Strand 10 A
Sponsor: Committee on Diversity in Physics
Date: Monday, January 11
Time: 7–8:30 p.m.

Presider: *Daniel Smith*

FB01: 7-7:30 p.m. The Dual Degree Approach: Improving the Success of Minority Physicists/Engineers

Invited – Anderson Sunda-Meya, Xavier University of Louisiana, 1 Drexel Dr., New Orleans, LA 70152-1098; asundame@xula.edu

The Dual Degree Engineering Program (DDEP) is a specifically designed curriculum for undergraduate students to prepare them for transferring into an engineering school. This five-year program, offered in conjunction with partner schools, allows students to take pre-engineering courses in the sciences along with Xavier's other offerings in the arts, humanities, and social sciences for three years, followed by two years of advanced engineering studies. The DDEP not only increases transfer opportunities for students, but also imparts the basic skills in science, engineering and mathematics for tomorrow's engineers. Successful support systems are put in place to combat the general engineering attrition. Surveys indicate that all stakeholder groups are positive about this program, and gains are indicated in personal dimensions and increase in the number of graduates in physics.

FB02: 7:30-8 p.m. Recovery of New Orleans Physics Post-Katrina

Invited – Abdalla Darwish, Dillard University, Department of Physics, New Orleans, LA 70122; adarwish@dillard.edu

Robert Collins, Dillard University

Ten years later, after the devastation of Hurricane Katrina, which left most of the schools from elementary to higher education in disarray, the question that our higher education is facing today is "Are we recovered yet?" Hurricane Katrina left all the state and private universities in New Orleans, and especially the three HBCU universities in the city, in a state of devastation and chaos. The student enrollment dropped in some cases, like Dillard University, to 44%. Students left their homes, educators were relocated to other states as far as Alaska, families disengaged and moved out, and even out-of-state students didn't trust the safety environment of the city to come back. Physics departments had their share of the hurricane's devastation as well. In this presentation, we will try to answer the question posed, and show both faces of Hurricane Katrina.

FB03: 8-8:30 p.m. Physics at Tulane University

Invited – Lev Kaplan, Department of Physics and Engineering Physics, Tulane, New Orleans, LA 70118; lkaplan@tulane.edu

Katrina was a transformative event for Tulane, as it was for all the institutions in the New Orleans region. Following some painful retrenchment, particularly in several of the traditional engineering fields, we emerged with a new School of Science and Engineering (SSE) for the 21st century, where science and engineering disciplines are integrated in our teaching, research, and outreach activities. SSE as a whole now attracts more first-year students than any other school at Tulane. The physics department, which dates back to the 19th century, reinvented itself as the Department of Physics and Engineering Physics, offering two major programs, in Physics and in Engineering Physics, and attracting more majors than ever before. We continue to offer our students the experience of an R1 university with a strong undergraduate focus, where students have the opportunity to engage with faculty in cutting-edge science and engineering research.

Session FC: The Best Physics on YouTube

Location: Strand 11 B
Sponsor: Committee on Physics in Undergraduate Education
Co-Sponsor: Committee on Science Education for the Public
Date: Monday, January 11
Time: 7–8:30 p.m.

Presider: *Kathleen Falconer*

FC01: 7-7:30 p.m. Best YouTube Videos in the WebSights Column

Invited – Dan MacIsaac, SUNY Buffalo State College, 1300 Elmwood Ave., Buffalo, NY 14222 ;danmacisaac@mac.com

Andre Bresges, Jeremias Weber, Florian Genz, University of Cologne

David Abbott, SUNY Buffalo State University

I will present some of the outstanding YouTube videos selected and published in the WebSights column of *The Physics Teacher* from the founding of YouTube in 2005 through to the present. Caveats on the limited learning power of YouTube videos will be shared as well as remarks on what I believe makes a great physics YouTube video. Finally, I will present efforts colleagues and I are currently undertaking to support my own students in creating their own physics YouTube videos to promote their own physics learning.

FC02: 7:30-8 p.m. Using Video Resources in the High School Classroom

Invited – Diane Riendeau, Deerfield High School, 1959 Waukegan Rd., Deerfield, IL 60015, driendeau@dist113.org

YouTube can be a powerful tool to bring real-world problems into your classroom. As the past editor of the YouTube Physics column in *The Physics Teacher,* I spent a lot of time sifting through YouTube to find great videos for the column. At first, I only used cute videos to spark student interest. Although I would not consider myself an expert, I have learned a few different strategies from my mentors and peers that I will share. These include analyzing video for labs, having students create videos, teacher created YouTube channels and distance tutoring via YouTube.

FC03: 8-8:30 p.m. Using Physics to Find Fake Videos

Invited – Rhett Allain, Southeastern Louisiana University, SLU, 10878 Hammond, LA 70402; rallain@selu.edu

Yes, there are many cat videos on YouTube and they are all probably real. But what about a bird picking up a kid and flying away? What about that crazy basketball trick you saw? Are those real? Using some basic physics principles, we can investigate different videos to determine their validity.

Session FD: International Women in Physics

Location: Bolden 6
Sponsor: Committee on International Physics Education
Co-Sponsor: Committee on Women in Physics
Date: Monday, January 11
Time: 7–8 p.m.

Presider: *Claudia Fracchiolla*

FD01: 7-7:30 p.m. Training Women in Physics at Two Georgia Women's Colleges

Invited – Marta L. Dark, Spelman College, Department of Physics, Atlanta, GA 30314-4399; mldark@spelman.edu

Amy Lovell, Agnes Scott College

This paper will discuss our experiences at two Atlanta area women's colleges: Agnes Scott and Spelman. The majority of physics majors at these two colleges are from the United States, where many students will need additional mathematics preparation before attempting calculus. Engaging such students meaningfully in physics and encouraging their interest while they gain mathematics expertise is a challenge in sequenced curriculum design. After graduation, in addition to further study in related disciplines, our physics majors pursue careers in diverse fields such as patent law, biomedical devices, education, and finance.

FD02: 7:30-8 p.m. Women Physicists in Canada

Invited – Tetyana Antimirova, Ryerson University, 350 Victoria St., Toronto, ON M5B 2K3, Canada; antimiro@ryerson.ca

Over the past four decades the representation of female physicists in Canada has been steadily growing at each educational level and in academic careers, but the progress remains slow compared to other professions previously dominated by males. Overall, the pattern of gender participation in Canadian STEM is somewhat similar to that in the U.S. The Canadian gender participation rates in physics largely reflect the number of high school graduates with physics background. The relatively low participation rate of women students in high school physics is identified as an important contributing factor for female under-representation in Canadian undergraduate STEM education. Although relatively few females obtain an undergraduate degree in physics, the attrition rates are similar for female and male students at the Masters and PhD levels. This talk will also discuss current initiatives to increase female representation in physics and provide case studies of female student success across Canada.

Session FE: Developing and Sustaining Collaborations in IPLS: The Role of Focused Conferences

Location: Empire C
Sponsor: Committee on Physics in Undergraduate Education
Date: Monday, January 11
Time: 7–8:30 p.m.

Presider: Mel Sabella

FE01: 7-7:30 p.m. Physics of Medicine Collaborations

Invited – Nancy L. Donaldson, Rockhurst University, Physics Department, Kansas City, MO 64110; nancy.donaldson@rockhurst.edu

Conferences addressing topics in physics for the health sciences broaden faculty understanding of ways to bring the study of physics to our students in a relevant, long-lasting method that enhances their study of the life sciences and their future careers in medicine and health-related professions. The Physics of Medicine Program at Rockhurst University, first implemented in 2009, was designed to serve our large population of pre-health students by deepening their understanding of the relevance of physics principles to medicine. An inaugural population of nine students has successfully grown to a current enrollment of 50 declared majors/minors in Physics of Medicine. As a small university of 1500 undergraduates, collaboration was essential to the development of our program. This talk will discuss successful collaborations that directly led to innovative ideas, new active-learning curriculum, an increased number of physics students, a NSF grant award and great enjoyment by faculty and students!

FE02: 7:30-8 p.m. Physics for the Modern World

Invited – Donald Franklin, Penfield College of Mercer University, 39 West Main St., Hampton, GA 30228; dgfrank1@aol.com

Gigi K. Nevils-Noe

This etext is designed to help prepare students for medical careers. The first chapter starts with Medical Applications of Nuclear Physics, which shows the the students that Physics is relevant. The rest of the chapters explore the use of Physics in understanding how the body functions. Using online textbooks cuts the cost of the text and allows the educator to design the course for their students. Multiple texts can be used to develop your course to cover the material that is relevant to their careers. This also allows for the educator to design the ebook to fit their syllabus.

FE03: 8-8:30 p.m. Epistemological and Methodological Balancing Acts in IPLS Collaboration

Invited – Benjamin D. Geller, Swarthmore College, 500 College Ave., Swarthmore, PA 19081; bgeller1@swarthmore.edu

In this talk I will describe the epistemological and methodological balancing acts that are inherent to IPLS collaborative work. My efforts in IPLS curricular development have been driven by interactions with members of the community who possess particular (and sometimes disparate) conceptual and epistemological commitments about the role that biological examples should play in a physics classroom. In particular, I will describe how curricular choices must resolve an apparent tension between the desire to make life science students' experiences across the sciences more coherent, and the desire to foreground ways of thinking that students may be unlikely to encounter outside of the physics classroom. Methodologically, my current work is a blend of quantitative and qualitative approaches to understanding student interest in IPLS examples, and I will describe the challenges and successes of blending these methodological approaches.

Session FF: Interactive Lecture Demonstrations – What's New? ILDs Using Clickers and Video Analysis

Location: Strand 10 B
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Educational Technologies
Date: Monday, January 11
Time: 7–8:30 p.m.

Presider: Priscilla Laws

FF01: 7-7:30 p.m. Interactive Lecture Demonstrations: Active Learning in Lecture Including Clickers and Video Analysis

Invited – David R. Sokoloff, University of Oregon 1274 University of Oregon, Eugene, OR 97403-1274; sokoloff@uoregon.edu

Ronald K. Thornton, Tufts University

The results of physics education research and the availability of computer-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).

FF02: 7:30-8 p.m. Interactive Lecture Demonstrations: Effectiveness in Teaching Concepts

Invited – Ronald K. Thornton, Tufts University, 12 Temple St., Medford, MA 02155] ronald.thornton@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 FG: High School

Location: Bolden 5
Sponsor: AAPT
Date: Monday, January 11
Time: 7–8 p.m.

Presider: Marla Glover

FG01: 7-7:10 p.m. AP Physics 1 & 2 in a Single Traditional Year

Contributed – Elizabeth Hondorf, Oak Ridge High School, 1450 Oak Ridge Turnpike, Oak Ridge, TN 37830; ebhondorf@ortn.edu

The change from Physics B to Physics 1 and 2 has provided opportunities for students to deepen their conceptual understanding of Physics and to experience more hands-on learning through lab activities. However, finding a way to offer the complete sequence of AP Physics 1, AP Physics 2, AP Physics C Mechanics and AP Physics C Electricity and Magnetism in a traditional, 8 period day provides scheduling challenges for students, teachers and administrators since this amounts to three years of Physics courses. This session will examine a solution developed at Oak Ridge High School (Tennessee) that allows students to complete both AP Physics 1 and AP Physics 2, with appropriate lab time, in a single school year, which prepares them to take both AP Physics C courses in a subsequent year.

FG02: 7:10-7:20 p.m. Educating Students in More Than Just Physics

Contributed – Michelle T. Tantillo, 801 W Kensington, Mount Prospect, IL 60056; michelle.tantil@d214.org

Social emotional learning is important and powerful for teaching all students. This session will inspire teachers to not only teach physics in their high school classrooms, but to teach students tools for their emotional well being. It only takes a few minutes each week out of physics content to help students grow in character and values and learn tools for success outside of any classroom. Resources and activities will be shared that can be added to any physics curriculum to help give extra inspiration for students of all levels.

FG03: 7:20-7:30 p.m. How to Organize STEM Festivals (Contribution of Physics Hands-ons)

Contributed – Ali L. Dal, Harmony Science Academy - El Paso, 9405 Betel Dr., El Paso, TX 79907; adal@harmonytx.org

STEM Festivals are the fun way of engaging students interests into Science, Technology, Engineering, and Mathematics. By using "magic" in physics to spark students' interest in these fields. I will be presenting some of the mysterious hands-on activities. I will go through the process of how to engage students into festivals and how to organize one in your schools.

Harmony STEM SOS (Student On Stage) Model Applications

FG04: 7:30-7:40 p.m. Using the AAPT Photo Contest Photos in Introductory Courses

Contributed – Frank D. Lock, Georgia State University, c/o 4424 Sardis Road, Gainesville, GA 30506; fasterlock@att.net

Files of the winning entries to the AAPT High School Physics Photo contest from 1998 through 2015 are available on the AAPT website (http://aapt.org/Programs/contests/photocontest.cfm). This presentation will introduce an activity using these photos in an introductory lesson in your high school or university first course in physics.

FG05: 7:40-7:50 p.m. Physics-related Contexts in Mathematics Textbooks for Mexican Secondary School

Contributed – Josip Slisko, Benemérita Universidad Autónoma de Puebla, Puebla, México; jslisko@fcfm.buap.mx

Adrián Corona Cruz, Honorina Ruiz Estrada, Benemérita Universidad Autónoma de Puebla, Puebla, México

Problem solving skills are among the most important 21st century competences. Mathematics teaching should help students identify, practice and improve those skills in real-world contexts. A school problem is "authentic" if (a) event or situation happens or could happen in the real world; (b) numerical data describing event or situation are real or, in principle, possible and (c) question asked in problem is reasonable. Otherwise, a problem is "artificially contextualized." In that case, students' real-world knowledge and common sense might lead them to conclude that mathematics problems are useless for their lives and future professional work. In this talk, a collection of alarming, artificially -- contextualized physics-related problems found in mathematics textbooks for Mexican secondary school will be presented and commented. These problems, along with others, were collected within the research project "The use of physics contexts in mathematics education: the defects and the didactic remedies," funded by the VIEP-BUAP.

FG06: 7:50-8 p.m. Individualized Instruction in Physics with STEM Students on the Stage Model (SOS)

Contributed – Levent Sakar, Harmony Public Schools, 9321 W. Sam Houston Pkwy S., Houston, TX 77099; lsakar@harmonytx.org

STEM SOS is a rigorous, interdisciplinary, standards-focused, and engaging STEM teaching approach that is teacher-facilitated, student-centered and directed through sets of project- and inquiry-based (P&IBL) projects. The Harmony PBL approach is to maintain the focus on standards-based teaching while enriching and extending the learning of students through PBL projects. The goal is to promote not only collaborative skills and student ownership of learning but also to promote student success in state and national standards. I will show samples of students' e-portfolios as final products of physics projects. There is high level technology integration and digital citizenship as 21th century skills. These e-portfolios allows online collaboration among students from different classes and teachers from different subjects.

Session FH: Lessons Learned from the Demise of the SSC

Location: Empire D
Sponsor: Committee on History and Philosophy in Physics
Date: Monday, January 11
Time: 7–8:30 p.m.

Presider: Ruth Howes

FH01: 7-7:30 p.m. SSC Death and the Renaissance of Physics Advocacy

Invited – Philip W. Hammer, American Institute of Physics, One Physics Ellipse, College Park, MD 20740; pwhammer@gmail.com

The death of the Superconducting Super Collider at the hands of Congress was the beginning of a renaissance in how the physics community advocates for taxpayer support of R&D. I will argue that despite ongoing negative repurcussions for U.S. high energy physics, there have been numerous unexpected positive outcomes for science because the physics community came to realize that as far as Congress is concerned, science is just another interest group and we have to behave like one. As a result, science funding has not suffered as badly as it might have over the last two decades, because our community has learned how to lobby Congress and argue effectively for the societal benefits of federally funded R&D.

FH02: 7:30-8 p.m. How America Losing the Higgs Launched a New Era

Invited - Mark Elsesser, American Physical Society, 529 14th St., NW, Washington, DC 20045; elsesser@aps.org

Almost 25 years ago near Waxahachie, TX, construction began on the Superconducting Super Collider (SSC) – a U.S. version of the Large Hadron Collider. Two years, $2 billion and 14 miles of tunnels later, Congress officially cancelled the project. But the end of the SSC may have marked the beginning of science lobbying in Washington, DC. While the science and political landscapes have changed, lessons learned from the SSC are still relevant today. I will present a brief history of the SSC, discuss how its cancellation influenced the American Physical Society (APS) to establish its Office of Public Affairs, and describe how the SSC's story helps inform our advocacy efforts. Additionally, I will present the early findings of a new APS initiative – A Roundtable Series on U.S. Participation in Large-Scale, International Collaborations – that aims to develop an effective script for advocating for future projects.

FH03: 8-8:30 p.m. Lessons from the SSC - A Scientist's View

Invited – Patricia L. McBride, Fermilab, Box 500, Batavia, IL 60510; mcbride@fnal.gov

The SSC project was the flagship project of the U.S. particle physics community and its cancellation had significant impact on the particle physics program in the U.S. and on a generation of physicists who planned their to do their research at the laboratory's facilities. The lessons learned from the SSC project have long been debated within the physics community. The experience served to educate the physics community of the value of outreach and advocacy and highlighted the need for international collaboration in all stages of the development of future large scientific facilities. The global particle physics community pulled together to construct the Large Hadron Collider. I will give a personal recollection on the life of a scientist at the laboratory and on the efforts to advocate for the scientific promise of the SSC project.

Session PST2: Poster Session 2

Location: Storyville Hall, 3rd floor
Sponsor: AAPT
Date: Monday, January 11
Time: 8:30–10 p.m.

Persons with odd-numbered posters will present their posters from 8:30–9:15 a.m.; even-numbered will present 9:15–10 a.m.

Astronomy

PST2A01: 8:30-9:15 p.m. American Eclipse Project (AEP)

Poster – William A. Dittrich, Portland Community College, PO Box 19000, Portland, OR 97280; tdittric@pcc.edu

A recreation of Eddington's Classic Experiment measuring gravitational deflection of light is being planned for the eclipse path across America in 2017. While Einstein published his General Theory in 1915, it was not until Aug. 21, 1917. that the first attempt to verify gravitational lensing was undertaken at an observatory in India. This first attempt was a failure, measuring the deflection of light from the bright star Regulus without an eclipse was most ambitious. 100 years later Regulus once again is near the limb of the sun and this time it occurs during the eclipse crossing America. Universities and Space Grant Consortia are partnering with Oregon State University to offer the amazing opportunity for hundreds of students to perform a recreation of one of the few most important experiments in physics and astronomy from the 20th century. This is a discussion telling the story of the American Eclipse Project.

PST2A02: 9:15-10 p.m. Bringing Large Asteroid Data Sets into the Classroom

Poster – Jordan K. Steckloff, Purdue University, 9322 E. 100 S. West, Lafayette, IN 47907-2040; jstecklo@purdue.edu

Steven Dail, Harrison High School

Rebecca Lindell, Purdue University

Elementary Mechanics is typically motivated with examples on the Earth that are familiar to students. However, such examples are subject to nonideal conditions (e.g. air drag, rolling friction, noninertial reference frames), and their use may unintentionally reinforce incorrect schema that students have on their underlying physical processes (e.g. moving objects naturally come to rest without a driving force). In this talk we present a motivation for gravitation and circular motion using the Minor Planet Center's most recent published dataset of asteroid spin periods and radii, which are obtained from asteroid light curve studies. Asteroid motion is not subject to friction, which complicates the understanding of Newton's laws on the Earth. Additionally, students are typically unfamiliar with asteroid mechanics and therefore possess fewer preconceived notions of how asteroids should behave.

PST2A03: 8:30-9:15 p.m. Cosmological Parameter Estimation from CMB Data for Undergrads*

Poster – Daniel M. Smith Jr., South Carolina State University, 300 College St., NE, Orangeburg, SC 29117-0001; dsmith@scsu.edu

Cosmology has become, over the last several years, a precise science due to Cosmic Microwave Background (CMB) data from the WMAP and Planck missions. Extracting early universe physics from that data has, however, been largely left to experts, but that need not be the case. Analyses of CMB data suitable for undergrad physics majors will be presented. For example, CMB data can be used in conjunction with theoretical curves generated by NASA's CAMB Web Interface tool to determine the curvature parameter. Also, the matter parameter can be approximated by fitting the peaks of the CMB power spectrum to theoretical approximations in previous literature.

*Supported by NSF PAARE AST-0750814

PST2A04: 9:15-10 p.m. Introductory Astronomy Laboratory Visual Back and Camera Upgrade

Poster – Mariah N. Birchard, Appalachian State University, Department of Physics and Astronomy, 231 Garwood Hall, 525 Rivers St., Boone, NC 28608; sitardj@appstate.edu

Faith K. Montgomery, Zachary R. Pruett, Kaitlyn L. Smith, David J. Sitar, Appalachian State University

A positive introductory astronomy lab experience is essential for drawing in new prospective majors and promoting an open attitude towards science for general education students. In order to provide students with a more engaging learning experience, we are in the process of upgrading the Rankin GoTo Laboratory. Two "piggybacked" refracting telescopes; an 80mm Explore Scientific apochromatic refractor with a 480mm focal length, and an 80mm Lunt achromatic refractor with a 560mm focal length, were tested on top of an 11-inch Schmidt-Cassegrain Telescope (SCT). An SBIG STF-8300C CCD camera was included in the imaging experiment. The CCD has built-in color capabilities and is 17.96x13.52mm, a significant upgrade from our current black and white cameras with a 4x5mm CCD size. The SCT was also tested with the SBIG camera. All telescopes were tested to find the most effective and user-friendly imaging setup. The SCT demonstrated best results.

PST2A05: 8:30-9:15 p.m. pyro: A Teaching Code for Computational Astrophysical Hydrodynamics

Poster – Michael Zingale, Stony Brook University, Department of Physics and Astronomy, Stony Brook, NY 11794-3800; michael.zingale@stonybrook.edu

We describe pyro: a python-based, freely-available hydrodynamics code to aid students in learning the computational hydrodynamics methods widely used in astrophysics. pyro is written with simplicity and learning in mind and intended to allow students to experiment with various methods popular in the field, including linear advection, compressible, incompressible, and low Mach number hydrodynamics, multigrid, and diffusion in a finite-volume framework.

PST2A06: 9:15-10 p.m. Publishing Pathways in the Journal of Astronomy & Earth Sciences Education

Poster – Timothy F. Slater, University of Wyoming, 1000 E. University, Laramie, WY 82071; timslaterwyo@gmail.com

Filling a needed scholarly publishing avenue for astronomy education researchers and earth science education researchers, the *Journal of Astronomy & Earth Sciences Education*– JAESE published its first volume and issue in 2014. JAESE is a scholarly, peer-reviewed scientific journal publishing original discipline-based education research and evaluation, with an emphasis of significant scientific results derived from ethical observations and systematic experimentation in science education and evaluation. International in scope, JAESE aims to publish the highest quality and timely articles from discipline-based education research that advance understanding of astronomy and earth sciences education and are likely to have a significant impact on the discipline or on policy. JAESE uses an open-access publishing model and articles appear online in GoogleScholar and in catalogs of 440,000 libraries that index online journals. Rather than paid for by library subscriptions or by society membership dues, the annual budget is covered by page-charges paid by individual authors, their institutions, grants or donors: This approach is common in scientific journals, but is relatively uncommon in education journals. http://www.JAESE.org

Labs/Apparatus

PST2B01: 8:30-9:15 p.m. A Simple Technique for Effectively Studying Near-field Diffraction*

Poster – John Noe, Stony Brook University, Department of Physics and Astronomy, Stony Brook, NY 11794-3800; johnnoe@gmail.com

As described in a separate talk at this meeting, the Laser Teaching Center at Stony Brook University is a unique educational environment in which students (mostly new to research) create and document novel hands-on optics-related projects in collaboration with a mentor. In this poster we describe one such recent project by a freshman undergraduate (Max Stanley) that could easily be adapted to more traditional laboratory instruction at minimal expense. Max investigated Fresnel diffraction by a 0.5-mm diameter circular aperture illuminated by a HeNe laser. Highly magnified patterns were projected on to a 2-meter distant viewing screen with a 10x microscope objective mounted on a translation stage. Measured lens positions for a sequence of bright- and dark-centered patterns were in excellent agreement with Fresnel theory.

*We thank Martin G. Cohen for conversations related to this project.

PST2B02: 9:15-10 p.m. Developing Experimental Skills in a First-Year Thermal Physics Course

Poster – Mary Ann H. Klassen, Swarthmore College, 500 College Ave., Swarthmore, PA 19081; mklasse1@swarthmore.edu

Peter Collings, Swarthmore College

Many of us are daunted by the prospect of developing entirely new lab curricula. At Swarthmore College, we took a first step by adapting existing experiments so they explicitly teach laboratory skills. We describe our experience with this adapted lab curriculum for our first-year thermal physics course. Experiments were modified to allow students time to design their own procedure and to promote good laboratory habits like error estimation and record-keeping.

PST2B03: 8:30-9:15 p.m. Developing NGSS Practices Through a Series of Inquiry Labs

Poster – Nathan J. Carle, Souhegan High School, 412 Boston Post Road, Amherst, NH 03031; ncarle@sprise.com

Students often struggle with the eight Next Generation Science Standards practices. This session will describe a series of lab investigations that build explicit teaching of the NGSS practices into the high school physics classroom. I will highlight several inexpensive labs and supporting materials that are used to help teach the practices while students apply their knowledge of kinematics, propose a model for electromagnetism, and draw conclusions about sound.

PST2B04: 9:15-10 p.m. Diamond Explorations: Nitrogen Vacancy Magnetometry, Thermal Conductivity & Refractive Index

Poster – Joshua Bridger, Harvard University & Dover Sherborn High School, 46 Chauncey St., Watertown, MA 02472; bridgerj@dovesher-born.org

High school physics lab curriculum seldom introduces students to material science or contemporary research. In an effort to provide such enrichment for Advanced Placement Physics students, three exploratory investigations were developed. Two are explorations of physical properties of diamonds: index of refraction and thermal conductivity. One is an exploration of Nitrogen Vacancy (NV) centers in diamonds and the construction and testing of a diamond magnetometer using Electron Spin Resonance (ESR). The three-lab sequence encourages original experimental design and exposes students to contemporary research practices, materials and equipment.

PST2B05: 8:30-9:15 p.m. Effectiveness of IOLabs in Enhancing Student Understanding of Introductory Physics

Poster – Eric C. Martell, Millikin University, 1184 W. Main St., Decatur, IL 62522; emartell@millikin.edu

IOLabs are portable wireless data acquisition systems which interface with a PC/Mac using a USB dongle from up to 100 ft away. The most recent version of the IOLab contains more than 20 sensors or inputs, including a 3D accelerometer, a 3D magnetometer, a 3D gyroscope, wheels that record position, velocity, and acceleration, a force probe, and both analog and digital inputs. We have investigated the effectiveness of using IOLabs to teach Newton's third law as well as to better connect in-class instruction with real-world physics applications. Preliminary results indicate that a 20-minute lesson with the IOLabs produces a statistically significant effect on understanding of Newton's third law. Also, there is a potential signal of IOLabs helping students, especially female students, develop expert-like perspectives on physics, as measured by the CLASS, but further investigation is necessary due to small sample sizes.

PST2B06: 9:15-10 p.m. Light Source for Optics Labs

Poster – Steven W. Daniels, Eastern Illinois University, Physics Department, Charleston, IL 61920-3099; swdaniels@eiu.edu

Light sources for optical rails or other optics experiments have a long history of use in education. These sources are often based on small wattage bulbs in metal cases with a translucent front that has a printed object on the surface. These are generally available but can be costly and have other problems. An LED version of this technology has been developed with significant advantages. We report on a cheaper, low temperature, intense, and adaptable optics light source that has been implemented into our introductory labs with success.

PST2B07: 8:30-9:15 p.m. Microcontroller-based Mechanical Chaotic Oscillator

Poster – Eric Ayars, California State University, Chico, Campus Box 202, Chico, CA 95929-0202; eayars@csuchico.edu

Brandon Thacker, California State University, Chico

We have built a microcontroller-based mechanical chaotic oscillator suitable for Advanced Lab use that allows complete control of all system parameters including drive frequency, drive amplitude, static field, rotational inertia, and damping parameter. The onboard microcontroller synthesizes the drive signal, tracks position and time, and reports at synchronized intervals suitable for generation of multiple Poincare plots over an entire drive cycle. Control and communication is managed via USB through IEEE 488.2-compatible commands, making the instrument easily usable with LabVIEW or any other serial-capable language. The instrument can be constructed inexpensively with tools and construction techniques readily available to advanced undergraduates in physics.

PST2B08: 9:15-10 p.m. Photogates, Piezos, and Arduinos

Poster – Marc 'Zeke' Kossover, Exploratorium, 1378 Gilman Ave., San Francisco, CA 94124; zeke_kossover@yahoo.com

An Arduino's precision clock allows its use for inexpensive motion timing. See how to build an inexpensive photogate using mostly off the shelf components, a drop timer that can measure g to better than a percent, and a marble launcher that easily lets you measure time of flight.

PST2B09: 8:30-9:15 p.m. Physics of Stringed Instruments: Experimenting in the Classroom

Poster – Katarzyna Pomian, Loyola University, Chicago, 1536 Courtland Dr., Arlington Height, IL 60004; kpomian@luc.edu

We analyzed 12 different stringed instruments using a variety of complimentary experimental methods. We gathered string spectral analysis of sound waves when strings were plucked at different locations. We studied the instruments' body resonances at different frequencies using Chladni patterns which allowed us to visually view the standing waves within the instruments' bodies. Finally, we took high-speed videos of the strings. We captured string vibrations and analyzed them to find the effective decay constants. Correlations between the string resonances, body resonance data, and high-speed video data were made. We used a variety of different approaches and conducted a cross examination of all the different string instruments to determine the dependence of the timbre of stringed instruments on their body shape. The experimental methods we used could be adapted into the laboratory and the results can be used to study waves in the classroom at all levels in a practical way.

PST2B10: 9:15-10 p.m. Providing Research Experience in the Advance Student Lab

Poster – Nina Abramzon, Cal Poly Pomona / Physics and Astronomy department, 3801 W Temple Ave., Pomona, CA 91768-4031; nabramzon@cpp.edu

Peter B. Siegel, Cal Poly Pomona / Physics and Astronomy department

We report on our experiences in implementing experiments using state-of-the-art spectroscopy research equipment into the advance laboratory course. Students were exposed to a laboratory experience that very closely resembles real-life research by performing the following activities: determining the activity of a salt substitute purchased in a local store, measuring the radioactive isotopes in an environmental sample, and measuring spectra of helium and hydrogen sources using an optical emission spectrometer and comparing the helium wavelengths to those of hydrogen to identify the transitions. The experimental design elements will be presented in detail together with assessment of student learning and student attitudes.

PST2B11: 8:30-9:15 p.m. Using Slinkies to Explore More Wave Properties

Poster – Taha Mzoughi, Kennesaw State University, 1000 Chastain Rd, #1202, Kennesaw, GA 30144-5591; tmzoughi@kennesaw.edu

By combining Slinkies, wave properties like transmission, reflection, and speed can be investigated. The poster will provide information about the setup, example data and information about how to use video analysis to collect such data.

PST2B12: 9:15-10 p.m. Systematic Errors in Intro Lab Video Analysis

Poster – John W. Zwart, Dordt College, 498 4th Ave NE, Sioux Center, IA 51250; john.zwart@dordt.edu

Kayt Frisch, Tim Martin, Dordt College

In video analysis lab experiments, students frequently find large discrepancies between results based on self-filmed videos and expected values (e.g. for g determined by a fit to projectile motion data). These differences are frequently far larger than the uncertainty calculated from their fit. Using an inexpensive point-and-shoot camera with a 4x optical zoom to record video, we investigated two possible causes of this error: the effect of placing the reference meterstick at a different object-to-camera distance and the effect of the motion of interest being in a plane not perpendicular to the camera lens. When we observed these phenomena for wide angle, normal, and telephoto focal length settings we found systematic errors as large as 40%. Based on our findings, we make recommendations for minimizing these errors.

Upper Division and Graduate

PST2C01: 8:30-9:15 p.m. Characterizing Problem Types and Problem Solving Strategies in PhD-level Research

Poster – Benjamin M. Zwickl, Rochester Institute of Technology, 84 Lomb Memorial Drive, Rochester, NY 14623-5603; benjamin.m.zwickl@rit.edu

Jarrett Vosburg, SUNY Geneseo

Javier Olivera, Anne Leak, Rochester Institute of Technology

Problem solving is frequently cited as a skill needed in the 21st century STEM workforce, but there is limited research on types of problems encountered in the workplace and how these problems are overcome. Through a series of interviews with 10 graduate students from the physical sciences and engineering, we cataloged types of problems encountered in graduate-level research and typical approaches used to solve these problems. Using a grounded theory approach, these interviews were coded by three to five people, developing taxonomy of problems and problem solving methods. Problems ranged from routine tasks, like programming and using lab equipment, to higher-level challenges, like establishing the direction of a research project, collaborating with others, and determining when a product is "good enough." Finally, we will report on graduate students' comparative reflections between problem solving in undergraduate coursework and in PhD-level research.

PST2C02: 9:15-10 p.m. Designing an Intermediate Course in Scientific Computing

Poster – Mark E. Rupright, Birmingham-Southern College, 900 Arkadelphia Road, Birmingham, AL 35254-0001; mruprigh@bsc.edu

I am designing a new intermediate-level undergraduate course in scientific computing for physics, mathematics, engineering, and chemistry majors, to be taught in AY2016-17. It is designed to fit into the gap between introductory "how to use Matlab" and advanced numerical analysis courses, and will provide necessary tools for using computing in advanced science and mathematics courses, as well as advanced undergraduate research. I am soliciting ideas and feedback on the course design before its first run.

PST2C03: 8:30-9:15 p.m. Exploring Mastery Learning in Upper-Division Physics Courses

Poster – Daryl Macomb, Boise State University, Department of Physics, Boise, ID 83725-0399; dmacomb@boisestate.edu

Mastery learning, as practiced since the 1960s, is usually characterized by demanding that students reach a satisfactory level of knowledge in pre-requisite topics before moving on to more advanced material. Material is divided into small units that utilize formative assessments to monitor student progress and guide corrective instruction. This cycle allows students to reach a mastery level on the unit (high score on an assessment), enabling progression to further material. This approach is appealing in many ways including; allowing students to progress at a more individualized rate, ensuring adequate understanding of pre-requisite material, providing coherent units of material, and placing the student at the center of the process. Here we describe the use of modified versions of mastery learning in several upper-division physics courses including quantum and classical mechanics. We describe past uses of mastery, the course structures applied, and changes in student attitudes vs. a normal class structure.

PST2C04: 9:15-10 p.m. Fostering Computational Integration by Developing Local Community Support Agents*

Poster – Norman J. Chonacky, Yale University - Department of Applied Physics, P.O. Box 208284, BectonCenter, New Haven, CT 06520-8284; norman.chonacky@yale.edu

The recent use of computers as one of now three approaches (experiment, theory, and computation) for addressing physical analyses and problem solving has surfaced over most areas of science and engineering practice during the past several decades. The corresponding use of computation is not yet so prevalent in preparing physics undergraduates. There is clear evidence that educational practice in this regard is finally changing, mostly it seems by the "heroic" efforts of individuals with the necessary time and resources. This talk will describe an effort to develop supportive resources to extend computational reform by a process analogous to that of Physics Teaching Resource Agents (PTRA's) of the past generation for HS physics instructional reform. It is an effort to lower the barriers to beginning computational integration and to raise the standard of what otherwise individual instructors would be able to achieve alone.

*Supported in part by NSF under IUSE-1505278.

PST2C05: 8:30-9:15 p.m. Wind Tunnel Ballistics

Poster – Joel C. Berlinghieri, The Citadel, Physics Department, Grimsley Hall, Charleston, SC 29409; berlinghieri@citadel.edu

Joseph Littlejohn, Joseph McCall, The Citadel

In the 17th century pistols, muskets, and cannons fired a spherical projectile. Such projectiles had limited target precision. In the 19th century the Minié Ball (essentially a sphere attached to a cylinder with hollow skirt) was introduced which along with rifling of the gun barrel improved target precision. Most projectiles today retain the basic design of the Minié. Four projectile designs were studied and compared: spherical, slug (Minié), double-cone, and teardrop. For similar Reynolds number and projectile speeds of 1,000 m/s to 1,500 m/s scaled models (x20) of these designs were measured in a wind tunnel with air flow speeds of 50 to 75 m/s. Transverse and longitudinal forces, with particular emphasis on random fluctuations, were recorded as a function of air speed.

Technologies

PST2D01: 8:30-9:15 p.m. 3D-Printed Physics Tactile Objects as Aids for Students with Disabilities

Poster – Steven C. Sahyun, University of Wisconsin - Whitewater, 800 W. Main St., Whitewater, WI 53190-1319; sahyuns@uww.edu

Christopher Marshall, Rebecca Holzer, University of Wisconsin - Whitewater

Science is highly pictographic as the use of diagrams is fundamental to understanding of the world around us. The strong reliance on pictures may place a student who is unable to see or interpret the displayed diagram or simulation at a conceptual disadvantage. The increasing availability of 3D-printers to create objects out of polylactic acid (PLA) thermoplastics provides a novel, low-cost and easy method for fabrication and distribution of tactile manipulative objects in order to aid teaching of STEM related courses. This poster will present the initial development and techniques for creating several 3D-printable objects for learning physics to aid students with visual disabilities. We describe some initial methods of design with considerations toward tactile learning, consistent fabrication, and methods of distribution of objects that may be used at remote locations to aid teaching students with visual impairments where tactile learning aids would be of use.

PST2D02: 9:15-10 p.m. A New App for Physics Simulations

Poster – Sonia Tye, CK-12 Foundation 3610 Jetty Point Carlsbad, CA 92010 sonia.tye@ck12.org

Byron J. Philhou,r San Francisco University High School

Neeru Khosla, CK-12 Foundation

In collaboration with physics teachers, animators, and software developers, the nonprofit cK-12 Foundation has generated dozens of new free-to-use tablet and laptop-ready HTML5-based interactive physics simulations. Recently, we have released an app for mobile tablets that allows easy access to the simulations (which can, through the app, be accessed offline). Our goal for each simulation is to build a bridge between compelling real-world situations and the more abstract and mathematical physics descriptions. These sims are appropriate for middle school, high school, and introductory college level physics. Topical coverage is broad, from motion and mechanics to electricity & magnetism, sound and light, and modern physics. Our physics sims are based in engaging, real-world examples, big questions, a playful interactive sandbox, graphs of data, and diverse modes of instructional feedback. This poster presentation is one part of our efforts to engage in a discussion with the physics education community about how best this work can be used to facilitate both classroom-based and independent instruction, foster interest in science, challenge misconceptions, and support best practices in online learning.

PST2D03: 8:30-9:15 p.m. Computation in the Undergraduate Physics Curriculum*

Poster – Marie Lopez del Puerto, University of St. Thomas, 2115 Summit Ave., Saint Paul, MN 55105; mlpuerto@stthomas.edu

Gerry Ruch, Jeff Jalkio, Marty Johnston, Paul Ohmann, University of St. Thomas

The University of St. Thomas Physics Department is engaged in an ambitious, collaborative project to effectively embed computation throughout the curriculum. Computational physics is introduced in the sophomore-level Applications of Modern Physics course through laboratory exercises and homework problems. Advanced skills and techniques are explored in a Computational Physics course (currently under development – to be offered Spring 2016). Computational exercises and projects in Theoretical Mechanics, Electricity and Magnetism, Optics, and Quantum Mechanics ensure students have continued exposure to computation, which is essential for solidifying students' skills and enhancing their confidence in using them.

*This work is supported in part by NSF grant DUE-1140034. Additional author: Adam Green, University of St. Thomas

PST2D04: 9:15-10 p.m. Evaluation of SMASH*: Modern Physics App

Poster – Tugba Yuksel, Department of Curriculum and Instruction, Purdue University, 525 Northwestern Ave., West Lafayette, IN 47907; tyuksel@purdue.edu

Rebecca Lindell, Purdue University

The SMASH*: Modern Physics app debuted for the fall 2015 semester, where it was used in Purdue's flipped modern physics course for engineers. Each week students answered a series of multiple-choice research-based conceptual questions specifically designed to help students improve their understanding of the basic concepts in the course. These questions were delivered through the students' handheld device. Evaluation of this app and its questions utilized both qualitative and quantitative methods. Students were asked to voluntarily participate in qualitative focus groups. Conducting a psychometric analysis on the different questions and performing a primary trait analysis yielded quantitative evidence on the effectiveness of the app. Finally, students completed an end of the semester evaluation questionnaire designed to probe students' opinions about the app. The combination the individual results from all these different evaluations, yielded an overall evaluation of the SMASH*: Modern Physics app.

*Scientific Multiple-choice Assessments for Student Handhelds.

PST2D05: 8:30-9:15 p.m. Instructional Designs Using Learning Glass Tchnology for Online Physics Courses

Poster – Matt Anderson, San Diego State University, 5500 Campanile Dr., San Diego, CA 92120; matt@sciences.sdsu.edu

Shawn Firouzian, San Diego State University

The Learning Glass is an effective technology for undergraduate physics education as we will discuss in our contributed talk. The instructor writes on a glass screen with LED illuminated edges. A camera on the opposite side of the glass records the video and horizontally flips the image. In this poster, we share four different instructional designs we created adapting Learning Glass technology for online undergraduate physics courses. The lectures were either streamed live via rich media platforms such as Mediasite or prerecorded on YouTube high definition channels. Students' engagements and peer instructions were prompted and facilitated via web conferencing tools such as Blackboard Collaborate for live students or Facebook page and virtual discussion boards for asynchronous participants. Students' responses to our post-class surveys of summer 2015 showed that majority preferred live online lectures with a discussion of clicker questions every 10 to 15 minutes.

PST2D06: 9:15-10 p.m. Integrating Computation into Existing Physics Courses*

Poster – Marie Lopez del Puerto, University of St. Thomas, 2115 Summit Ave., Saint Paul, MN 55105; mlpuerto@stthomas.edu

Larry P. Engelhardt, Francis Marion University

Kelly R. Roos, Bradley University

Norman Chonacky

Marcos D. Caballero, Michigan State University

Robert Hilborn, AAPT

You know your students need computational physics skills, but how can you fit one more thing into the curriculum? By integrating computation into existing courses! Attend a summer faculty-development workshop conducted by the Partnership for Integration of Computation into Undergraduate Physics (PICUP) and receive direct, and continuing, support for the planning, design, and implementation of a computational component in your physics courses. PICUP is a national-scale community of physics faculty who are dedicated to aiding and supporting one another in this important computational education effort. This poster describes one of PICUP's current projects.

*This work is supported by the National Science Foundation under DUE IUSE grants 1524128, 1524493, 1524963, 1525062, and 1525525.

PST2D07: 8:30-9:15 PM Making iPad Videos to Learn Physics*

Poster – Andrew J. Roberts, SUNY Buffalo State College, 1300 Elmwood Ave., Buffalo, NY 14222; ajroberts17@gmail.com

Dan MacIsaac, David Abbott, Bradley Gearhart, Kathleen Falconer, SUNY Buffalo State College

We describe the iPad video physics project at SUNY Buffalo State College, in which we used a class set of iPads to support student learning of introductory-level physics content both in traditional undergraduate courses and graduate-level courses for physics teacher preparation. The iPads were used both for traditional digital video capture and model fitting via Vernier Video Physics, and for the production of student physics content multimedia presentations via iMovie and iMotion, akin to abbreviated YouTube videos. We report student feedback, some pre- and post- standardized student conceptual learning scores (BEMA, TUG-K and FCME) for the courses, instructor comments and lessons learned.

*This work was supported by the NSF, SUNY IITG and the University of Cologne as well as SUNY Buffalo State Physics.

PST2D08: 9:15-10 p.m. MIX-ing It Up: A New Microsoft Power Point Plugin Enriches High School Physics Instruction

Poster – John C. Weisenfeld, Pasco High School, 1108 N 10TH Ave., Pasco, WA 99301; weisenfeldj@spu.edu

Jim Federico, Microsoft

During the 2014-2015 school year, a preview (i.e. beta) technology from Microsoft called Office Mix was utilized in the author's high school physics classroom. Mix is basically a plugin for PowerPoint which increases the interactivity of the presentation. In particular, the PowerPoint author can record their own voice, video and pen-based annotations on each slide, and upload the Mix (i.e. a Mix-enabled PowerPoint presentation) to a server where it can be accessed by students during class. Mix also allows the inclusion of video clips, the creation of polls or multiple choice or true/false questions on slides. Physics teachers will be especially interested to know that Phet simulations can be embedded in PowerPoint slides with no loss of interactivity or fidelity. Finally, metrics captured per student user when they "log in" to view the Mix that allow the teacher to get real-time and semi-real-time assessment of student engagement and understanding are discussed.

The web site for Office Mix is mix.office.com.

PST2D09: 8:30-9:15 p.m. Physics Bites! – Lenses

Poster – John Di Bartolo, NYU Polytechnic School of Engineering, 6 Metrotech Center, Brooklyn, NY 11201[john.dibartolo@nyu.edu

The purpose of the iOS app Physics Bites! is to give the user a chance to better understand certain concepts in physics by playing with tiny simulations (or "Bites"). "Lenses" is the first Physics Bites! module, with the following five simulations: Lensmaker: The user adjusts the two radii of curvature and index of refraction, and the resulting lens and its focal length are shown. One Lens: The user controls the object distance and lens focal length, and the image size and location is shown. Two Lenses: The user controls the object distance, lens focal lengths, an inter-lens distance, and the image size and location is shown. Mirror: The user controls the object distance and mirror radius of curvature, and the image size and location is shown. Interface: The user controls the object distance, interface radius of curvature, and indices of refraction, the image size and location is shown.

PST2D10: 9:15-10 p.m. SMASH*: Modern Physics - Developing Questions

Poster – Brian May, Department of Physics and Astronomy, Purdue University, 525 Northwestern Ave., West Lafayette, IN 47907; bwmay@purdue.edu

Peter Thompson, Brandon Walker, Michael Yannell, Tugba Yuksel, Purdue University

SMASH (Scientific Multiple-choice Assessments for Student Handhelds): Modern Physics is an app designed to deliver research-based multiple-choice questions to a student's handheld. Each question strives to test areas of conceptual difficulty in modern physics as revealed by physics education research and 40+ years of instructional experience. During the summer of 2015, a team of undergraduates who had successfully completed the course, a PER graduate student specializing in college student understanding of quantum mechanics, a PER research faculty, and the professor of the course met regularly to develop ~500 suitable questions. Each question went through a multi-stage analysis to determine their appropriateness for inclusion in the app. An overview of the design process and preliminary results from the use of SMASH: Modern Physics will be presented. A web-based version of the app can be viewed at http://cychosz.com/SMASHphysics/modern/. Downloadable Android and iPhone based versions of the app are nearing completion.

*Scientific Multiple-choice Assessments for Student Handhelds

PST2D11: 8:30-9:15 p.m. Teaching Computational Modeling: The Basics

Poster – Ruth W. Chabay, North Carolina State University, 515 E. Coronado Road, Santa Fe, NM 87505; rwchabay@ncsu.edu

Bruce A. Sherwood, North Carolina State University

Most students in introductory physics courses have never written a computer program. This is true for many instructors as well. As interest in incorporating computational modeling into physics instruction increases, many novices, both students and instructors, are encountering computational ideas for the first time. There's a lot to learn. What should be omitted, what should be included, and how should it be taught? We'll describe one functional model, based on nearly two decades of experience in integrating computation into introductory physics.

Teacher Training/Enhancement

PST2E01: 8:30-9:15 p.m. APEX Professional Development for Alabama Physics Teachers

Poster – James A. Minstrell, Facet Innovations, 1314 NE 43rd St, Suite 207, Seattle, WA 98105; jimminstrell@facetinnovations.com

Mohan Aggarwal, Alabama A&M, Huntsville

APEX is an NSF-funded MSP for professional development of high school physics teachers in the state of Alabama. The five-year grant has four major components of professional development. The first and major focus is to provide opportunities for teachers to upgrade their understanding of most of the content in introductory physics. Secondly, teachers have an opportunity to learn more about the instructional implications of research on students' misconceptions and development of conceptual understanding of physics. Third is a focus on use of technology in the teaching of physics, and finally teachers have a requirement to conduct action research on learning and teaching in their own classrooms. There are three cohorts of teachers involved, totaling over 70 teachers. Each cohort is to participate in three two-week summer sessions, during three consecutive summers. Each cohort also participates in three two-day follow-up sessions during the year.

PST2E02: 9:15-10 p.m. ATE Workshop for Physics Faculty

Poster – Thomas L. O'Kuma, Lee College, P. O. 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 final year and has finished its 24th workshop/conference. In this poster, we will display information about the project and information about these workshops/conferences. Information concerning development of laboratory activities will also be displayed.

PST2E03: 8:30-9:15 p.m. Graphing Motion as a Concept Boundary in Pre-service Educators

Poster – David A. Osmond, University of North Georgia, 3820 Mundy Mill Road, Oakwood, GA 30566; david.osmond@ung.edu

Transitioning fluently between watching a movement happen and understanding how a graph of that motion can be created is an early boundary concept in physics. This project is an exploration of best practices in introducing motion-graphing, goals mastered, and the common misconceptions that are encountered in non-science majors. Two classes were trained in how to use Tracker video analysis and modeling software and subsequently shown five graphs depicting position and time. The students were tasked with video recording a team member moving in order to creating a graph of that motion. Assessment involved a written description of motion and a graph being drawn to represent that motion. Analysis of open-ended concept-based questions was used to support development of best practices for the introduction of graphing motion.

PST2E04: 9:15-10 p.m. IMPACT- Caused Changes in a Rural-Surrounded High-Needs Urban School District*

Poster – Gordon J. Aubrecht, Ohio State University, Marion 193 N. Washington St., Delaware, OH 43015-1609; aubrecht.1@osu.edu

Bill Schmitt, Science Center of Inquiry

Jennifer L. Esswein, Jessica G. Creamer, Education Specialist

IMPACT began over five years ago and changes have occurred in the school district's middle and high schools. This poster presents some of our results.

*This work supported in part by grants from the Ohio Department of Education C1457-OSCI-09-49 (2008-2009), C1667-MSP-10-410 (2009-2010), EDU01-0000006141 (2010-2011), EDU01-0000007902 (2011-2012), GRT00029161 (2012-2013), ODE-MSP-10673 (2013-2014), EDU01-0000013704 (2014-15), and ?? (2015-16).

PST2E05: 8:30-9:15 p.m. Using Interactive Video Technology to Support Modeling Middle School Teachers

Poster – Jeffrey T. Hengesbach, MCESA, 4041 N Central Ave., Phoenix, AZ 85012; jthengesbach@yahoo.com

Bradly A Bostick, MCESA

Maricopa County Educational Services Agency (MCESA) partnered with the American Modeling Teacher's Association (AMTA) to create a comprehensive modeling centered middle school science curriculum that meets NGSS standards. Twenty-six teachers from 10 rural school districts engaged in a three-week summer middle school modeling workshop training program in 2014, and although their experience and science backgrounds varied greatly, their students demonstrated increased enthusiasm and success through its implementation. Interactive Video Lab (IVL) technology was used to support the teachers by engaging them in research-based professional development, and providing for them timely access to pedagogical content experts for support, and by engaging them as members of a professional learning community. This paper will focus on the use of IVL technology to support rural teacher development while implementing the middle school modeling curriculum.

Pre-college/Informal and Outreach

PST2F01: 8:30-9:15 p.m. QuantumCraft – Assessing Middle School Student Understanding

Poster – Natasha Collova, Siena College, 515 Loudon Road, School of Science, Loudonville, NY 12211; ne24coll1@siena.edu

Michele McColgan, Siena College

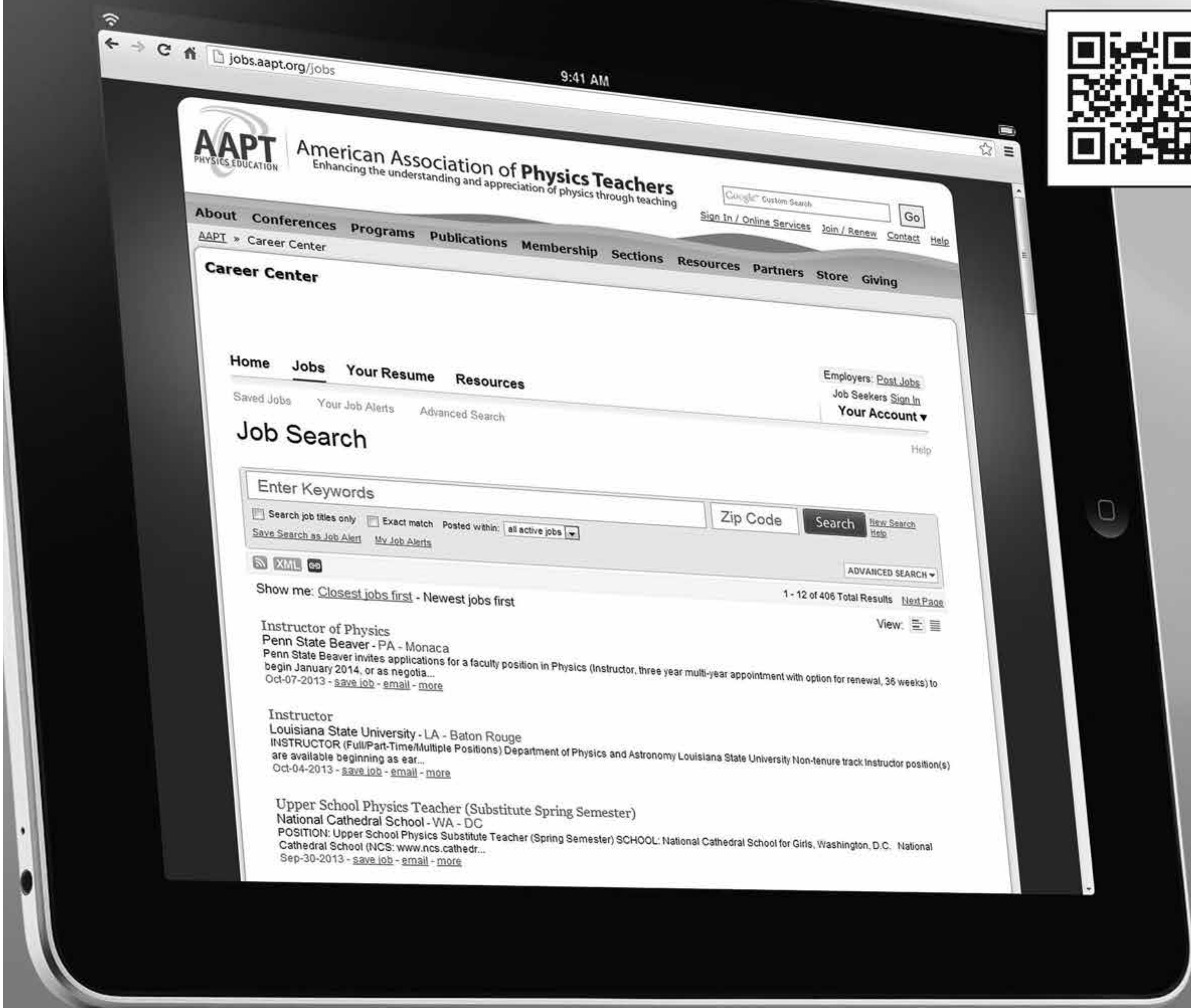
A quantum mechanics world and mod was developed in Minecraft by a group of people from Google, MinecraftEDU, E-line media, and CalTech. We added some crafting challenges to the world and asked middle school students to go through the world together in small groups with a leading mentor. We developed a short questionnaire on the concepts we believed the students would learn as they completed the challenges. The different challenges will be described and the survey and the results will be presented.

PST2F02: 9:15-10 p.m. Saturday Morning Astrophysics at Purdue: A New Astronomy Outreach Program

Poster – Matthew P. Wiesner, Purdue University, 3877 Chenango Place West, Lafayette, IN 47906; matthewwiesner@aol.com

David C. Sederberg Purdue University

In January 2015 we created a new outreach program at Purdue University modeled on the highly successful Saturday Morning Physics program at Fermilab. Saturday Morning Astrophysics at Purdue (SMAP) is targeted to local students in grades 6-12. It is offered on campus one Saturday a month for one hour. Each session is divided into an introduction and a hands-on activity. During the introduction, students are taught the basics of a concept in astrophysics. During the second half of the session, students complete an activity to demonstrate how astrophysics research is done, completing tasks such as classifying stars by their spectra, building telescopes, launching model rockets and more. In this poster, we describe the sessions we have taught, students' experiences in the program and our future goals for astronomy outreach at Purdue.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Tuesday, January 12 Highlights

High School Resource Lounge
10 a.m.–3 p.m.
Imperial 11

PERTG Town Hall
7:30–8:30 a.m.
Strand 11 B

SEES (Students to Experience Science and Engineering)
9 a.m.–12 p.m.
Empire B

AAPT Awards: Oersted Medal presented to John W. Belcher; DSCs; AIP Science Writing Awards; Presidential transfer
10:30 a.m.–12 p.m.
Celestin A-C

AAPT Symposium on Physics Education and Public Policy
2–3:30 p.m.
Celestin A-C

Session GA: Educational Applications of 3D Printers

Location: Bolden 1
Sponsor: Committee on Educational Technologies
Co-Sponsor: Committee on Apparatus
Date: Tuesday, January 12
Time: 8:30–9:50 a.m.

Presider: *Jeff Groff*

GA01: 8:30-9 a.m. Educational Applications from the Fab Lab

Invited – Kendra Sibbernsen, Metropolitan Community College, P.O. Box 3777, Omaha, NE 68103; ksibb@cox.net

Metropolitan Community College (MCC) in Omaha hosts a Fab Lab, or Fabrication Laboratory, a program originally developed at the Center for Bits and Atoms at MIT. The MCC Fab Lab equipment available includes several 3D printers, a 3D laser scanner, a laser cutter/engraver, vinyl cutter, soldering station, and computer lab. Examples of how the Fab Lab has been used in the physics department at MCC are printing models for classroom demonstrations, making custom prototypes for specialized research equipment, and having students design undergraduate research projects. Suggestions on how 3D printing can be used in science education, in collaboration with business, and with the general public will also be presented.

GA02: 9-9:30 a.m. The Suitability of 3D Printed Parts for Laboratory Use

Invited – Andrew Zwicker, Princeton Plasma Physics Laboratory, P.O. Box 191, Princeton, NJ 08543; azwicker@pppl.gov

Josh Bloom, Robert Albertson, Sophia Gershman, PPPL

3D printing has become popular for a variety of users, from home hobbyists to scientists and engineers interested in producing their own laboratory equipment. In order to determine the suitability of 3D printed parts for our plasma physics laboratory, we measured the accuracy, strength, vacuum compatibility, and electrical properties of pieces printed in plastic. The flexibility of rapidly creating custom parts has led to the 3D printer becoming an invaluable resource in our laboratory. The 3D printer is also suitable for producing equipment for advanced undergraduate laboratories.

Talk presented by Arturo Dominguez, Princeton University

GA03: 9:30-9:40 a.m. 3D Printing in the S-Lab: Concepts, Prototypes and Models that Facilitate Training in non-English Speaking Countries

Contributed – Stephen Mecca, Providence College, Department of Engineering-Physics-Systems, Providence, RI 02908; smecca@providence.edu

Claire Kleinschmidt, Providence College

The S-Lab has been operating in its current state for over a decade in the Department of Engineering-Physics-Systems at Providence College creating and managing meaningful research experiences for many students in both the sciences and other academic disciplines. When successful, the projects can impact schools, communities, and families in the developing world. One of the many tools of the lab is its Leap Frog 3D printer, a dual extrusion multi-plastic system that prints both full scale parts for use in prototyping designed components and production molds. A recent use of the 3D system has allowed us to cross the language barrier to train indigenous women masons as GSAP Microflush toilet MAKERs in Bolivia. The toilet is one of the innovations of the S-Lab that has now been introduced to 15 countries around the world.

GA04: 9:40-9:50 a.m. 3D Printing Opto-Mechanics

Contributed – David J. Starling, Penn State Hazleton, 76 University Drive, Hazleton, PA 18202-1291; djs75@psu.edu

Mari Magabo, Joseph Ranalli, Kenneth Dudeck, Penn State Hazleton

Optics labs require a host of specialized equipment to perform basic measurements. Much of this equipment has precision requirements at the micron scale. However, some devices require only moderate precision and are able to be constructed via 3D printing. To that end, we report on the results of the construction of a computer-controlled opto-mechanical rotation mount for use in quantum optics polarization measurements. The worm, worm gear, and enclosure are 3D printed and the rotation is done via stepper motors controlled by an Arduino microcontroller. This project is ideal for undergraduate science or engineering students and is fundamentally multidisciplinary, incorporating 3D CAD drawing, design, electronics and programming.

Session GB: K-16 Physics Education Collaboratives

Location: Strand 11 A
Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on Physics in High Schools
Date: Tuesday, January 12
Time: 8:30–10:30 a.m.

Presider: Claudia Fracchiolla

In this session we will discuss the role of informal science into the formal science environment, i.e. from outreach to the classroom and vice versa. We will also discuss about different types of resources available and how teachers can connect and collaborate with already set outreach programs.

GB01: 8:30-9 a.m. Bringing LIGO Outreach into the Formal Education Setting

Invited – Amber L. Stuver, LIGO Livingston Observatory, 1003 E Tom Stokes Ct., Baton Rouge, LA 70810; stuver@ligo-la.caltech.edu

The LIGO Science Education Center (SEC) in Livingston, Louisiana and the larger, nationwide LIGO Scientific Collaboration have been active in developing outreach to bring the basic science concepts underlying the complex field of gravitational waves to the public. Besides our extensive experience with student field trips and school visits, the LIGO SEC makes targeted efforts to train K-12 teachers through presenting professional development on how to make inexpensive versions of the museum-grade exhibits housed at the center in order to bring that science into their classrooms. Further, our outreach also reaches into the undergraduate curriculum by presenting to students, having those students participate in outreach delivery, and training STEM and education majors from Southern University, a HBCU, to serve as docents in the SEC. This talk will summarize the migration of public outreach into formal education setting at all levels.

GB02: 9-9:30 a.m. Informal and Formal STEM – How Do They Influence Each Other?

Invited – Michele McColgan, 515 Loudon Road, Siena College, Loudonville, NY 12211[mmccolgan@siena.edu

Teaching physics as part of an informal STEM program for middle school students from a high needs district has influenced my formal college physics teaching and vice versa. To maintain enrollment in this voluntary program requires a high level of engagement while making physics topics relevant and conceptually understandable. Working in informal STEM challenges you as an instructor to try to capture the engagement and enthusiasm and learning that happens in these informal settings. The other challenge is to bridge the gap between the rich type of experiences in informal STEM programs versus the very specific activities that we believe we need in a formal classroom setting, even in the best interactive engagement environment. Can we use the lessons learned in the informal environment to make these activities more engaging? Examples of MinecraftEDU physics lessons from both the informal classes and the general physics college classroom will be presented along with assessments we've used for both.

GB03: 9:30-10 a.m. Reaching the Next Generation of STEM Majors: Outreach Efforts

Invited – Jackie Spears, Kansas State University, 364 Bluemont Hall, Manhattan, KS 66506; jdspears@k-state.edu

NSF's inclusion of 'broader impacts' as a separate and discrete proposal review criterion in 1997 coupled with increasing needs in the STEM workforce have focused greater attention on STEM outreach to K-12 audiences. Outreach efforts vary in terms of the audience served and whether instruction is provided in or out of classroom settings. This presentation will describe illustrative outreach efforts made by STEM faculty at Kansas State University: (1) directly to K-12 students, (2) indirectly to K-12 students through K-12 teachers, and (3) indirectly to K-12 students and prents/adults. Based on evaluation data collected, the impact of these outreach activities as well as lessons learned will be described. Unexpected impacts and the redesign of outreach activities as a result of those impacts will also be presented. Finally, the extent to which institutional policy can play a role in encouraging and better focusing outreach to K-12 audiences will be discussed.

GB04: 10-10:10 a.m. A Study of Undergraduate Engineering Students Problem Solving Abilities

Contributed – Bayram Akarsu, Ericiyes University/the Ohio State University, 6643 Brixton Park Ave., Suite 208, Columbus, OH 43235; bakarsu@erciyes.edu.tr

Josip Slisko

Critical thinking and problem solving abilities are recognized as fundamental and crucial abilities in teaching science concept. The current study aims to explore undergraduate engineering students' critical thinking and problem solving skills. In addition, their problem solving and puzzle-based learning abilities were examined. Data were collected from 139 freshman students enrolled in different engineering department including Mechatronic, Civil, Electrical and Electronics, Biomedical, Industrial, Computer and Metallurgical and Materials engineering during spring semester of 2013. In terms of gender, a majority of them (N= 94) were male and % 33 (N=46) were female. In conclusion, findings revealed that most of the students lack of employing critical thinking and problem solving skills and are not prepared for puzzle-based learning science activities.

GB05: 10:10-10:20 a.m. K-16 Science at Edgewood: A Three School Collaboration

Contributed – Amy K. Schiebel, Edgewood College, 1000 Edgewood College Dr., Madison, WI 53711; aschiebel@edgewood.edu

Rachael A. Lancor; Edgewood College

In 1999, the Sonderegger Science Center was constructed on the Edgewood Campus. It was the first kindergarten through college science facility in the nation. The grade school, high school and college that inhabit the Edgewood Campus all share the Science Center and teach all, or most, of their science classes within its walls. The charge to the faculty is to work together to maximize the expertise and resources of each institution to create a comprehensive and coordinated science experience for all students. In the 16 years since the building's dedication, programs involving formal classroom science, informal science, science outreach, and faculty and student professional development have been developed and tested. In this talk, the general program will be discussed with an emphasis on the role of physics instruction and learning in creating a comprehensive science education program.

GB06: 10:20-10:30 a.m. Self-organized Physics Teacher Communities

Contributed – M Colleen Megowan- Romanowicz, American Modeling Teachers Association, 5808 13th Ave., Sacramento, CA 95820; amtaexec@modelinginstruction.org

Teaching is often solitary work. Where can a physics teacher go to connect with others who do what they do—to share thoughts and ideas, get help with persistent problems, pick up fresh ideas, learn to use the latest technology, stay up-to-date on available resources and opportunities? Teachers participate in local, regional, and national teacher communities for a variety of reasons, and sometimes, when there's nothing that quite answers their need, they invent a community of their own. In this presentation I will describe how three teachers' communities self-organized—one national, one regional, and one local. I will offer some data that may provide clues as to what motivates teachers to invest their energy and resources in such a community, the ways in which they want to engage with their respective communities, and what it takes to keep such communities healthy and vital.

Session GC: Physics on the Road

Location: Strand 10 B
Sponsor: Committee on Science Education for the Public
Date: Tuesday, January 12
Time: 8:30–10:20 a.m.

Presider: Steve Shropshire

GC01: 8:30-9 a.m. Physics and Performance: Demos for the Road!

Invited – Stanley J. Micklavzina, University of Oregon, Eugene, OR 97403-1274; stanm@uoregon.edu

Performance ideas and demos for the road will be discussed and displayed that are the result from shows developed for The International Year of Light and also participating in the Science Show International Cup held in Estonia late September 2015. The rules of the competition were challenging: Work in a team of two and present in two different presentation styles, Theatrical and Coordination. The Theatrical Show is a 30-minute presentation done which includes descriptions of the science being shown. The Coordination Show is a 15-minute performance where the presenters do not talk to the audience or each other while displaying science principles through a coordinated effort that can include projected slides, music, and flashing lights. Physics and Performance.... Game On! The results of the competition are not known at the writing time of the abstract, but the excitement of the challenge is at its peak!

GC02: 9-9:30 a.m. The Physics Factory at 10: Arizona, New York, Florida, Beyond!

Invited – Bruce Bayly, University of Arizona, Mathematics Department, 617 N Santa Rita Ave., Tucson, AZ 85721-0089; brucebayly@gmail.com*

Erik Herman, XRAISE, Cornell University

Kip Perkins The Physics Factory

Christopher DiScenza, University of Florida, Ocean Engineering Department

John Pattison, University of Arizona, Physics Department

The Physics Factory began as a bus-based mobile demo lab in Tucson, AZ. In 2005 we incorporated with 501c3 nonprofit status. Partnerships with the University of Arizona and local schools fostered growth, and the mobile operation expanded (national tours 2006, 2008, 2010, 2014). We added a Community Science Workshop for youngsters (2009), and the Arizona Math Road Show (2011). In 2014 the Ithaca Physics Bus started in collaboration with XRAISE at Cornell University, and the mobile program traveled to the USASEF, the Polish Academy of Kids in Gdansk (Poland) and the Beijing Science Festival (China). 2015 saw the creation of the Gainesville Physics Bus in Florida and the Alpine Science Club for children in the rural White Mountains region of Arizona. Our first decade combined purposeful growth with openness to unexpected opportunities. We don't know what will happen in our next decade, but we're looking forward to an exciting time!

*Sponsor: Steven Shropshire www.physicsfactory.org www.facebook.com/IthacaPhysicsFactory www.facebook.com/physicsbusgnv

GC03: 9:30-10 a.m. Physics on Broadway!

Invited – David P. Maiullo, Department of Physics and Astronomy/Rutgers University, 136 Frelinghuysen Road, Piscataway, NJ 08854-8019; maiullo@physics.rutgers.edu

During the summer of 2015, I was approached by a Broadway producer to develop and star in an off-Broadway production based on my frequent and popular physics demonstration shows. The show would be set in an 80-seat theater right next to Times Square on 46th Street in NYC. It was set for previews from Nov. 4 till Nov. 18, 2015, then with official shows to start on Nov. 19 and run through the 2015 holiday season. If successful, it will move into an even larger Broadway theater in the March/April time period, again with me starring. This talk will discuss the details of taking a standard physics demonstration show and (hopefully) detail the success of transferring it to Broadway!

GC04: 10-10:10 a.m. Texas A&M Physics Festival: Unique Learning Opportunity for Community and Students

Contributed – Tatiana L. Erukhimova, Texas A&M University, Department of Physics & Astronomy, 4242 TAMU, College Station, TX 77843-4242; etanya@tamu.edu

Texas A and M Physics Festival started in 2003 with a dozen of hands-on exhibits and inaugural lecture by Stephen Hawking. Over years it evolved into one of the largest STEM outreach events in the area. The Festival attracts over 4000 visitors annually from all over Texas and other states. It features over 100 interactive exhibits displayed by faculty and students, public lectures by world-renowned scientists and astronauts, professional bubble shows, and many other activities. I will report on the structure of the Festival as well as strategies for involving undergraduate and graduate students and faculty in public outreach. I will further discuss our innovative Discover, Explore and Enjoy Physics and Engineering (DEEP) program aimed at enhancing the learning and research experiences of students through their participation in outreach activities.

GC05: 10:10-10:20 a.m. Storytelling Makes Everything Better

Contributed – Marc Kossover, Exploratorium, 1378 Gilman Ave., San Francisco, CA 94124; zeke_kossover@yahoo.com

Humans learn by stories. Getting your audience involved with the right story can make your less flashy demonstrations the stars of the show and can dramatically improve the learning from the flashiest stunts. Crafting the right story, though, can be challenging. The right story doesn't dumb the science down, after all the audience came to physics show. Rather, the story should have them feel like they are a part of the science being done.

Session GD: Introductory Courses

Location: Bolden 2
Sponsor: AAPT
Date: Tuesday, January 12
Time: 8:30–10:10 a.m.

Presider: Stephen Spicklemire

GD01: 8:30-8:40 a.m. Get Real! – Appropriate Values for Introductory Electrostatics Problems

Contributed – Robert A. Morse, St. Albans School, retired, 5530 Nevada Ave. Washington, DC 20015-1784; ramorse@rcn.com

Novice physics students must work problems using unfamiliar quantities with unfamiliar magnitudes and unfamiliar units. Good practice should be to use physically reasonable values with magnitudes within students experience, when possible. Textbook mechanics problems usually meet this criterion, but in a sampling of about 20 introductory texts, this was not usually true in simple electrostatics problems, possibly because problem posers have little experience with reasonable charge values in an introductory laboratory. Electrostatic charge sensors [1] now available let students measure actual charge values in simple electrostatic experiments, so problem writers can in many cases use values consistent with observable charge magnitudes.

1. Robert A. Morse,"Electrostatics with Computer-Interfaced Charge Sensors," *Phys. Teach.* **44**, 498 (2006)

GD02: 8:40-8:50 a.m. Electric Field Line Diagrams Can Work (Better)

Contributed – James C. Martin, University of Alabama at Birmingham, 1014 Shades Crest Road, Birmingham, AL 35226-1906; jcmartin@uab.edu

Lauren E. Rast, David L. Shealy, Anca Lungu, Takahisa Tokumoto, University of Alabama at Birmingham

For 20 years electric field line diagrams (EFLDs) have been known to contain issues with 3D -> 2D projection and other distortions.[1] Yet internet apps still produce EFLDs with prominent artifacts. EFLDs displayed in introductory physics texts seem to come from the art department, rather than from calculations. Technical issues and changing pedagogical approaches to E&M have led some to question the utility of EFLDs in introductory courses.[2] We will discuss: 1. improved computational approaches yielding 2D EFLDs which are physically valid and useful for teaching; and 2. related pedagogical issues (improving students' initial understanding of field abstractions and strategies for selecting physical examples). We will describe an ISLE-inspired observational Gauss's Law experiment emphasizing multiple student-initiated explanations based on 2D EFLDs.

1. Wolf, Van Hook, and Weeks, *Am. J. Phys.* **64**, 714 (1996).
2. Chabay and Sherwood, *Am. J. Phys.* **74**, 329 (2006).

GD03: 8:50-9 a.m. Surface Charge in Electrostatics and Circuits

Contributed – Bruce A. Sherwood, North Carolina State University, 515 E. Coronado Road, Santa Fe, NM 87505; bruce_sherwood@ncsu.edu

Ruth W. Chabay, North Carolina State University

In electrostatics and in circuits, charge buildups on the surfaces of conductors contribute to the electric field inside and outside of the conductors. A relaxation method based on field [1] was used to compute the surface charge distributions in 3D for a number of interesting configurations. These distributions and the associated fields can be explored interactively with a GlowScript VPython program at tinyurl.com/SurfaceCharge. The talk will highlight some of the interesting features of these charge distributions. In the calculus-based intro E&M course this interactive program can help students to acquire a deeper sense of mechanism of circuit behavior, and to unify the explanations of electrostatic and circuit phenomena.

1. Preyer, Norris W., "Surface charges and fields of simple circuits,: *Am. J. Phys.* **68**(11), 1002-1006 (2000)..

GD04: 9-9:10 a.m. Harmonics from Overdriven Guitar Amplifier Tubes

Contributed – David Keeports, Mills College, 5000 MacArthur Blvd., Oakland, CA 94613; dave@mills.edu

Most electric guitar players who desire an overdriven or distorted sound prefer tube amplifiers to transistor amplifiers. The superior sound of tubes is usually attributed to the fact that when overdriven, tubes produce strong second harmonics while transistors produce strong third harmonics. In turn, second harmonics add pleasant complexity to sound while third harmonics can produce dissonance. But do tubes and transistors really produce the harmonics they are commonly said to produce? To answer this question, I will present the results of tests I performed upon a variety of tube amplifiers and tube amplifier simulators. For each test, I input a sine wave and increased amplifier gain while observing output with a frequency analyzer. The answer to my question is, "more yes than no, and with an interesting twist."

GD05: 9:10-9:20 a.m. Investigating Instructor Credibility in a Studio-Style Physics Class

Contributed – Jonathan David Housley Gaffney, Eastern Kentucky University, 521 Lancaster Ave., NSB 3140, Richmond, KY 40475; jon.gaffney@eku.edu

Amy L. Housley, Gaffney University of Kentucky

Instructor credibility refers to students' perceptions of the competence, trustworthiness, and caring of instructors. Difficult to gain but easy to lose, credibility is often closely correlated with overall course satisfaction. In this short talk, we present the curious case of an instructor who received unusually low credibility and satisfaction scores. We highlight potential explanations for those scores based on students' reported expectations and experiences in the course. By connecting students' perceptions to their expectations and experiences, we underscore the possible impact of course structure, student expectations, and instructor behavior on overall student satisfaction.

GD06: 9:20-9:30 a.m. Impact on Student Performance of an Introductory Physics Course at the PI

Contributed – Hagop Aynedjian, The Petroleum Institute, P.O. Box 2533, Abu Dhabi, UAE Abu Dhabi, n/a n/a United Arab Emirates, haynedjian@pi.ac.ae

As part of a drive by the physics department at The Petroleum Institute in Abu Dhabi to address the developmental needs of our students, a zero level introductory physics course [PHYS060] was introduced in 2013. The introductory course follows the studio physics approach previously adopted by the department. This paper will highlight preliminary results on student performance within the course itself and the impact it has had on student performances in the level one physics course [Phys 191]. As a more detailed review is under way the current paper will only focus on results from a summative assessment, learning environment surveys, and student interviews. The paper will include a discussion on the areas in need of improvement and future redevelopment efforts.

GD07: 9:30-9:40 a.m. Game Show Review Sessions

Contributed – David C. Dixon, Saddleback College, 28000 Marguerite Parkway, San Clemente, CA 92672; stark.effect@gmail.com

A style of review session for an introductory physics class in the form of a game of Jeopardy! will be presented. Students work together in teams to solve simple physics problems, which they pick from a game board for a given point value. A sample question set will be provided.

GD08: 9:40-9:50 a.m. Physics and Psychology: Integrating Disciplines Through Video Analysis

Contributed – Chamaree de Silva, Mercer University, 1400 Coleman Ave., Macon, GA 31207-0003; desilva_C@mercer.edu

Program in Integrative Science and Mathematics (PRISM) is a pilot project at Mercer University. It is designed to guide a selected cohort of our at-risk, non-calculus ready, incoming student population. Traditionally, this group of students has had a lower freshmen retention rate compared to that of our calculus-ready students. In this program, students study Physics, Psychology, Biology, Statistics, and Precalculus in an integrated manner with four faculty members over the first two semesters. Students learn how these subjects are not stand-alone disciplines, but are intertwined with one another giving these at-risk students an early introduction to what science is, as a whole. All PRISM students conduct and present authentic research on how the velocity and acceleration of predators (humans) affect the Flight Initiation Distance (FID) of squirrels. Here we integrate kinematics with psychology of small mammal behavior and statistics. Students record scenarios of their peers approaching squirrels on-campus and in the wild using a high-speed, high-resolution camera. Video analysis is performed using Logger Pro to determine the FID, velocity, and acceleration of humans and squirrels. Students gather conclusions based on this evidence and perform group presentations at the end of fall, and poster presentations at the end of the school year.

GD09: **9:50-10 a.m.** **Diffusion, Drug Elimination, Radioactive Decay and Osmosis for Introductory Courses**

Contributed – Peter Hugo Nelson, Benedictine University, 6601 Fernwood Drive, Lisle, IL 60532; pete@circle4.com

Teaching materials have been developed for introductory physics for the life sciences. They are written as self-contained self-study guides. The first chapter introduces students to using Excel using an authentic computational model of diffusion that introduces students to equilibrium as a dynamic stochastic process in the context of the oxygen cascade. Students discover that Fick's law is a consequence of Brownian motion in an active learning exercise using a kinetic Monte Carlo simulation of their own construction. Subsequent chapters introduce students to: algorithms and computational thinking; exponential decay in drug elimination and radioactive decay; half-life and semi-log plots; finite difference methods (and calculus); the principles of scientific modeling; model validation and residual analysis; and osmosis. Analysis of published clinical data and Nobel Prize winning research is featured. Because the materials are self-contained they can be used in a flipped-classroom approach. The chapters are available for free at http://circle4.com/biophysics/chapters/

GD10: **10-10:10 a.m.** **Tracking a System's Evolving Energy Distribution with a Ternary Diagram**

Contributed – Bob Brazzle, Jefferson College, 2019 Brutus Ct., Fenton, MO 63026; rbrazzle@jeffco.edu

Anne Tapp, Saginaw Valley State University

Ternary diagrams can be used to display a system's evolving energy distribution, provided the system has exactly three categories of energy. This type of graph is well-suited to systems involving transfers and transformations among Gravitational, Kinetic and Thermal energy (e.g. roller coaster) or Electric, Magnetic, and Thermal (e.g. LRC circuit). The advantages of using a ternary diagram in these contexts are: 1) an entire energy transformation scenario can be represented in a single graph, 2) on the same graph, changes can be tracked across very small time-steps, and 3) relative rates of energy changes can be directly seen. Though few students have ever encountered ternary diagrams, they are able to easily learn how to use and interpret them. The presenter will briefly introduce the ternary diagram, describe how he has used them in his introductory (calculus-based) physics course, and discuss initial assessments of the resulting student understanding of energy concepts.

Session GE: PER: Examining Content Understanding and Reasoning

Location: Strand 11 B
Sponsor: AAPT
Date: Tuesday, January 12
Time: 8:30–10:20 a.m.

Presider: Bethany Wilcox

GE01: **8:30-8:40 a.m.** **Investigating Student Ability to Construct Qualitative Reasoning Chains***

Contributed – MacKenzie R. Stetzer, University of Maine, 5709 Bennett Hall, Room 120, Orono, ME 04469-5709; mackenzie.stetzer@maine.edu

J. Caleb Speirs, University of Maine

Beth A. Lindsey, Penn State Greater Allegheny

Mila Kryjevskaia, North Dakota State University

As part of a larger, multi-institutional effort to investigate and assess the development of student reasoning abilities in the context of scaffolded physics instruction, we have been examining student ability to construct qualitative, inferential reasoning chains in introductory calculus-based physics. We are currently developing, testing, and refining several new research tasks and methodologies aimed at providing insight into the lines of reasoning students generate when responding to conceptual questions. In this talk, we will highlight some of these new tasks and present preliminary results from our ongoing investigation.

*This work has been supported by the National Science Foundation under Grant Nos. DUE-1431940, DUE-1431541, and DUE-1431857.

GE02: **8:40-8:50 a.m.** **How Students Use Prior Knowledge While Constructing Understanding**

Contributed – AJ Richards, The College of New Jersey, 2000 Pennington Road, Ewing, NJ 08628; aj.richards@tcnj.edu

Darrick C. Jones, Eugenia Etkina, Rutgers University

We recorded pre-service physics teachers learning about the physics of solar cells. Using a knowledge-in-pieces theoretical framework, we analyze their interactions in order to make inferences about the elements of prior knowledge they call upon as they build understanding of how these devices function. Of special interest are the instances when a student makes a significant conceptual breakthrough. We find that students who combine different aspects of their prior knowledge in specific ways may be more likely to make breakthroughs. We will discuss what instructors can do to prime learners to combine knowledge in productive ways so they are better able to achieve these breakthroughs.

GE03: **8:50-9 a.m.** **Investigating the Complex Nature of Student Thinking***

Contributed – Cody Gette, North Dakota State University, NDSU Dept. 2755, P.O Box 6050, rm 318A, Fargo, ND 58103; cody.gette@ndsu.edu

Mila Kryjevskaia, North Dakota State University

MacKenzie R Stetzer, University of Maine

Andrew Boudreaux, Western Washington University

Paula Heron, University of Washington

As part of an ongoing investigation of the development of student reasoning abilities in physics, we have been examining inconsistencies in student reasoning in introductory physics courses. Research has shown that even when students demonstrate that they possess the formal knowledge and skills necessary to answer specific types of questions correctly, some of these students abandon formal reasoning in favor of more intuitive approaches on analogous tasks. For this reason, we have been identifying and developing sequences of questions that allow for the disentanglement of various factors that affect student thinking (e.g., conceptual understanding, reasoning abilities, and contextual cues). Preliminary results from one such sequence will be presented and interpreted using the dual-process theory of reasoning and decision-making.

*This work has been supported by the National Science Foundation under Grant Nos. DUE-1431857, 1431940, 1432052, and 1432765.

GE04: **9-9:10 a.m.** **Investigating the Impact of Epistemology on Student Reasoning Approaches***

Contributed – Mila Kryjevskaia, North Dakota State University, Department of Physics, Fargo, ND 58108-6050 mila.kryjevskaia@ndsu.edu

MacKenzie R. Stetzer, University of Maine

Paula R.L. Hero,n University of Washington

Erika G. Offerdahl, Robert D. Gordon, North Dakota State University

In a previous study, we found that many students experienced significant difficulties with a basic task in which they were asked to express a distance in terms of wavelength. At the same time, most students were capable of measuring a distance in terms of nonstandard units (e.g., a pencil) in a more "everyday context." Various factors were considered in attempt to account for this failure to transfer relevant skills between the two tasks. For example, we considered the roles of representation, context, mathematical emphasis of instruction on interference, and others. In the current study, we designed a sequence of questions to probe the impact of epistemology on student judgment about the type of reasoning required to complete this task. Multiple data streams (including written responses, interviews, and eye-tracking data) were used to gain insight into student thinking.

*This work has been supported by the National Science Foundation under Grant Nos. DUE-1431857, 1431940, and 1432765

GE05: 9:10-9:20 a.m. Student Reasoning in Math Methods: Series Approximations*

Contributed – Michael E. Loverude, California State University, Fullerton, Department of Physics, MH611, Fullerton, CA 92834; mloverude@fullerton.edu

Upper division physics courses combine challenging physics content with increased mathematical complexity. Many physics departments offer a course in mathematical methods to help prepare students for upper-division theory courses in electricity and magnetism, classical mechanics, and modern physics. As part of an NSF-supported research and curriculum development project, we have studied student reasoning in math methods using written free-response problems and individual student interviews. In this talk we present data on student reasoning with series approximations collected in the context of a meth methods course. Examples of procedural errors and conceptual difficulties will be provided, along with a reflection on implications for researchers and instructors

*Supported in part by NSF grant #1406035

GE06: 9:20-9:30 a.m. Student Understanding of Non-Cartesian Coordinate Systems in Upper-Division Physics*

Contributed – Marlene Vega, California State University Fullerton, Department of Physics, MH 611, Fullerton, CA 92834; vegamarlene18@gmail.com

Michael Loverude, Gina Passante, California State University Fullerton

Warren Christensen, North Dakota State University

Understanding of Electricity & Magnetism in the upper-division requires a considerable amount of integration of calculus concepts with abstract physics concepts. The ability to incorporate the use of vectors in several different coordinate systems is an essential skill in an E&M course. This study aims to understand how students think about coordinate systems and vectors in non-Cartesian coordinate systems (plane polar and spherical). Data was collected in a math methods course for physics majors over several semesters, using free response written questions posed on ungraded quizzes and graded course assessments given after instruction. Student responses were coded and assigned to categories. As an example, many students answering incorrectly appear to be overgeneralizing from Cartesian coordinate systems in ways that are not productive.

*Supported in part by NSF grants DRL #1156974 and NSF DUE #1406035

GE07: 9:30-9:40 a.m. Student Thinking Regarding Coordinate Systems in the Upper Division

Contributed – Brian D. Farlow, North Dakota State University, NDSU, Department 2755, P.O. Box 6050, Fargo, ND 58108; brian.farlow@ndsu.edu

Marlene Vega, Mike Loverude, California State University Fullerton

Warren Christensen, North Dakota State University

As part of a broader study on the content of and student thinking within mathematics in the undergraduate physics curriculum, we report on student thinking about coordinate systems in the upper division. Early evidence suggests that upper-division physics students struggle to solve problems and answer conceptual questions requiring the use of Cartesian and non-Cartesian coordinate systems. Specifically, students have difficulty identifying the direction of unit vectors and constructing symbolic expressions for position and velocity in the plane polar coordinates. Additionally, students struggle to recognize appropriate units associated with these quantities. We report findings from one-on-one interviews that used a think aloud protocol designed to shed light on student thinking within this domain. We investigate the potential connection between student reasoning regarding Cartesian and non-Cartesian coordinates with emphasis on polar and spherical coordinate systems, and students' ability to answer conceptual questions and solve problems requiring the use of those coordinate systems.

GE08: 9:40-9:50 a.m. Using Eye Tracking Technology to Investigate 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

N. Sanjay Rebello, Purdue University

Elizabeth Gire, Oregon State University

This study investigates how introductory students and graduate students view and interpret motion graphs. Participants viewed several graphs of position, velocity, or acceleration versus time on a computer screen while their eye movements were recorded using a stationary eye tracker. Participants were asked to select which region of the graph best matched a description of motion and provide a verbal explanation for their choice. We compare performance on the questions with the audio-recorded explanations and eye movements.

GE09: 9:50-10 a.m. Using Physics by Inquiry in Physics Courses for Underprepared Students*

Contributed – Donna L. Messina, University of Washington, Department of Physics, Seattle, WA 98195-1560; messina@phys.washington.edu

Peter S. Shaffer, Lillian C. McDermott, University of Washington

Physics by Inquiry (PbI) is a research-based and research-validated curriculum designed by the Physics Education Group at the University of Washington.[1] Development and testing has taken place both in courses for K-12 teachers and in courses for students who are under-prepared for STEM-related careers. The guided-inquiry instructional approach has proved effective at helping both populations develop a firm conceptual understanding of basic physics topics, while also enhancing their reasoning and problem solving skills and their understanding of the scientific process. This talk will provide insight and data that support the use of PbI in providing an opportunity for under-prepared students to develop in-depth understanding, proficiency in the targeted skills, and recognition of the usefulness of the PbI experience in their future study of STEM topics.

1. Physics by Inquiry, L.C. McDermott and the Physics Education Group at the University of Washington, Wiley (1996). *Supported in part by the National Science Foundation.

GE10: 10-10:10 a.m. Distinguishing Reasoning Difficulties from Conceptual Difficulties in Energy Contexts*

Contributed – Beth A. Lindsey, Penn State Greater Allegheny, 4000 University Drive, Mc Keesport, PA 15131-7644; bal23@psu.edu

Andrew Boudreaux, Western Washington University

We are engaged in a multi-year, multi-institution collaborative research project to examine student ability to construct inferential reasoning chains in solving qualitative physics problems. In this talk, we will describe research involving simple situations in the context of energy, for instance, a student lifting a book near the surface of the Earth. We analyze the reasoning sequence that students must go through to complete these questions correctly, and identify the points at which students are most likely to fail to move through the chain appropriately. Data from student responses to written questions and individual or small-group interviews will be presented.

*This work was supported in part by the National Science Foundation under Grant Nos. DUE-1431541 and DUE-1432052.

GE11: 10:10-10:20 a.m. Investigating the Impact of Metacognitive Interventions on Student Reasoning*

Contributed – Nathaniel Grosz, Department of Physics, NDSU, Fargo, ND 58102-6050; Nathaniel.C.Grosz@ndsu.edu

Mila Kryjevskaia, Department of Physics, NDSU

MacKenzie Stetzer, University of Maine

Andrew Boudreaux, Western Washington University

This study was motivated by research findings that suggest that, on certain topics, student conceptual and reasoning difficulties persist even after instruction expressly designed to address such difficulties. We have been developing a suite of different metacognitive interventions for use in introductory calculus-based physics courses. Interventions intended to promote (individual) student metacognition were administered in a web-based format outside of class. Interventions supporting socially mediated metacognition were implemented as part of laboratory instruction. The metacognitive interventions were multi-layered in order to address specific types of student responses. The impacts of these interventions were assessed on a course exam. In this presentation, preliminary results will be presented and implications for instruction will be discussed.

*This work has been supported by the National Science Foundation under Grant Nos. DUE-DUE-1245999, 1245313, and 1245993.

Session GF: Big Science Data in the Classroom

Location: Bolden 5
Sponsor: Committee on Educational Technologies
Co-Sponsor: Committee on Space Science and Astronomy
Date: Tuesday, January 12
Time: 8:30–10:30 a.m.

Presider: Duncan Carlsmith

GF01: 8:30-8:55 a.m. Big Ideas and Big Science in the Classroom

Invited – Lynn R. Cominsky, Sonoma State University, 1801 East Cotati Ave., Rohnert Park, CA 94928; lynnc@universe.sonoma.edu

SSU's education and public outreach programs have integrated big science and big data in a variety of innovative ways that bring NGSS-aligned scientific practices to physics classrooms. Through NASA's Fermi Gamma-ray Space Telescope education program, we train students to use a robotic ground-based telescope that acquires visible light data that can be correlated with Fermi's space-based observations. We have also developed a two-semester course that uses real scientific data for advanced high school or general education college students entitled "Big Ideas in Cosmology." Fermi data are used by citizen scientists to discover new gamma-ray pulsars through the Einstein@Home project, developed by scientists at the Max Planck Institute for Gravitational Physics in Hannover, Germany. In this talk, I will provide examples of scientific discoveries made by students and citizen scientists and will demonstrate how big science and big data can be used to improve teaching and learning in your classroom.

GF02: 8:55-9:20 a.m. Big Accelerator Means Big Data

Invited – Don Lincoln, Fermilab, MS 205 Batavia, IL 60510; lincoln@fnal.gov

The Large Hadron Collider is the world's largest scientific facility and enables scientists to collide particles together with center of mass energies last common in the universe a mere tenth of a trillionth of a second after the Big Bang. Since it began operation in 2008, scientists using the facility have published over a thousand scientific papers, most notably including the discovery of the Higgs boson. In this talk, I will talk the magnitude of the accelerator and the detectors involved in this prodigious enterprise. I will also describe the size of the data sets involved, from the individual channel counts in the detectors to the amount of data recorded. I will describe methods for people to analyze this data on their own, including LHC@Home and CERN Open Data. This talk dovetails with Ken Cecire's talk in which he focuses on programs for bringing this data to classrooms.

GF03: 9:20-9:45 a.m. Big Data on Student Desktops*

Invited – Kenneth Cecire, University of Notre Dame, Department of Physics, 225 Nieuwland Science Hall, Notre Dame, IN 46556; kcecire@nd.edu

The Large Hadron Collider (LHC) at CERN produces billions of proton collision events every second, each sending tens or hundreds of particles into a giant detector like the Complact Muon Solenoid (CMS). A small portion of this data - still multiple orders of magnitude more than most students normally see in their classes or labs —is found in the CMS masterclass and the CMS e-Lab. We will see how students characterize large numbers of events and analyze them statistically to make scientific assertions about the most fundamental particles.

*This work is sponsored under the QuarkNet program by the National Science Foundation and the Department of Energy Office of Science.

GF04: 9:45–10:10 a.m. NASA EDUCATION: Inspiring the Future Generation of Explorers

Invited – Roosevelt John, NASA Education Deputy Assoc. Administrator

NASA and its Office of Education is using a variety of Citizen Science-oriented strategies to engage and inform educators, learners and educational institutions about the Agency's missions. From Mars Challenges about payload design ideas to SpaceApps Challenges where teams of students across the globe collaborate and engage with publicly available data to design innovative solutions for global challenges, NASA provides excellent opportunities for public participation in countless fields. Learn about NASA's latest Citizen Science activities and how the Agency is incorporating them into its STEM education activities to inspire the future generation of explorers.

GF05: 10:10-10:20 a.m. Motivating Elementary Mechanics with Large Asteroid Data Sets

Contributed – Jordan K. Steckloff, Purdue University, 525 Northwestern Ave., West Lafayette, IN 47907-2040; jstecklo@purdue.edu

Steven Dail, Harrison High School

Rebecca Lindell, Purdue University

Elementary Mechanics is typically motivated with examples on the Earth that are familiar to students. However, such examples are subject to non-ideal conditions (e.g. air drag, rolling friction, non-inertial reference frames), and their use may unintentionally reinforce incorrect schema that students have on their underlying physical processes (e.g. moving objects naturally come to rest without a driving force). In this talk we present a motivation for gravitation and circular motion using the Minor Planet Center's most recent published data set of asteroid spin periods and radii, which are obtained from asteroid light curve studies. Asteroid motion is not subject to friction, which complicates the understanding of Newton's laws on the Earth. Additionally, students are typically unfamiliar with asteroid mechanics and therefore possess fewer preconceived notions of how asteroids should behave.

GF06: 10:20-10:30 a.m. Incorporating Large Asteroid Data Sets into IB Physics

Contributed – Steve Dail, Harrison High School ,29995 W. 12 Mile Road, Farmington Hills, MI 48334; steve.dail@farmington.k12.mi.us

Jordan K. Steckloff, Purdue University

Rebecca Lindell, Purdue University

Modern astronomy has produced large data sets of small planetary body behavior, which exhibit gravitational and circular motion under ideal (i.e. frictionless) conditions. Modern high school students enrolled in Advanced Placement (AP) or International Baccalaureate (IB) Physics courses are already familiar with the software and skills needed to manipulate these data sets. Here we present an inquiry-based classroom activity in which students use Microsoft Excel to manipulate the Minor Planet Center's most recent light curve-based asteroid data set. The students use Excel to plot different variables within the data set against one another, and look for obvious trends (size vs. spin rate). This pair of variables shows that asteroid spin rates pile up at a period of ~2.2 hours, but seldom spin faster. The students then determine that this spin barrier is the result of a critical spin rate above which gravity fails to hold the asteroid together.

Session GG: Enhancing Diversity in Astronomy

Location: Bolden 6
Sponsor: Committee on Space Science and Astronomy
Date: Tuesday, January 12
Time: 8:30–10 a.m.

Presider: Richard Gelderman

GG01: 8:30-9 a.m. Building Bridges to Diversity: The Fisk-Vanderbilt Masters-to-PhD Program

Invited – Kelly Holley-Bockelmann, Vanderbilt University, Department of Physics and Astronomy, Nashville, TN 37240-0001; k.holley@vanderbilt.edu

Arnold Burger, Fisk University

Keivan Stassun, Dina Stroud, Vanderbilt University

We describe the Fisk-Vanderbilt Masters-to-PhD Bridge program as a successful model to increase the participation of underrepresented minorities in the physical sciences. Since 2004 the program has admitted 98 students, 80 of them underrepresented minorities (52% female), with a retention rate to STEM PhD programs of 82% (compared to the national average of 50%). We summarize the main features of the Bridge program, including our methods to recognize and select for unrealized potential during the admissions process, and how we cultivate that unrealized potential toward development of successful scientists and leaders. We specifically discuss our mentoring and student tracking strategies, and note that a large number of our materials available online as part of the Bridge Program Architects Toolkit: http://www.vanderbilt.edu/gradschool/bridge/tools.htm.

GG02: 9-9:30 a.m. Using New Research Lens to Address Diversity Issues in Astronomy

Invited – Stephanie Slater, Center for Physics & Astronomy Educ/Res, 604 South 26th St., Laramie, WY 82070; stephanie@caperteam.com

While the majority of STEM fields have met or are near gender parity, the fields of astronomy and physics have stubbornly resisted improvement related to gender diversity, despite impressive levels of financial and human resource investment. This reality provides warrant to question if we truly understand the problem's relevant underlying issues and variables, and whether we are applying resources in ways that meaningfully address our fields' sociological problems. This paper presents results from two longitudinal studies of women in astronomy, within the context of NSFs longstanding REU program. Results from 15 years of interpretive, grounded theory research suggest that the program did not influence retention, or provide a substantive educational experience; instead participants began the REU with pre-existing, remarkably strong conceptions related to science and to the "self," which the REU did not alter. Data additionally suggests that participants' stable scientific identities were shaped by pre-college, familiar, long-term mentoring relationships.

GG03: 9-30-9:40 a.m. A Feminist Physics Education: Minoritized Students' (Dis)Connections with Physics

Contributed – Diane C. Jammula, Rutgers University, Newark 101 Warren St., Newark, NJ 07102-1897; diane.jammula@rutgers.edu

While interactive physics curricula have doubled students' learning gains, gender and race gaps persist. A modified version of the Modeling curriculum was taught in an algebra-based interactive physics course at an urban public college to see how minoritized students (dis)connect with physics in an interactive classroom. A "feminist physics" conceptual framework was developed by indentifying dichotomies in conventional physics education (e.g. rational/emotional, theoretical/practical, and elite/accessible). The denigrated terms were then included in the modified Modeling curriculum. Participants were 7 female and 16 male students of different race and ethnic backgrounds, and I was the course instructor. Field notes, students' journals, and classroom artifacts were analyzed using open coding to see how students (dis)connect with physics. Results show some students affiliated with perceptions of physics as personal, in the everyday, accessible, and collaborative, suggesting that broadening notions of physics may allow a wider range of students to connect with the discipline.

Session GH: Introductory Labs/ Apparatus

Location: Bolden 4
Sponsor: AAPT
Date: Tuesday, January 12
Time: 8:30–10:10 a.m.

Presider: Jeremiah Williams

GH01: 8:30-8:40 a.m. The Electrophorus

Contributed – John M. Welch, Cabrillo College, 6500 Soquel Drive, Aptos, CA 95003; jowelch@cabrillo.edu

The Electrophorus is a simple device invented in the late 1700's to produce electrostatic charge via induction. It's a great activity for teaching about induction and polarization, a good source of charge for electrostatics demos and labs, and is very easy to make. Construction and use will be discussed and demonstrated.

GH02: 8:40-8:50 a.m. Beyond Hook's Law in Scale Bungee Jumping with Rubber Bands

Contributed – Michael R. Gallis, Penn State Schuylkill, 200 University Dr., Schuylkill Haven, PA 17972; mrg3@psu.edu

Scaled bungee jumping activities are popular at many levels, often implemented as "Barbie Bungee Jumping" using dolls or action figures and elastic cord made from rubber bands. The departure from Hooke's law in the elastic behavior of the cord can be significant in these activities, and can be a worthwhile part of a discussion of Hooke's law and its limitations. In this presentation, the measurement of features such as non-linearity, hysteresis, and plastic deformation measured as part of a pre-drop activity will be discussed. An Easy Java-Script Simulation of a bungee jumper has been developed which incorporates a student measured model of the hysteresis envelope and a phenomenological model of the effects of hysteresis during the dynamics of the drop. This simulation will be presented. Finally, some techniques that facilitate the extraction of data from video analysis programs like Tracker will be discussed.

GH03: 8:50-9 a.m. Using Sensors Sensibly in the Introductory Lab

Contributed – Joseph F. Kozminski, Lewis University, Department of Physics, One University Pkwy., Romeoville, IL 60446; kozminjo@lewisu.edu

The use of technology in the introductory lab has increased rapidly over the last two decades with the emergence of relatively affordable sensor systems with accompanying software and lab manuals. These sensors allow for a wide range of experiments to be performed at the introductory level with a low threshold for implementation. However, these systems can also cover up much of the underlying physics and analysis such that they can essentially become black boxes spitting out nice results. Two questions that will be addressed in this talk are: How can we use these sensors sensibly in the lab? and When do we need to unplug?

GH04: 9-9:10 a.m. Recycling Christmas Lights for an Inquiry-based Lab

Contributed – James C. Kernohan, Milton Academy, 170 Centre St. Milton, MA 02186-3397; jim_kernohan@milton.edu

I will present a simple, inquiry-based lab I use in my high school freshman physics class. I recycle white Christmas lights and challenge students to wire them so that they are all the same brightness, all are the same brightness but dimmer than the first circuit, that three are bright and one is dim, etc. When I give them ammeters and volt meters, they can start to discover Kirchhoff's laws. The most advanced students will discover that resistance of these bulbs depends on their brightnesses. By letting students use equipment that is recycled and recognizable, they are unafraid that they will break anything and more willing to play and take risks.

GH05: 9:10-9:20 a.m. Laboratory Experiments in Forensic Physics*

Contributed – Frederick D. Becchetti, University of Michigan-Ann Arbor, Department of Physics-Randall Lab, Ann Arbor, MI 48109-1120; fdb@umich.edu

Ramon Torres-Isea, Andrew Stenberg, University of Michigan-Ann Arbor

Using recent developments in affordable research-level instrumentation suitable for student laboratory work, we have developed several experiments in physics-based forensics. The latter is used in the general sense although some experiments do involve crime-scene analysis. The experiments cover physics-related techniques used in various fields of scientific investigation: forensic metallurgy, art forgery, geosciences including lunar and planetary mineralogy, environmental sciences, earth and climate sciences, medical sciences, anthropology, etc. Students are thus introduced to fields outside conventional physics, but areas that often utilize physics technology with important consequences. As an example analysis of ancient coinage using x-ray fluorescence (XRF) provides insight to the rise, expansion and fall of past civilizations e.g. the Roman Empire. Using various techniques, the students analyze many interesting samples: ancient coins (authentic and forged), meteors and terrestrial rock samples, various paint pigments (old and new formula), preserved small animal specimens, and crime-scene evidence as appropriate.

*Work supported by UM Quick Wins program and the U.S. National Science Foundation.

GH06: 9:20-9:30 a.m. Peer-Review in the Introductory Lab

Contributed – Dyan Jones, Mercyhurst University, 501 E 38th St., Erie, PA 16505; djones3@mercyhurst.edu

We are currently undertaking initiatives to incorporate best practices of science into the introductory physics sequence. This talk explicates how we've incorporated a peer-review process in the introductory labs, and includes information about implementation, successes and challenges, and some trends regarding student participation and learning.

GH07: 9:30-9:40 a.m. From Psychology Experiment to Physics Lab: Feeling Angular Momentum

Contributed – Susan M. Fischer, DePaul University, 2219 N. Kenmore Ave., Department of Physics, Chicago, IL 60604-2287; sfischer@depaul.edu

Alison Ryder, DePaul University

Carly Kontra, Daniel J. Lyons, Sian L Beilock, University of Chicago

In a recent study,[1] we found that when students performed embodied activities in which they directly felt the consequences of the vector nature of angular momentum, their performance on related quiz questions improved relative to students who received similar information, but without the embodied component. Our study involved highly controlled lab classrooms that required students to stick to their assigned embodied or non-embodied role and perform the designed activities in a scripted order. These are, however, undesirable features for a physics lab built around active engagement and peer instruction. This talk will report on the preliminary assessment and analysis of a lab activity that has been designed to transform the original psychology experiment on physics students into a physics lab that employs research-based teaching methods while preserving the most important aspects of the embodied activities.

1. Carly Kontra, et al., "Physical Experience Enhances Science Learning," *Psych. Sci.*, **26**, 737 (2015).

GH08: 9:40-9:50 a.m. Latent Heat of Fusion of Ice

Contributed – Pei Xiong-Skiba, Austin Peay State University, 601 College St., Clarksville, TN 37044; xiongp@apsu.edu

Anthony Mendez, Austin Peay State University

One of the popular experiments in an introductory physics and/or chemistry laboratory course is to measure the latent heat of fusion of ice using calorimeter. Like most heat related experiments, measurement errors are often significant, possibly up to 50%. This presentation explores what experimental conditions systematically affect the calculated percentage errors, especially the sensitivity to initial water bath temperatures and ice forms. Heat losses through various mechanisms are also examined. It is found that under "proper" experimental conditions, the calculated percentage errors can be 5% or less, making the experiment more "meaningful" to students.

GH09: 9:50-10 a.m. IOLab Status and Outlook

Contributed – Mats A. Selen, University of Illinois, Department of Physics, 1110 W. Green St., Urbana, IL 61801; mats@illinois.edu

IOLab an inexpensive battery-powered wireless laboratory system that allows students to do hands-on physics activities outside the classroom. The system combines flexible software with a wireless data acquisition platform containing an array of sensors. Interest by the physics community has grown steadily over the past year and over 500 devices are currently in the hands of collaborators across the country. In this talk I will describe the status and outlook on all IOLab fronts: pedagogy, content, hardware, software, and user community.

GH10: 10-10:10 a.m. Simple Video-Recorded Spring Force Sensor

Contributed – Lauren Rast, University of Alabama at Birmingham, 310 Campbell Hall, 1300 University Blvd., Birmingham, AL 35294; laurenr@uab.edu

Robert Collins, James Martin, David Shealy, Anca Lungu, University of Alabama at Birmingham

Introductory physics lab hardware and software can measure almost any relevant physical parameter with elegance and ease. The problem now is deciding what to measure; and WHO will decide what to measure (students or lab creators). Tools for online courses with labs are still an issue. But even outside physics labs, motion-based data is easy to grab with ubiquitous cell phone cameras and electronic info captured with cheap open-source boards. Providing affordable and understandable force sensors for online students is a challenge. We are investigating simple spring-based force sensors with video data recording, and analysis software such as Tracker. We will discuss sensor design for several experimental situations, easy calibration methods, operating details, performance limitations, and extension strategies for other sensor types.

Session GI: The Wonderful World of *AJP*

Location: Strand 10 A
Sponsor: Committee on Physics in Undergraduate Education
Date: Tuesday, January 12
Time: 8:30–10:30 a.m.

Presider: David Jackson

GI01: 8:30-9 a.m. Falling Through the Earth: A Non-Uniform Adventure

Invited – Alexander R. Klotz, McGill and MIT, 3600 rue University, Montreal, QC H3A2T8 Canada; aklotz@gmail.com

How long does it take to fall through a frictionless tunnel through the center of the Earth to the other side? This question, posed to undergraduates, can be solved by an application of Newtonian gravity, the Shell Theorem, and an understanding of Simple Harmonic Motion, given the assumption that the Earth is a uniformly dense sphere. It can be shown that it would take 42 minutes to fall through the center, and remarkably, the same amount of time to fall between any two points connected by a straight line. The Earth, however, is not uniformly dense. I will discuss how taking into account the Earth's internal density profile affects the time it takes to fall through the center, as well as implications for the chord path and the brachistochrone curve. The updated answer sheds light on the validity of the assumptions of uniform planetary density and constant internal gravity.

GI02: 9-9:30 a.m. Creation and Rupture of Soap Films: From Minimal Surfaces to Interfacial Bubbles

Invited – Laurent Courbin, IPR UMR UR1 - CNRS, 6251 263 Avenue General, Leclerc Rennes, Brittany 35042, France; laurent.courbin@univ-rennes1.fr

Louis Salkin, Alexandre Schmit, Pascal Panizza, IPR UMR UR1 - CNRS 6251

Minimal surfaces have been studied extensively over the centuries as they impact a wide range of phenomena and problems in engineering, mathematics, and physics. Such surfaces can be easily materialized with soap films which seek the shape that minimizes their surface area because of surface tension. Here, we investigate the influence of the nature of the liquid-liquid, liquid-solid, liquid-gas, or liquid-gas-solid boundary on the existence and stability of minimal surfaces made of soap films. Similar to the theory of phase transitions, we show that all studied surfaces exhibit a universal behavior in the vicinity of their existence thresholds. We begin by discussing catenoids, the familiar shapes sought by soap films spanning two rings having either identical or different radii. We then examine the case of other surfaces that include two portions of catenoids connected by a planar film and half-symmetric catenoids. The latter shape, observed when withdrawing a ring from a bath of soap solution, becomes unstable above a critical height and collapses to leave a planar film on the ring and an interfacial bubble in contact with the bath. We conclude with a brief discussion of the formation and rupture of these bubbles.

GI03: 9:30-10 a.m. The Physics of the Granite Sphere Fountain

Invited – Jacco H. Snoeijer, University of Twente Meander, 265 Enschede, Enschee 7500 AE, Netherlands; j.h.snoeijer@utwente.nl

Ko van der Weele, University of Patras

Fluids can exhibit beautiful flow patterns, but the underlying fluid mechanics is a challenging, often counterintuitive, topic for students. Here we will discuss the central elements of fluid mechanics using the remarkable "kugel fountain": a granite sphere weighing over a ton can be levitated by a very thin film of flowing water. This fountain admits a clear-cut analysis that shows how the viscosity and flow rate of the fluid determine (i) the small thickness of the film supporting the sphere and (ii) the surprisingly long time it takes for rotations to damp out. The theoretical results compare well with measurements on a fountain holding a granite sphere of 1 meter in diameter. We show that the fountain can be viewed as a giant ball bearing, and we close by discussing several related cases of fluid levitation.

GI04: 10-10:30 a.m. The Puzzle of the Steady-State Rotation of a Reverse Sprinkler

Invited – Wolfgang Rueckner, Harvard University, 1 Oxford St., Cambridge, MA 02138; rueckner@fas.harvard.edu

The continuous rotation of the reverse sprinkler has been a puzzle for over two decades. We present a series of experiments that demonstrate that a properly designed reverse sprinkler experiences no steady-state torque and does not rotate. If any sustained rotation of the reverse sprinkler occurs, it is because a force couple produces a torque accompanied by vortex flow inside the body of the sprinkler. No steady-state rotation occurs if the vortex is suppressed or prevented from forming in the first place.

Session GJ: Teaching with LIGO

Location: Foster 1
Sponsor: Committee on Space Science and Astronomy
Date: Tuesday, January 12
Time: 8:30–10:30 a.m.

Presider: Amber Stuver

GJ01: 8:30-9 a.m. Cutting Edge Research to Teach Basic Concepts: LIGO Lab EPO

Invited – William Katzman, LIGO, 19100 LIGO Lane, Livingston, LA 70754; wkatzman@ligo-la.caltech.edu*

LIGO's Livingston Laboratory has been reaching out to educate school children via informal methods for the past decade. While LIGO is searching for elusive gravitational waves, or ripples in space-time, LIGO's outreach focuses on reaching out to thousands of K-12 students and educators, and hundreds of university students. While the science of LIGO seems daunting, a lot of the technology underlying it involves simple physical interactives such as pendulums and optics. We will present an overview of the objectives, methods, and results of LIGO Science Education Center's attempts at outreach & education. In particular we will look at how K-12 students and teachers have reacted to outreach elements that blend modern physics with basic physical science concepts.

*Sponsor: Amber Stuver

GJ02: 9-9:30 am. Teaching LIGO Science to Visitors

Invited – Kathy Holt, LIGO LLO Science Education Center, 19100 LIGO Lane, P.O. Box 940, Livingston, LA 70754; kholt@ligo-la.caltech.edu

The LIGO Lab in Livingston, LA searches for gravitational waves or ripples in space-time caused by massive objects undergoing incredible accelerations – such as colliding neutron stars or black holes. LIGO Science Education Center, SEC seeks to connect this active scientific research to the public through simple science activities and demonstrations. Kathy Holt, Senior Science Educator will provide an overview of several low-cost demonstrations and activities. It's important that the connection be made to help visitors better understand the Science of LIGO.

GJ03: 9:30-10 a.m. The Gravitational Wave Frontier in the Physics Classroom

Invited – Shane L. Larson, Northwestern/CIERA, 2145 Sheridan Road, Evanston, IL 60208; s.larson@northwestern.edu

Gravitational wave physics and astronomy holds a special appeal for students. It is a thoroughly modern science, at the frontiers of our theoretical knowledge and experimental capability. While playing a fundamental role in the astrophysical evolution of many phenomena, and being a prominent result derived from general relativity, gravitational waves have a surprising array of basic properties that can be understood and explored by students at all levels of their education in physics and astronomy. This embarrassment of riches makes gravitational waves an ideal subject to use in the classroom to illustrate traditional physics and astronomy concepts, within the context of a new and exciting branch of frontier science. In this talk we will outline just a few of the broad physical concepts that are amenable to illustration with gravitational waves, and show examples of use in the classroom.

GJ04: 10-10:30 a.m. Bringing the Physics of Gravitational-wave Detectors into the Classroom

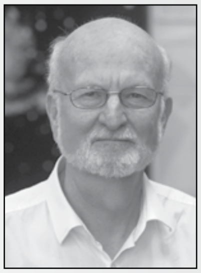
Invited – Katherine Dooley, The University of Mississippi, Department of Physics and Astronomy, 108 Lewis Hall, University, MS 38677-1848; kldooley@olemiss.edu

Gravitational-wave detectors offer a plethora of interesting examples of physics that can be used to engage and enhance the student's learning experience in the classroom. The detectors are multi-kilometer-long laser interferometers that push the limits of precision measurement technology and are a feat in both engineering and the fundamental physics they confront. Despite the complexity of the detectors, simple examples of their design and the experimental challenges faced in commissioning can be extracted to bring the physics concepts taught in the classroom to life. Examples will be presented that range from the use of pendulums to isolate the mirrors from ground motion to challenges that result from direct confrontation with Einstein's equivalence principle to impressive effects due to the force that the photons exert on the mirrors.

Awards Session

Location: Celestin A-C
Date: Tuesday, January 12
Time: 10:30 a.m.–12 p.m.

Presider: Steven Iona



John W. Belcher

Oersted Medal

presented to John W. Belcher

The Challenges of Pedagogical Change at a Research I University

John W. Belcher, MIT, Department of Physics, Boston, MA

TEAL (Technology Enabled Active Learning) is an active engagement format for teaching introductory physics in the main-stream introductory physics courses at MIT. The model is based on Professor Robert Beichner's SCALE-UP pedagogy developed at North Carolina State University. The implementation of this format at MIT, beginning on a large scale in spring 2003, was not without controversy. The often-times turbulent history of the TEAL program has been described by Dr. Lori Breslow of MIT in an article in *Change: The Magazine of Higher Learning,* "Wrestling with Pedagogical Change: The TEAL Initiative at MIT," **42**(5), 23-29, 2010). I will recount some of that history in this talk. I will also review the visualization efforts in electromagnetism that constitute the innovative contribution of TEAL.

Homer L. Dodge Citations for Distinguished Service to AAPT

Marina Milner-Bolotin
University of
British Columbia

Michael Faleski
Delta College

Karl C. Mamola
Appalachian State
University

Gay Stewart
West Virginia
University

David Weaver
Chandler-Gilbert
Community College

Roger H. Stuewer

Roger H. Stuewer awarded:

Special Recognition for Extraordinary Service to *AJP* and the Association

AIP Science Writing Awards:
Writing for Children Category

Agnieszka Biskup

Tammy Enz

Dia L. Michels

AAPT Presidential Transfer Ceremony

Mary E. Mogge
California State Polytechnic University
2015 AAPT President

Janelle M. Bailey
Temple University
2016 President

Session HA: Astronomy Papers

Location: Strand 10 A
Sponsor: AAPT
Date: Tuesday, January 12
Time: 12:30–1:30 p.m.

Presider: Don Smith

HA01: 12:30-12:40 p.m. American Eclipse Project (AEP)

Contributed – William A. Dittrich, Portland Community College, PO Box 19000, Portland, OR 97280; tdittric@pcc.edu

A recreation of Eddington's Classic Experiment measuring gravitational deflection of light is being planned for the eclipse path across America in 2017. While Einstein published his General Theory in 1915, it was not until Aug. 21, 1917, that the first attempt to verify gravitational lensing was undertaken at an observatory in India. This first attempt was a failure, measuring the deflection of light from the bright star Regulus without an eclipse was most ambitious. 100 years later Regulus once again is near the limb of the Sun and this time it occurs during the eclipse crossing America. Universities and Space Grant Consortia are partnering with Oregon State University to offer the amazing opportunity for hundreds of students to perform a recreation of one of the few most important experiments in physics and astronomy from the 20th century. This is a discussion telling the story of the American Eclipse Project.

HA02: 12:40-12:50 p.m. Elementary Surprising Facts About the Sun's Path in the Sky

Contributed – A. James Mallmann, Milwaukee School of Engineering, New Berlin, WI 53146-2522; mallmann@msoe.edu

Steven P. Mayer, Milwaukee School of Engineering

Over the recent decades investigations and studies of the interactions of rays of sunlight with raindrops and with airborne ice crystals have resulted in a better understanding of rainbows, halos, sun dogs, sun pillars, and many other patterns of light and color in the sky. We will report on a simpler observation of the Sun's path in the sky. Consideration of the Sun's path inspired calculations and measurements that surprised me, and may surprise you as well.

HA03: 12:50-1 p.m. NY Times Space/Astronomy Article Applications to Help Teach Physics

Contributed – John P. Cise, Austin Community College, 1212 Rio Grande St., Austin, TX 78701; jpcise@austincc.edu

Since 2007 I have been using New York Times articles with physics applications to help teach physics. The New York Times has many sections (Sports,Automotive, Science, Space, Astronomy, etc.) with articles containing physics applications. Articles and related graphics are placed in WORD then edited to fit on one web page. More graphics are added. Also added are: Introduction, questions, hints, and answers. The one page WORD document is saved as a pdf file and uploaded to the authors N Y Times application site. About 400 physics applications can be found at: http://CisePhysics.homestead.com/files/NYT.htm or http://CisePhysics.homestead.com/files/NYT.pdf. The site specific to this paper on "NY Times Space/Astronomy Article Applications To Help Teach Physics" is: http://CisePhysics.homestead.com/files/NYTSpaceAstApps.pdf. The author uses the N Y Times Applications for: Introduction to new concepts, quizzes, extra credit, and test questions. Students and author enjoy these current news physics applications.

HA04: 1-1:10 p.m. Teaching Light Pollution: The Importance of Dark Skies in Astronomy*

Contributed – Zodiac T. Webster, NC School of Science and Mathematics, 1219 Broad St., Durham, NC 27715; zodiac.webster@ncssm.edu

Dark skies are essential to the successful execution of astronomical observations. Light pollution negatively affects the enjoyment of naked eye astronomy and the science of astronomy but is also a concern to the biorhythms and behaviors of insects, birds, sea turtles, and people. I will introduce lesson plans introducing light pollution, how individuals can mitigate it, and ways students can become advocates for dark skies. The cross-disciplinary nature of the topic appeals to adolescents and provides an interesting hook for an astronomy unit, a science club, or a community relations activity. Lesson plans, a link to an online module for use in a course management system, and links to resources will be provided. This lesson sequence was inspired by a Galileo Teacher Training Project workshop and was developed as part of the Georgians Experience Astronomy Research in Schools Project.

*GEARS was funded by NASA Office of Education Grant NNX09AH83A and was supported by the Georgia Department of Education, Columbus State University, and Georgia Southern University. http://cheller.phy.georgiasouthern.edu/gears/

Session HB: Energy in the Classroom

Location: Bolden 1
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Physics in High Schools
Date: Tuesday, January 12
Time: 12:30–1:30 p.m.

Presider: Aaron Osowiecki

HB01: 12:30-1 p.m. Energy First – How We Do It and Why You Should Too

Invited – Jesse J. Southwick, Boston Latin School, 50 Rossmore Road, Jamaica Plain, MA 02130; jesse.southwick@gmail.com

Aaron Osowiecki, Boston Latin School

Traditional physics courses begin with the kinematic equations and Newton's laws of motion. Though Isaac Newton's laws of motion help students understand why objects move, they aren't prerequisites for active citizenship. However, contemporary society constantly faces important energy questions. Shouldn't our physics courses emphasize this important topic? At Boston Latin School our introductory physics course begins with energy—providing a unifying theme throughout the course. Come find out how we do "energy first" and why you should too.

HB02: 1-1:10 p.m. Energy-based High School Physics Curriculum

Contributed – Laura L. Lang, Sauk Prairie High School, 105 Ninth St., Prairie Du Sac, WI 53578; laura.lang@saukprairieschools.org

Energy concepts are woven into all aspects of my high school physics curriculum. Students learn how to analyze data and form conclusions based on the consumption, production, exportation and importation of fossil fuels, nuclear energy, and renewable sources of energy. They investigate the household consumption of energy due to heating, cooling, or operation of appliances. After discussing why fuel conservation is important to our society, they analyze the factors that affect gas prices, compare gas mileage for different vehicles, and determine how gas mileage can be maximized for a given vehicle. Together we investigate the energy production of our solar panels. After sharing their individual research on new technology that uses alternative forms of energy to produce electricity, each student writes a letter to the President with a recommendation of what to include in the next national energy plan demonstrating their knowledge of the importance of energy to our society.

HB03: 1:10-1:20 p.m. EnergyTeachers.org Compiles Best Practices in Energy Education

Contributed – Shawn Reeves, EnergyTeachers.org, 1559 Beacon St., Apt 1, Brookline, MA 02446; shawn@energyteachers.org

Not only do topics in energy production and use give learners impetus for learning the standard physics curriculum, but a new field is emerging with the help of physics teachers and educators in other fields. We will describe the many effective ways of learning about energy we've found since our organization in 2004 began to investigate. We will also review some of the ways energy (and electronics) topics have improved learners attitudes towards physics in general.

HB04: 1:20-1:30 a.m. RC Solar Car: An Effective Method to Introduce Solar Energy

Contributed Mehmet Gokcek Harmony School of Innovation 3521 Mike Godwin Drive El Paso, TX 79936 mgokcek@harmonytx.org

As the world is facing bigger environmental and social problems everyday it becomes urgent for physics teachers to take action and implement possible solutions into the physics curriculum. Solar energy stands out as one of the leading contestants to solve future energy crises while helping today's environmental pollution issues. Building a remote-controlled solar car is a great affordable way of teaching the basics of solar energy systems and how they function. The project is called Chariot of Ra, where students start out by constructing a solar panel using simple cheap solar cells. Members of the physics class take on this engineering challenge and solder bus lines, learn about use of diodes to avoid issues of the system overheating. They also design a light body using a simple solution; insulating foam as well as an affordable cutting edge material; carbon fiber frame. Remote control unit helps introduce fundamentals of digital electronics.

Session HC: Professional Skills for Graduate Students

Location: Strand 11 B
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Graduate Education in Physics
Date: Tuesday, January 12
Time: 12:30–1:30 p.m.

Presider: Gina Quan

HC01: 12:30-1 p.m. Academic Writing in Physics Education Research

Invited – Charles Henderson, Western Michigan University, WMU Physics, Kalamazoo, MI 49008-5252; charles.henderson@wmich.edu

Academic writing is a very important professional skill to develop as part of your graduate education. In this interactive session I will use my experiences as a journal editor and an author to answer your questions about effective academic writing and provide some tips for getting your articles published.

HC02: 1-1:30 p.m. Externalizing and Publishing in PER: A Discussion of Challenges, Practices, and Opportunities

Invited – Noah Finkelstein, University of Colorado Boulder, UCB-390 Department of Physics, Boulder, CO 80309; finkelsn@colorado.edu

In this interactive panel discussion we will discuss the opportunities and challenges of publishing work in physics education research. Based on studies of the field and my own experiences (with 100 articles/chapters and 400 public addresses), we will have the opportunities to engage in discussions of: what makes for a good paper or talk, audience, publishing venue, what counts (and to whom), and practical advice for writing, working with advisors and co-authors, and responding to reviewers and editors.

Session HD: Innovations in Online Education

Location: Bolden 5
Sponsor: Committee on Educational Technologies
Date: Tuesday, January 12
Time: 12:30–1:30 p.m.

Presider: John Stewart

HD01: 12:30-12:40 p.m. Peer Instruction in Online Introductory Physics

Contributed – Kent J. Price, Morehead State University, Department of Physics, Morehead, KY 40351; k.price@moreheadstate.edu

Peer Instruction (PI) has been well-established as more effective at teaching introductory physics concepts than traditional lecture in face-to-face classrooms. Yet in the traditional implementation of PI, students communicate with one another in real time. Because one of the significant advantages of online instruction is its asynchronous nature that allows students to work on their own schedules, traditional PI is not feasible in online courses. The author will present the results of utilizing a modified form of PI in online algebra-based physics at Morehead State University. The modified method retains the 'initial commitment to a response' and 'peer interaction' aspects of PI, while allowing the peer interaction to occur in an asynchronous manner. The method will be described and compared to traditional face-to-face PI. Force Concepts Inventory assessments and individual student responses will be presented showing that online PI can be effective in increasing student understanding of elementary physics concepts.

HD02: 12:40-12:50 p.m. Using an Online Course to Supplement an On-Campus Course

Contributed – Andrew G. Duffy, Boston University, 590 Commonwealth Ave., Boston, MA 02215; aduffy@bu.edu

During spring 2015, we developed and taught an AP Physics 1 course on edX (currently running again). Because there is so much overlap of that content with the first semester of our university-level algebra-based introductory physics class, we set up a local instance of the online course, supplemented the material with additional units on fluids, heat, and thermodynamics, and provided it to our on-campus students as an additional free resource. In this talk, we report on the outcomes of the fall 2015 experience, including results of student surveys regarding whether they found this additional material to be useful, how often they used it, and their comments regarding how it could be improved.

HD03: 12:50-1 p.m. Facilitating Students' Problem Solving Using Computer Coaches in Classroom

Contributed – Bijaya Aryal, University of Minnesota Rochester, Rochester, MN 55904; baryal@r.umn.edu

Computer Coaches allow students to pace their own interaction while receiving coaching from the tool. Instructors at University of Minnesota Rochester have utilized web-based Computer Coaches for problem solving activities in a small classroom setting in an introductory level physics course for the last three years. However, to improve flexibility for students in choosing their solution paths, the University of Minnesota Physics Education Research Group has been developing Customizable Computer Coaches for Physics Online (C3PO). We have explored various strategies to make the tool appealing to more students and improve the effectiveness of the usage. We report the results derived from students' quiz and exam grades pertaining to physics problem solving in order to describe the educational impact of the tool. Using student interviews, observation of student interactions and a survey we compare the effectiveness of the two versions of the coaches on students' usability and their problem solving performances.

HD04: 1-1:10 p.m. Research Validated Distance Learning Labs for Introductory Physics Using IOLab

Contributed – David R. Sokoloff, University of Oregon and Portland State University, Eugene, OR 97403-1274; sokoloff@uoregon.edu

Erik Bodegom, Portland State University

Erik L. Jensen, Chemeketa Community College

The IOLab is a versatile, relatively inexpensive data acquisition device developed by Mats Selen and his colleagues at University of Illinois.[1] It is self-contained in a cart that can roll on its own wheels, while an optical encoder measures motion quantities. It also contains probes to measure a variety of other physical quantities like force, temperature, light intensity, sound intensity and current and voltage. With a cost of around $100, students can purchase their own individual device (like a clicker), and can—in theory—use it to do hands-on laboratory, pre-lecture (flipped classroom) and homework activities at home. We report on the preliminary results of a National Science Foundation-funded project to develop distance-learning (DL) laboratories using the IOLab.[2] We plan to develop RealTime Physics[3,4]-like mechanics labs based on the IOLab, test them in a supervised laboratory environment at PSU, and then test them as DL labs at PSU and Chemeketa. Research on student learning and epistemological issues will be done with the FMCE[5] and ECLASS.[6]

1. See http://www.iolab.science/ 2. Funded under NSF DUE – 1505086, July 1, 2015-June 30, 2017. 3. David R. Sokoloff, Ronald K. Thornton and Priscilla W. Laws, "RealTime Physics: Active Learning Labs Transforming the Introductory Laboratory," *Eur. J. of Phys.* **28** (2007), S83-S94. 4. David R. Sokoloff, Ronald K. Thornton and Priscilla W. Laws, *RealTime Physics: Active Learning Laboratories, Module 1: Mechanics*, 3rd Edition (Hoboken, NJ, John Wiley and Sons, 2011). 5. Ronald K. Thornton and David R. Sokoloff, "Assessing student learning of Newton's laws: The Force and Motion Conceptual Evaluation and the Evaluation of Active Learning Laboratory and Lecture Curricula", *Am. J. Phys.* **66**, 338-352 (1998) 6. See http://www.colorado.edu/sei/departments/phys-advlab-eclass.htm

HD05: 1:10-1:20 p.m. Adaptations of Learning Glass Technology in Undergraduate Physics Education

Contributed – Matt Anderson, San Diego State University, 5500 Campanile Dr., San Diego, CA 92182; matt@sciences.sdsu.edu

Shawn Firouzian, Lorah Bodie, Chris Rasmussen, San Diego State University

The Learning Glass is an innovative new instructional technology that holds considerable promise for engaging STEM class students and improving their learning outcomes. The Learning Glass screen acts as a transparent whiteboard. The instructor writes on a glass screen with LED illuminated edges. A camera on the opposite side of the glass records the video and horizontally flips the image (and hence the instructor is not required to write backward). In this report we share the results of an efficacy study between an online calculus-based physics course using Learning Glass technology and a large auditorium-style lecture hall taught via document projector. Both courses were taught with the same instructor using identical content and materials. Our quasi-experimental design involved identical pre- and post-course assessments evaluating students' attitudes and their conceptual learning gains. Results are promising, with similar learning gains for all students, including minority and economically disadvantaged students.

Session HE: Women Physicists in Leadership Positions

Location: Bolden 6
Sponsor: Committee on Women in Physics
Co-Sponsor: Committee on Professional Concerns
Date: Tuesday, January 12
Time: 12:30–1:40 p.m.

Presider: Geraldine L. Cochran

HE01: 12:30-1 p.m. Why We Need More Woman Leaders in Physics: An Insider's Perspective

Invited – Vivian Incera, University of Texas at El Paso, 500 W. University Ave., El Paso, TX 79968-8900; vincera@utep.edu

It is known that women are largely underrepresented in physics. In such a male-dominated discipline, it is no surprise that women in leadership positions are scarce. It does not help that female physicists who become leaders at any level within their institutions often have to face gender-bias attitudes that do not exist for their male colleagues. Yet, woman leaders tend to be transformational leaders who focus on building consensus, inspiring workers, and developing productive and engaged communities. In the academic world, woman leaders can be effective role models for students and hence help to solve the lack of female representation in physics. In this presentation, I will talk about my experience as academic leader and share the lessons I have learned in the process. I would also like to engage the audience in a conversation about what can be done to change the prevalent culture in our discipline, so we can be more successful in nurturing and promoting more woman to positions of leadership.

HE02: 1-1:30 p.m. Producing 'Exotic Nuclei'

Invited – Sherry Yennello, Texas A&M University, Cyclotron Institute, College Station, TX 77843-3366; yennello@comp.tamu.edu

Exotic nuclei share similarities with superstar faculty, extraordinary students, amazing technical developments, and revolutionary scientific ideas: while it is the last neutron or proton that makes everyone take notice, the nucleus would not exist without ALL of the nucleons, and some gluons as well. The more exotic the nucleus, the more effort it takes to bring all of the pieces together in just the right manner. The same can be said of leading a nuclear physics center - the whole of the team is really much greater than the sum of the parts, and a delicate balance must be maintained. This talk will discuss what it takes to manage a cohesive, harmonious workgroup and produce 'exotic nuclei.'

HE03: 1:30-1:40 p.m. Women Physicists and Procreation

Contributed – Ruth H. Howes, Ball State University, 714 Agua Fria St., Santa Fe, NM 87501; rhowes@bsu.edu

After about five months, it is nearly impossible to hide a pregnancy. Women physicists have always had babies in the face of company, university, and government rules that try to force them to stop work. Many of them have received strong support from their immediate supervisors and members of their research groups both before and after the births of their babies. This talk will examine that support and the sometimes comic ways women have coped with having babies while continuing to work as physicists beginning with stories from the Manhattan Project. It will address some of the unique problems mothers face in the lab and the office and the types of support from colleagues and spouses.

Session HF: Upper Division Concerns

Location: Strand 11 A
Sponsor: AAPT
Date: Tuesday, January 12
Time: 12:30–1:50 p.m.

Presider: Shannon Willoughby

HF01: 12:30-12:40 p.m. Classical Particle Exchange: A Quantitative Treatment

Contributed – Jarrett L. Lancaster, University of North Carolina at Greensboro, 2907 E. Gate City Blvd., Greensboro, NC 27401; jllancas@uncg.edu

Colin McGuire, Lowcountry Preparatory School

Aaron P Titus, High Point University

The "classic" analogy of classical repulsive interactions via exchange of particles is revisited with a quantitative model and analyzed. This simple model based solely upon the principle of momentum conservation yields a nontrivial, conservative approximation at low energies while also including a type of "relativistic" regime in which the conservative fomulation breaks down. Simulations are presented that are accessible to undergraduate students at any level in the physics curriculum as well as analytic treatments of the various regimes which should be accessible to advanced undergraduate physics majors.

HF02: 12:40-12:50 p.m. Collisions and the Coefficient of Restitution in Galilean and Special Relativity

Contributed – Roberto Salgado, University of Wisconsin - La Crosse, 1725 State St., La Crosse, WI 54601; rsalgado@uwlax.edu

Using spacetime diagrams and energy-momentum diagrams, we develop a unified formulation for collision problems in Galilean and Special Relativity. We treat some standard introductory-textbook examples with our approach. We conclude with our attempts to define a Coefficient of Restitution in Special Relativity.

HF03: 12:50-1 p.m. Designing a New Laboratory Course for Underrepresented Students in a Graduate Bridge Program in South Africa

Contributed – Christine Lindstrøm, Oslo and Akershus University College, Pilestredet 52 Oslo, NO 0475 Norway; christine.lindstrom@hioa.no

Saalih Allie, University of Cape Town

Heather J. Lewandowski, University of Colorado Boulder

The National Astrophysics and Space Science Programme (NASSP) is a graduate program established in 2003 to educate the next generation of South African astrophysicists and space scientists. Due to high initial attrition rates for black South African students in NASSP, a yearlong Postgraduate Bridging Program (PGB) was established in 2008. The PGB, however, is heavily theoretical and does not help students develop research skills. Our project is to create a laboratory course to better prepare the students for their future research projects. The first step of our project included interviews with NASSP project supervisors and former NASSP/PGB students, and collection of previous NASSP project reports. The data sources were analyzed with the lens to understand who the PGB students are and estimate their level of prior knowledge and previous challenges in NASSP. This analysis resulted in a set of guiding principles for how to design the laboratory course.

HF04: 1-1:10 p.m. Differential Forms as a Supplementary Framework for Teaching Upper-Level Electricity and Magnetism

Contributed – Kaca Bradonjic, Wellesley College, 106 Central St., Wellesley, MA 02481-8203; kbradonj@wellesley.edu

Dominique McKenzie, Jelena Begovic, Wellesley College

The standard 300-level course on electromagnetic theory is often seen by students as one of the most challenging classes due to the complicated formalism of vector calculus and the abstract nature of various fields. Visual representations of fields and laws, like the Gauss' law, improves students' understanding, but are not as effective for all relevant examples, such as Ampere's law. We present an alternative framework for teaching electromagnetism in the language of differential forms, which can be used in conjunction with the traditional formalism. The use of differential forms has several advantages, the most relevant ones being that the necessary mathematical machinery is simplified, the distinction between the electric field D and electric induction E (and the magnetic field H and the magnetic induction B) is made clear from the start, and the visual representation is readily available for all of time-independent Maxwell's equations.

HF05: 1:10-1:20 p.m. Partnership for Integration of Computation into Undergraduate Physics: A Mission*

Contributed – Norman J. Chonacky, Yale University, Department of Applied Physics, P.O. Box 208284, BectonCenter, New Haven, CT 06520-8284; norman.chonacky@yale.edu

For the past decade, an informal partnership (the PICUP) among physics faculty has emerged to envision a future in which computation would be as integral a part of undergraduate physics as it is currently in science and engineering practice. Its partners have conducted research-surveys of current departmental computational practices, attitudes toward possible roles for computation, and possible reasons for this gap between practice and education. Recently some PICUP's proposals for understanding and remedying this gap have received reviewers' attention. Each research project awarded is a collaboration involving multiple institutions, each offering a different perspective on what the gap signifies and what are remedies to pursue across a wide diversity of institutions. It is this mix that has enriched the PICUP's several projects and extended the prospect that the strategies it devises will have wide applicability across diverse institutions.

*In part funded by the NSF project awards: IUSE-1432363; IUSE-1525525; IUSE-1505278.

HF06: 1:20-1:30 p.m. Interdisciplinary Materials Science Projects Lead to Meaningful Student Collaboration

Contributed – Andra Petrean, Physics Department, Austin College, 900 N. Grand Ave., Suite 61556, Sherman, TX 75090; apetrean@austincollege.edu

Bradley W. Smucker, Chemistry Department, Austin College

Our society is becoming increasingly more complex, and the issues we face oftentimes require expertise from more than one discipline. As educators, we serve our students best by creating opportunities for meaningful interdisciplinary collaborations. Over the last few years, we linked our Advanced Laboratory in Physics and our Inorganic Chemistry classes. The Physics and Chemistry students collaborated actively on Materials Science projects involving nanotechnology and high temperature superconductivity. Students synthesized and characterized materials, much like in a research team composed of experts in different disciplines. Their collaboration culminated in a poster session open to the Austin College community.

HF07: 1:30-1:40 p.m. Investigating Students' Ideas in Mathematization

Contributed – Deepa Nathamuni Chari, Kansas State University, Department of Physics, Manhattan, KS 66502; deepu.chari@gmail.com

Dylan E McKnight, Saginaw Valley State University

Eleanor C. Sayre, Kansas State University

In upper division physics problems, students apply many mathematical and conceptual tools. As students discuss a problem, they co-ordinate the ideas and make their choices about these tools. In this study, we investigate students' problem solving in two upper division physics classes, Electromagnetic fields I and Quantum mechanics. Our data are drawn from classroom video of students working in small groups. We examine the videos of group problem solving for 30 problems across the two courses, using the ACER framework to identify their problem solving moves. In this talk, we present examples of students' tool choices as mediated by course and problem.

HF08: 1:40-1:50 p.m. Measuring Students' Epistemologies About Experimental Physics: Ongoing Validation of the E-CLASS

Contributed – Bethany R. Wilcox, University of Colorado at Boulder, 2510 Taft Dr., Unit 213, Boulder, CO 80302; Bethany.Wilcox@colorado.edu

H. J. Lewandowski University of Colorado at Boulder

Student learning in instructional physics labs represents a growing area of research that includes investigations of students' beliefs and expectations about the nature of experimental physics. To directly probe students' epistemologies about experimental physics and support broader lab transformation efforts at the University of Colorado Boulder (CU) and elsewhere, we developed the Colorado Learning Attitudes about Science Survey for Experimental Physics (E-CLASS). Previous work with this assessment has included establishing the accuracy and clarity of the instrument through student interviews and preliminary testing. Several years of data collection at multiple institutions has resulted in a growing national data set of student responses. Here we report on results of the ongoing analysis of these data to investigate the statistical validity and reliability of the E-CLASS as a measure of student epistemologies for a broad student population.

Session HG: Teacher Training/ Enhancement

Location: Strand 10 B
Sponsor: AAPT
Date: Tuesday, January 12
Time: 12:30–1:20 p.m.

Presider: Claudia Frachiolla

HG01: 12:30-12:40 p.m. Teaching Best Physics Teaching Practices to Future High School Teachers

Contributed – David J. Sitar, Appalachian State University, Department of Physics and Astronomy, 231 Garwood Hall, 525 Rivers St., Boone, NC 28608; sitardj@appstate.edu

During the fall 2015 semester, a Physics Instruction Practicum course (PHY3400) was designed, prepared and taught. From a blank canvas to the final product; this talk will highlight what went right, what went wrong and everything in between. After a brief presentation, audience members are encouraged to share their experiences with teaching similar courses. Since there are only a few text books available that address the teaching of physics to future high school physics teachers, there is a need for such a discussion to ensure that there is a positive teaching environment, well developed assignments as well as adequate assessment.

HG02: 12:40-12:50 p.m. Leading Successful Technology-enhanced Pro-D in Beijing: Lessons Learned

Contributed – Marina Milner-Bolotin, University of British Columbia, 2125 Main Mall, Vancouver, BC V6T 1Z4 Canada; marina.milner-bolotin@ubc.ca

In May of 2015 I was invited to conduct two week-long professional development institutes in Chaoyang School District in Beijing, China. These 30-hour institutes aimed at engaging Chinese mathematics and science secondary teachers (almost 60 teachers participated) with contemporary technology-enhanced pedagogies. We explored the use of data collection and analysis tools (Logger Pro), computer simulations, smartphone apps, and many other technologies. However, most importantly, we discussed how we teach mathematics and science and how we engage students in a meaningful way. While the educational culture in China is very different from North America, we had a lot to learn from each other. In this presentation I will share what I have learned from this experience and how I will plan my future visits. I hope more North American teachers will seize these fantastic opportunities and will visit China to not only conduct professional development but also learn from local teachers.

HG03: 12:50-1 p.m. STEMteach: One Year, New Career*

Contributed – Earl D. Blodgett, University of Wisconsin - River Falls, 410 S 3rd St., Boyceville, WI 54725-5059; earl.d.blodgett@uwrf.edu

Diane Bennett, Larry Solberg, University of Wisconsin - River Falls

This presentation seeks to share information about a novel program for STEM teacher preparation that others may wish to explore. STEMteach is a novel one-year graduate course of study designed for STEM degree holders who wish to become certified to teach in their area of qualification. Inspired by the UTeach program at the University of Texas – Austin, the program at the University of Wisconsin – River Falls brings together graduate students from many areas of science and mathematics for an intensive one-year cohort experience. The courses closely follow the UTeach model, providing extensive authentic field experiences from the very first week of the program. The first cohort of the program began in June 2015, with completion of the program in May 2016. All will earn 24 graduate credits applicable towards an optional Master of Science in Education degree.

*Funded in part by NSF Noyce Capacity Building Grant 1439768.

HG04: 1-1:10 pm. Improving Physical Science Teaching and Learning at the Elementary Level*

Contributed – Mark C. Spraker, University of North Georgia, Department of Physics, Rogers Hall, Dahlonega, GA 30597-1001; mcspraker@ung.edu

April A. Nelms, Sanghee Choi, University of North Georgia

Cheryl W. Sundberg, Ronin Institute

The Physical Science Content Inquiries Training Program provides professional development for 34 teachers from high-needs schools in grades K-5 in the core content of physical science for ninety hours over one year. The overarching goal is to provide opportunities for elementary teachers to learn both college-level physics content and an elementary-level appropriate pedagogy model. The program is delivered using an inquiry-based teaching approach, the 5E learning cycle (Engage, Explore, Explain, Elaborate, and Evaluate). This program, the 5E approach and specific examples of physical science learning and teaching models will be shared along with measures of success as demonstrated by the teachers' performance on known instruments that measure conceptual understanding.

*This work is partially supported by the Title II B Mathematics and Science Partnership FAIN: S366B150011

HG05: 1:10-1:20 p.m. Discovering the Interconnectedness of Human Spirit Beneath the Night Sky

Contributed – Richard P. Hechter, University of Manitoba, Department of Curriculum, Teaching, and Learning, Room 310, Education Building, Winnipeg, MB R3T2N2; richard.hechter@umanitoba.ca

Richard P. Hechter, University of Manitoba

This presentation will highlight the interconnectedness of people and the human spirit from diverse cultural, geographic, and political backgrounds found by coming together under the awe and wonder of the night sky. From Canada to Iceland, and Greece to Israel, this project has found that through sharing and listening to authentic and meaningful interpretations of celestial manifestations from different perspectives and voices found around the world, the role physics education can have in bettering our world can become apparent. Here, astronomy education is the curricular context leading teachers towards developing globally collaborative and passion-based learning experiences emphasizing the blurring of diversity lines. This project allowed conventional physics teachers to deviate from being solely technicians of physics phenomena to becoming storytellers of culture where the physics curriculum stories to be shared in their classrooms engage, enlighten, and communicate intention for a better world.

SYMPOSIUM on Physics Education

AAPT Symposium on Physics Education and Public Policy

Ramón Barthelemy

Meredith Drosback

Tuesday, January 12, 2–3:30 p.m. • Celestin A-C

Policymakers formulate decisions everyday that impact curriculum, standards, funding, and many other aspects of physics education at all levels. AAPT works with a number of partners to keep policymakers informed on the views of physics educators and to suggest appropriate policy options within the Association's sphere of influence. This session brings together individuals who play pivotal roles in helping to shape policies and who provide information to policymakers. We hope to provide a look at the process of policy making as well as actions you might make to contribute to decisions about policies affecting physics and STEM education.

Facilitator: *Noah Finkelstein, Professor of Physics, University of Colorado at Boulder*

Speakers:

Ramón Barthelemy, *AAAS (American Association for the Advancement of Science) Science Policy Fellow in the U.S. Department of Education*

Meredith Drosback, *Assistant Director, Education and Physical Sciences, Science Division, Office of Science and Technology Policy, U.S. White House*

Session IA: Post-deadline Abstracts (Papers)

Location: Bolden 1
Sponsor: AAPT
Date: Tuesday, January 12
Time: 3:30–4:20 p.m.

Presider: Kathleen Falconer

IA01: 3:30-3:40 p.m. Demonstration of Concepts in Quantum Mechanics Using a String and Mass Chain

Contributed – Roger H. Yu, New York Institute of Technology, 1855 Broadway, New York, NY 10023; ryu@nyit.edu

The solutions of the mechanical wave equation for a loaded mass chain and the Schrodinger equation of a set of quantum wells are similar. The physical properties of both systems such as discrete energy (frequency) levels, frequency or energy band structure and band gap, density of states, defects, etc. share commonality. We have studied the vibrational properties of a finite one?dimensional string?mass chain experimentally and theoretically. More importantly, these highly visible studies have been used as demonstrations to illustrate the properties of a finite quantum well system for which the visualization would not be possible otherwise in a general physics lab. We will present some details about the studies of a mass chain, along with the parallel between these two physical systems.

IA02: 3:40-3:50 p.m. Origins of General Relativity in Newton's Laws of Motion

Contributed – Munawar Karim, St. John Fisher College, 3690 East Ave., Rochester, NY 14618; karim@sjfc.edu

I will describe and demonstrate (through videos) the physics of freely falling bodies. The concept of weightlessness is key to understanding why gravity is a geometric concept. The link between Newton's laws of motion and Einstein's theory of gravity will be elucidated.

IA03: 3:50-4 p.m. Determining the Diagnostic Properties of the Force Concept Inventory

Contributed – Mary A. Norris, Virginia Tech, 1071 Opal Lane, Blacksburg, VA 24060; mnorris@vt.edu

Gary Skaggs, Virginia Tech

With the evolution of postsecondary education to include accountability, it is important for instructors to identify student misconceptions and to adjust their instruction accordingly. The Force Concept Inventory (FCI) is widely used to measure learning in introductory physics. Typically, instructors use total score. Investigation suggests that the test is multidimensional. This study fits FCI data with cognitive diagnostic and bifactor models in order to provide a more detailed assessment of student skills. A well-fit multidimensional model of the FCI would allow a more nuanced understanding of student knowledge which would encourage and empower both instructors and students to focus their teaching and learning efforts in those areas that are weakest.

IA04: 4-4:10 p.m. School-based Factors and Physics Students' Enrollment and Achievement in Nigeria

Contributed – Telima Adolphus, University of York, UK Department of Education (Science education group), Heslington York, YO10 5DD United Kingdom; telimabel@yahoo.com

Despite the laudable relevance of physics and physics education, the

teaching and learning of physics is still bedeviled by several challenges of poor infrastructure and inadequate teaching and learning facilities in Nigeria. This study utilized the mixed methods to examine the effect of school-based factors on the enrolment and achievement of senior secondary school physics students in selected locations in Nigeria. In all 248 physics students, 116 non-physics students and 14 physics teachers were involved in the study to elicit data. Major findings from the study revealed that students' achievement and enrolment correlated positively with resource availability, teacher qualification, resource utilization and teaching experience. The implication of this study is that schools in Nigeria are poorly financed with grossly inadequate laboratory facilities and resources for the teaching and learning physics which has resulted to the low popularity of the subject among students and poor achievement.

IA05: 4:10-4:20 p.m. Collaborative Completion of Homework Solutions Using Virtual White Board Technology

Contributed – Mark Haseman, United States Military Academy, Department of Physics and Nuclear Engineering, West Point, NY 10996-5000; mark.haseman@usma.edu*

For a number of introductory physics students, reviewing instructors' complete written solutions to homework problems can be a daunting experience. However, if the instructor can provide a solution to the student that outlines the process step-by-step, the once intimidating process is made accessible to the student. Virtual white board technology, like the Explain Everything mobile app, allows the instructor to develop these solutions, accompanied with their audio explanation of the problem solving process. Here we describe our efforts using a virtual white board platform to provide students with guided homework solutions. Initial feedback from surveys indicate that students prefer these guided solutions to the traditional static solutions. This better understanding led to increased classroom interaction, and performance on assessments will be presented to highlight trends.

*Sponsor: LTC Corey Gerving

Session IB: Post Deadline II Papers

Location: Bolden 5
Sponsor: AAPT
Date: Tuesday, January 12
Time: 3:30–5 p.m.

Presider: Tim Slater

IB01: 3:30-3:40 p.m. Investigating Scientific Inquiry Expectations in Undergraduate Physics Students

Contributed – Gabriel H. Nguyen, University of Sydney, 38 Hercules St., Fairfield East, NSW 2165, Australia; gabriel.nguyen@sydney.edu.au*

Manjula D. Sharma, John O'Byrne, University of Sydney

University science students are expected to encounter and develop scientific inquiry skills in their undergraduate years. As the focus on the quality of STEM education and workplace-ready graduates intensifies, we require tools that evaluate physics students on scientific inquiry skills. Our study focused on the development of a survey instrument that explored student expectations of the laboratory program from the perspective of scientific inquiry as they entered university. This survey was given to 950 first year physics students at the University of Sydney. Students entering university have optimistic expectations about the physics laboratory program, expecting the program to teach them about scientific inquiry skills. In particular, a factor on generic graduate attributes (Cronbach ? = .812) and another on science-specific skills (Cronbach ? = .777) were identified as a potential basis for a model of student expectations of the laboratory program.

*Sponsor: Manjula D. Sharma

IB02: 3:40-3:50 p.m. Junior-level Classical Mechanics Co-taught by an Engineer and a Physicist

Contributed – Jolene L. Johnson, St. Catherine University, 2004 Randolph Ave., St. Paul, MN 55105; jljohnsonarmstrong@stkate.edu

Kaye Smith, St. Catherine University

St. Catherine University in launching a new applied physics major. As part of our major we are slowly adding classes that prepare students for future education and careers in engineering or physics. This fall we offered "Mechanics for physicists and engineers" for the first time. The class was co-taught by an engineer and a physicist. Class content was a combination of material from a traditional statics and dynamics engineering class and a junior level classical mechanics physics class. In this talk I will discuss the structure of the class, the active learning activities we did, and the lessons learned from co-teaching physics and engineering content.

IB03: 3:50-4 p.m. Producing Videos for an Introductory Mechanics MOOC

Contributed – Michelle R. Tomasik, MIT, 36 Highland Ave., Apt. 45, Cambridge, MA 02139; mtomasik@mit.edu

Peter Dourmashkin, James Cain, MIT

Video is an important medium of instruction in online and blended classes. In this talk I will talk about two types of our experimental videos. We have been using the Adobe suite to produce short, simple animations. Making these videos is quite time consuming but they have the advantage of being able to add complex diagrams and break them down simply, as well as the ability to revise and edit the videos. Another new type of video has been made using the "light board". This type of board was originally created by Michael Peshkin at Northwestern and involves the instructor facing the camera and writing on a glass surface (the image is then mirrored using software). This form is more natural to teachers and is less time consuming but is limited in terms of editing and space available for presentation.

IB04: 4-4:10 p.m. Representational Fluency: A Key to Effective Physics Education

Contributed – Matthew J. Hill, The University of Sydney, Building A28, The School of Physics, Sydney, New South Wales, 2006 Australia; matthew.hill@sydney.edu.au*

Physicists view the world through a lens of representations (graphs, words, equations, and diagrams). Most research on representations in physics education focuses on individual representations, e.g. how do students use distance/time graphs, but little has been done on generic representational fluency combining a range of different representations. How can we facilitate learning representational fluency at university? 11 sets of research-based, online modules were deployed to first-year students at the University of Sydney. These pre-instruction modules targeted the use of equations, diagrams, and graphs in physics relevant to the week's lectures. Parallel were another set of modules targeting the conceptual knowledge required in first-year physics. Results indicate both sets of modules have a positive effect on both representational fluency (measured by the Representational Fluency Survey) and conceptual knowledge (measured by the Force Motion Concept Evaluation). This indicates that explicit teaching of quantitative skills can have a positive effect on in-lecture learning.

*Sponsor: Manju Sharma

IB05: 4:10-4:20 p.m. Social Annotation Analysis of General Physics by Using Machine Learning

Contributed– Suyoung Jin, Seoul National University, 1 Gwanak-ro, Gwanak-gu Seoul, 08826 Korea; s-young0@snu.ac.kr

Junehee Yoo, Seoul National University

The purpose of the study was to classify the interactive Social Annotation of general physics and to find its features by using Machine Learning that is used a document filtering based on the Naive Bayesian Classifier. Social annotations of general physics course adopted Flipped Learning were divided non interactive group and comments group. And then we make it learn document filtering algorithm. We compared to the probability of the word among the group. The difference between the two groups were analyzed by linguistic features and scientific terms based on scientific argumentation and properties of subjects. This will not be missing the important information for teacher by immediate and overall analysis. At the same time, this will be leading to participation and interaction of learners. The snu-samsung smart campus research center at Seoul National University provides research facilities for this study.

IB06: 4:20-4:30 p.m. Transforming Teaching Practices at the Undergraduate Level with a 'Peer Review of Teaching' Program

Contributed – Helen Georgiou, The University of Sydney NSW, NSW 2006; helen.georgiou@sydney.edu.au

Manjula D. Sharma, The University of Sydney

Research on effective teaching in undergraduate science unambiguously endorses certain pedagogies such as 'Active Learning', and offers evaluation strategies that encourage an evidenced-based approach to the development of teaching practices. However, the products of these efforts remain to be integrated in university teaching in any consistent or comprehensive way. In an attempt to bridge this notorious chasm between research and practice, a Peer Review of Teaching (PRT) program was introduced into The Faculty of Science at The University of Sydney, Australia. The PRT program aimed to: embed effective teaching strategies emerging from the literature into practice, create a community of practice amongst lecturers across the scientific disciplines, and raise the status of teaching in the research-intensive context. A description of the program will be presented, including details of the resources developed (such as the tools used to review teaching practices) and the outcomes of the program more generally.

IB07: 4:30-4:40 p.m. Latency Toward Public Speaking in Pre-Engineering and Physics

Contributed – Pamela A. Maher, University of Nevada Las Vegas, 718 Lacy Lane, Las Vegas, NV 89107; maherp@unlv.nevada.edu

Janelle M. Bailey, Temple University

Allan M. Tucka, College of Southern Nevada

This paper results from a research opportunity for students at a two-year college. It reports on latency, or hesitancy, toward public speaking among participating pre-engineering and calculus-based physics students. Thirty (N = 30) students self-selected to participate in this grant-funded outreach project. Participants each built a kit-based model of a da Vinci machine, designed an informational flyer aligned to state K-12 physical science standards, and presented informally to the general public visiting a planetarium. Multiple qualitative analyses of collected data assessed the participants' perceptions toward and latency about public speaking. Results suggest that latency stems from the fear of making mistakes or giving out misinformation. Participants demonstrated increased confidence in their ability to share their knowledge with the general public after having guided informal speaking opportunities. The results of this study can inform the practice of training future scientists and engineers in such soft skills.

IB08: 4:40-4:50 p.m. The Importance of Effective Study Strategies in a Blended Physics Course

Contributed – Jennifer DeBoer, Purdue University, 701 W Stadium Ave., West Lafayette, IN 47907; deboerj@purdue.edu*

Xin Chen, Purdue University

Lori Breslow, Saif Rayyan, Massachusetts Institute of Technology

We study student behaviors in an introductory studio physics course in a blended learning context at a large private university. Faculty and instructors had selected resources from a massive open online course they participated in developing and adapted those resources to make them available in the course on the local version of the university's MOOC platform. An initial survey revealed that students overwhelmingly liked the ability to learn immediately whether the answers to homework problems were correct or not. With that finding, we conducted a rigorous mixed-methods study of the students' use of the immediate corrective feedback from "checkable answers" as well as other online resources the students accessed while solving online homework problems. We find that students' organization of time and other effective study strategies play an important role in student performance, even controlling for their other behaviors, which has important implications for physics course design.

*Sponsor: John Belcher

IB09: 4:50-5 p.m. Knowledge Gain Through in-lab Videos in Physical Sciences Courses

Contributed – Jorge Dayer, UTEP 500 W. University, El Paso, TX 79912; jadayercarrillo@miners.utep.edu

Sergio Flores Garcia, Roy J. Montalvo, Maria D. Gonzalez, Leonardo J. Rodriguez, UTEP

The Physics Education Group from The University of Texas at El Paso has developed a hybrid instruction model to combine lab activities and a tutorial-based inquiry through the use of interactive videos. This didactical approach was designed and implemented at the physics department. Students in physical science courses were exposed to a lecture-in-lab understanding activity to construct the concept of density in the contexts of solids and liquids. Students were exposed to a 30-min video of the lab activities that were available for the students throughout the entire lab session, allowing them to watch it as needed. Data was collected through a post-test, a pre-test, and homework designed in the same context of the corresponding learning topics. Finally, we will present the corresponding learning Hake Gains.

Session IC: Post Deadline III

Location: Bolden 6
Sponsor: AAPT
Date: Tuesday, January 12
Time: 3:30–5 p.m.

Presider: Don Franklin

IC01: 3:30-3:40 p.m. Adapting MOOC Pedagogy to a Blended Quantum Mechanics Course

Contributed – Saif Rayyan, MIT, 77 Massachusetts Ave., room 8-310, Cambridge, MA 02139-4307; srayyan@mit.edu

Barton Zwiebach, MIT

In spring 2015, the physics department at MIT offered a MOOC on edX in intermediate quantum mechanics (8.05x: Mastering Quantum Mechanics). In parallel to running the MOOC, MIT students were offered the opportunity to take the course for credit. In this experimental residential offering, lectures and traditional homework sets were eliminated in favor of learning sequences (based on video recorded lectures and short exercises) and online homework from the MOOC. While most of the course activities were moved online, students had to meet with the instructor for two recitation hours, and took traditional pen and paper exams (a midterm and a final). I will describe the design of the course, the technology used to transform the content to an online format, and the results of the experiment in terms of student performance, habits and attitudes toward the course.

IC02: 3:40-3:50 p.m. Connecting Introductory Astronomy with Majors Outside of the Sciences

Contributed – Matthew P. Perkins Coppola, Indiana University-Purdue University, Fort Wayne, 2101 E. Coliseum Blvd., Fort Wayne, IN 46805-1499; perkinsm@ipfw.edu

Introductory astronomy is popular with non-science majors in need of a laboratory course for graduation. Students come to this course with sincere interest in learning more about the universe, but often fail to appreciate how their own career paths may intersect with astronomy in significant ways. In my section of introductory astronomy I asked students to research these intersections and write a paper summarizing their findings. Students in all majors found ways to connect to astronomy, transforming a course of disconnected curiosities into career opportunities for their futures.

IC03: 3:50-4 p.m. Exploring the Nature of Interactions During Peer Instruction for Different Subject-Experience Pairs

Contributed – Judy Vondruska, South Dakota State University, Box 2222, SDEA 263 Brookings, SD 57007; judy.vondruska@sdstate.edu

Previous subject experience has been shown to influence interactions during peer instruction in an introductory physics course. This paper will present results from a qualitative study, conducted during the Fall of 2015, exploring the nature of interactions during peer instruction for different subject-experience pairs. Specifically, the study examines student perceptions about the value of student response systems in learning physics, the value of peer interactions during lecture, and the nature of the discourse between peer instruction partners. The data for this study was collected through semi-structured interviews with physics students from different subject-experience pairs in an introductory, one-semester physics survey course. This study is Phase II of an explanatory-sequential mixed methods research design.

IC04: 4-4:10 p.m. Fusing Physical Science and Culture with the Concept of Time

Contributed – R. Steven Turley, Brigham Young University, N345 ESC, Provo, UT 84602-0002; turley@byu.edu

Brian Jackson, Brigham Young University

Brigham Young University has introduced a set of General Education/Honors classes called "Unexpected Connections." These courses are intended to explore ideas from the perspective of two different disciplines, in our case physical sciences and cultural studies. The classes are taught by faculty from different disciplines with a unifying focus. Our course was taught by a physics and an English professor. We chose the topic of time as our unifying theme. From the physical science side we discussed Newton's Laws, Relativity, geological time, astronomical time and distance, and cosmology. On the global/cultural side we discussed time and nature in pre-modern cultures, factory time and time in modern life, frames of cultural reference (e.g., Hiroshima from a U.S. and Japanese perspective), and creation stories. In this presentation, we will discuss our successes, challenges, and surprises in getting students from a variety of majors to critically engage a topic from such disparate disciplines.

IC05: 4:1-4:20 p.m. Students' Conceptual Understanding Difficulties with Vector Operations

Contributed – Leonardo J. Rodriguez, UTEP, 500 W University, El Paso, TX 79968; leordz96@hotmail.com

Sergio Flores, Roy J. Montalvo, Maria D. Gonzalez, Jorge A. Dayer, UTEP

Many introductory physics students encounter challenges in understanding vector operations. A functional understanding of this concept requires that students be able to reason about vectors in different contexts. We present data collected from more than 300 students and related to traditional instructions. This data describes students' conceptual difficulties with vector addition/subtraction. These students were organized in small groups led by student Teaching Assistants (TAs). The TAs help students understand vector operations during a hands-on 50 minute session. Analysis of the data suggests that, after traditional instruction, some students were unable to reason qualitatively about the vector operations. We describe some specific procedural and reasoning difficulties we have observed (e.g. 1. Closing the loop, 2. Tip-to-tip, 3. Use of Pythagorean Theorem, and 4. Adding as scalars) and describe modifications to laboratory instruction that we have design on the basis of our research into student's understanding.

IC06: 4:20-4:30 p.m. Using Robotics and Relatable STEM Topics to Motivate Students to Pursue Careers in Science

Contributed – Mostafa A. Elaasar, Natural Sciences Department/Southern University at New Orleans, 6400 Press Dr., New Orleans, LA 70126; melaasar@suno.edu

Rachid Belmasrour, Jeniece Alberts, Brandon Bailey, Amber Dillon, Natural Sciences Dept./Southern University at New Orleans

Southern University at New Orleans (SUNO), through the Research on the Science and Engineering of Signatures" (ROSES) grant, hosted two 2-week mathematics and science camps (GEMS) for students completing grades 2nd through 6th by June 1, 2015. GEMS is intended to capture grade school students' interest in math and science and motivate them to pursue careers in STEM fields. The camps consisted of one week of Lego Robotics and one week of various demonstrations in biology, forensic science, mathematics, and physics. Many members of the SUNO faculty graciously volunteered during the camps to teach topics related to their fields. Approximately 90 children attended the two sessions. We will discuss the camps and present the survey results. Funded by U. S. Department of Energy, National Nuclear Security Administration (NNSA), the Minority Serving Institution Partnership Program (MSIPP) Grant Number DE-NA0002683.

IC07: 4:30-4:40 p.m. Embedding Digital Technology in College Physics by Inquiry Learning Progressions

Contributed – Andrew W. Dougherty, The Ohio State University, 191 West Woodruff Ave., Columbus, OH 43210; dougherty.63@osu.edu

Bruce R. Patton, The Ohio State University

Physics by Inquiry at The Ohio State University has evolved over several decades starting from the original University of Washington framework. Changing core science standards, new equipment options, and experimental innovation have played roles in the current format of the course offered as a key part of K-12 teacher preparation. The attempt to align content with Ohio science and math standards has expanded the learning progression approach implicit in Physics by Inquiry. The incorporation of computers and sensors is used as a natural extension of introductory hands-on activities which develop conceptual understanding and intuition. The digital lab analysis then emerges as a higher order construct rather than a black box that many students remember from physics labs. The sequence is useful as a representation of the NGSS progression from K to 12 grades as well as a way to develop robust and technologically advanced understanding in a course sequence.

IC08: 4:40-4:50 p.m. The Impact of 1:1 Laptops in Senior High School Sciences

Contributed – Simon Crook, University of Sydney, School of Physics, Building A28, Sydney, NSW 2006 Australia; scro9006@uni.sydney.edu.au*

Manjula D. Sharma, Rachel Wilson, University of Sydney

Our study capitalized on a unique natural experiment rather than a researcher- designed, randomized experiment whereby, thanks to the Australian Government's Digital Education Revolution, half of grade 9 students received laptops and half did not. Consequently, when these students sat for their grade 12 standardized external examinations, half of them had been schooled with 1:1 laptops for over three years, and half without. With school principals and district administrators asking the question "what will these laptops do to our examination results?" this dichotomous scenario presented us with a unique opportunity to find out. The science students (N=967) from 12 high schools in Sydney, Australia were studied. Using socio-demographic, school and examination data, multiple regression analyses were performed to measure the impact on student attainment in biology, chemistry and physics. Our findings will be presented plus further analyses that will explain the different impacts between the subjects.

*Sponsor: Manjula D. Sharma

Session PST3: Post Deadline Posters

Location: Storyville Hall, 3rd Floor
Sponsor: AAPT
Date: Tuesday, January 12
Time: 3:30–5 p.m.

Persons with odd-numbered posters will present their posters from 3:30–4:15 p.m.; even-numbered will present 4:15–5 p.m.

PST3A01: 3:30-4:15 p.m. MinecraftEDU and Higher Education

Poster – Amanda Depoian, Siena College, 4 Filmore Ave., Coram, NY 11727; al17depo@siena.edu

Labs were developed for college-level physics introductory courses using Minecraft. Worlds were developed in MinecraftEDU for students to perform experiments to measure constant velocity and the acceleration of gravity. In addition to the MinecraftEDU worlds, lab instructions, a pre-test and post-test, and a python inotebook to perform the line fitting and statistical analysis were developed. Two lab sections completed the labs in Minecraft while two other lab sections did the traditional labs. The results of the pre-test and post-tests, as well as any takeaways from the lab instructors or the students will be presented.

PST3A02: 4:15-5 p.m. Spin First Instructional Approach to Teaching Quantum Mechanics in Sophomore Level Modern Physics Courses

Poster – Homeyra R. Sadaghiani, Cal Poly Pomona, 1632 E. Autumn Dr., West Covina, CA 91791; hrsadaghiani@cpp.edu

James Munteanu

As part of ongoing research in teaching and learning quantum mechanics using the Spin First approach, we are investigating student learning of basic introductory quantum concepts in sophomore level Modern Physics courses at Cal Poly Pomona. In the Spin First approach, postulates of quantum mechanics are introduced in the context of Stern-Gerlach experiments with discrete spin-half bases. We have collected QMCA post-test data for several sophomore-level classes using either Spin First or traditional approaches in teaching quantum concepts. We will share the results and discuss the implications for instructors of introductory quantum courses.

PST3A03: 3:30-4:15 p.m. An Alternative Door to the Physics Lab

Poster – Ravin Kodikara, Webster Universit,y 470 E Lockwood Ave., St Louis, MO 63119; ravinkodikara30@webster.edu

Laboratory activities are an important part of undergraduate physics course. Generally a lab manual contains multiple instructions including a brief introduction, equipment needed, the methodology, instruction to analyze data and follow-up questions. This conventional procedure is popular among faculty and students due to many reasons including the clarity of instructions, and the ability to generate accurate data and results. However, during years of direct engagement with physics labs, author of this poster has identified several drawbacks associated with the conventional procedure. For an example, a lab with detailed instructions designed to produce accurate results might not promote student's creativity, critical thinking and/or retention. Attempting to address the above issues, at Webster University, a series of novel undergraduate physics labs were developed following an alternative approach. This poster presents several of these new labs and a comparison between the two lab procedures in terms of students' engagement, application and retention.

PST3A04: 4:15-5 p.m. Incorporating Video Games into the Physics Classroom

Poster – David Rosengrant ,Kennesaw State University, 370 Paulding Aven., Marietta, GA 30062; drosengr@kennesaw.edu

Tracey Beyer, Philip Money, River Ridge High School

Berkil Alexander, Kennesaw Mountain High School

Motivation is a key factor in learning. If you can "hook" students so that they are personally vested then they typically want to learn the material. One student hook is to use video games. Though physics games can at times suspend reality, they typically need to follow the laws of physics to make the game believable. Some games even provide necessary information instructors can use in their lessons. This presentation focuses on two ways you can use video games: full lessons and video game vignettes. Examples of a full lesson can be based off a video of a game or actual game play while they do a lab. A video game vignette is an alternative to the back of the book problems. It's a short clip of a video game that is accompanied by a question that the student may need to make assumptions or extrapolations from that clip in order to answer the question.

PST3A05: 3:30-4:15 p.m. Inquiry Instruction vs. Inquiry and Lecture Instruction for College Physics

Poster – Cody Postupac, Westminster, 10 Quail Ct., Export, PA 15632; postct22@wclive.westminster.edu

An inquiry-based style of teaching can be more beneficial instructional strategy for students than compared to lecture. However, the time that it takes to cover the material using inquiry-based style is often the greatest concern for teachers. Consequently, a teacher using inquiry may feel pressure to move to some lecture mixed with inquiry-based instruction. This study, which is currently in the data analysis stage, was conducted using introductory physics and astronomy classes at Westminster College, under the NSF Noyce IQ Stem scholarship program. As a teacher's assistant, I employed two different teaching styles, inquiry and a mix of lecture with inquiry, in different sections of the courses to compare the two styles. The results of the data, obtained using a pretest/posttest design will show if there are any differences in student achievement between groups.

PST3A06: 4:15-5 p.m. Professional Development: Practice Makes Perfect

Poster – Aaron T. Lee, UC Berkeley, Astronomy Department, 501 Campbell Hall, Berkeley, CA 94720; a.t.lee@berkeley.edu

Training courses for new faculty and graduate students often focus on discussing the pedagogy literature rather than the teaching experiences of the participants. Instructors inadvertently present literature findings as "recipes for success" but fail to address how to effectively, for example, run group work activities or write strong assessments. I discuss an approach to a professional development course that emphasizes (and encourages) participants to try out different teaching techniques in their classrooms. Course time is spent discussing the successes and failures of the participants. Implementing this course over the past four years here at UC Berkeley, I have found that the graduate student participants together arrive at the same results as those found in the literature, which makes the results more memorable and applicable to their own classrooms. This poster also discusses how this course could be implemented as an informal discussion group amongst new and seasoned faculty members.

PST3A07: 3:30-4:15 p.m. Understanding Solar Motion Through Analyzing Satellite Photography

Poster – Margaret Jensen, Purdue University, 400 N River Road, apt 1622, West Lafayette, IN 47907-2040; jensen38@purdue.edu

Shane L. Larson, Northwestern University

A topic often taught in introductory astronomy courses is the changing position of the Sun in the sky as a function of time of day and season. Traditionally, students often have difficulty understanding the geometry of the observed motion in the sky, due to graphical representations and visualizations that can be difficult to render and grasp. Sometimes students are asked to observe the Sun's changing motion and record their data, but this is a long-term project requiring several months to complete. This poster outlines an activity for introductory astronomy students that takes a modern approach to this topic, namely determining the Sun's location in the sky on a given date through the analysis of satellite images of the Earth. This activity shows that with a few simple measurements, students can solidify their understanding of annual solar motion in a more relevant, real-world context.

PST3A08: 4:15-5 p.m. Legacy of the PhysTEC Grant

Poster – Chuhee Kwon, California State University Long Beach, 1250 Bellflower Blvd., Long Beach, CA 90840-0119; chuhee.kwon@csulb.edu

Galen T. Pickett, Laura Henriques, California State University Long Beach

California State University, Long Beach is a legacy PhysTEC site that completed the grant in Aug. 2013. We have managed to sustain most of the components initiated with the grant. The number of paid Learning Assistants has increased from 10 during the grant to 20. Two courses initiated with the grant, early teaching experience (PHYS 390) and PCK (PHYS 491), are thriving. Monthly Demo-Sharing, bi-annual Physics Teacher Open House, and Physics Mixer events are also continuing with a healthy number of high school teachers and majors attending regularly. The PhysTEC grant has been a transformative experience for the department. We have more than tripled the number of undergraduate majors, graduated 32 bachelors and 4 masters in AY 2014-15, increased the number of students in the physics credential program, and developed several collaborative projects with the Science Education Department.

PST3A09: 3:30-4:15 p.m. Analysis of an Electric Field Driven Charged Pendulum

Poster – Jared M. Gavin, University of Arkansas at Monticello, 346 University Drive, Monticello, AR 71656; gavinj@uamont.edu

The implementation of an operational amplifier in combination with a Pasco based lab apparatus will be presented as a technique for analyzing a pendulum driven by an electric field as observed with Franklin's Bell. This experimental setup provides undergraduate physics students with a platform to investigate Coulomb force, signal detection, nonlinear dynamics, and one of the most useful electronic devices in analog circuitry. The one-way travel time between parallel plates will be approximated, measured and compared to theoretical predictions. The operational amplifier utilized in this experiment is low-cost and gives students experience in constructing their own devices that can be used to tackle more challenging measurements.

PST3A10: 4:15-5 p.m. How to Be Successful in Introductory Physics Despite Weak Math Background

Poster – Irene Guerinot, Maryville College, 502 E. Lamar Alexander, Maryville, TN 37804; irene.guerinot@maryvillecollege.edu

Pre-health, biology, and exercise science students are required to take Physics courses at Maryville College. The vast majority of these students do not have a very strong math background and failing Introductory Physics is a strong possibility. We will discuss the modifications we made into our course delivery and context to avoid such negative outcome.

PST3A11: 3:30-4:15 p.m. Progress Toward the Design and Construction of a Low-cost Raman Spectrometer

Poster – Jason Alexander, University of Tennessee at Martin, 20 Mt. Pelia Road, Martin, TN 38238; jalexa39@utm.edu

Rebecca Bloodworth, Krysten Harris, Amber Taylor, Casey, Vincent University of Tennessee at Martin

Over the past two semesters, eight students from across disciplines have worked together to design and begin construction on both a tunable diode laser system and a low cost, high performance Raman spectrometer. Raman spectroscopy is a non-destructive technique that uses laser light to excite molecular vibrations. It is used across industry, the biological, and physical sciences to characterize the behavior of molecules in ways complimentary to other spectroscopic methods. Like a fingerprint, no two molecular species have the exact same Raman spectrum. This makes it a powerful ally to visible, IR, and mass spectroscopy. Compared to commercial units with similar performance, the laser is ~1/6 the cost and the spectrometer is ~1/3 the cost. We will discuss the design parameters for these instruments as well as conducting physics research with non-physics majors.

PST3A12: 4:15-5 p.m. Shifting from Core Concepts to Integrated Topics in Astro 101

Poster – Debbie A. French, University of Wyoming, 816 Ord St., Laramie, WY 82070; frenchd14@yahoo.com

Andrea Burrows, Timothy F. Slater, University of Wyoming

This study focuses on Astro 101 students' ability to apply core astronomy ideas such as Universal Gravitation and the Doppler effect to the broader task of calculating the amount of dark matter in a galaxy. Fifty-four undergraduate Astro 101 students participated in this study. Students received a variety of instructional methods prior to the Dark Matter activity. Sixty-nine percent of students successfully calculated the amount of Dark Matter in NGC 2742, 16% partially completed the task, and 15% submitted work that did not demonstrate sufficient understanding. Students reported they remembered basic facts (e.g., Newton's Laws of Motion, definitions of mass, weight), personal stories of scientists, hands-on activities, and the abundance of dark matter (post only) best from this section. These results are important because 40% of Astro 101 students eventually become education majors. These encouraging results illustrate how introductory college science classes can be re-designed to include inquiry-based teaching methods.

PST3A13: 3:30-4:15 p.m. Teaching Argumentation in Physics Through Citizen Science: Traffic Cameras

Poster Matthew P. Perkins Coppola Indiana University-Purdue University Fort Wayne 2101 E. Coliseum Blvd. Fort Wayne, IN 46805-1499 perkinsm@ipfw.edu

Citizen science is a well-established way of including non-scientists in authentic research projects in biology and astronomy. Examples in physics are sparse if non-existent. Preservice secondary science and mathematics teachers enrolled in a teaching methods course applied their knowledge of kinematics in the investigation of the safety of traffic intersections in their community. Students then researched and wrote an argumentative paper taking a position on the use of traffic cameras to police red light and speed violations. The future teachers successfully considered the model for traffic safety and developed informed positions on a topic of opinionated debate in many communities.

PST3A14: 4:15-5 p.m. Student Engagement Using "Real-life" Physics Activity

Poster – Gideon A. Adu, Claflin University School of Natural Sciences, Dept of Math/Computer Science, Orangeburg, SC 29115-4477; ekpenuma@claflin.edu

Jason S. Cummins, Alex Q. Keitt, Abraham Rotich, Ifeanyi K. Uche, Sylvester Ekpenuma, Claflin University

Groups of students were assigned to perform real life projectile motion playing basketball– trying to make free throws. Measurements of times, heights, distances were made in order to verify the equations for maximum height, range, and trajectory (the parabolic equation) of the projectile motion, and to determine the effect of air resistance which was neglected in classroom discussions. This activity was to evaluate student engagement outside of a classroom setting, their conceptual understanding and ability to make applications. This group will present and discuss their results.

PST3A15: 3:30-4:15 p.m. Teachers' Perceptions of Integrated STEM After a STEM Guitar Institute

Poster – Debbie A. French, University of Wyoming, 816 Ord St., Laramie, WY 82070; frenchd14@yahoo.com

Richard M. French, Purdue University

This study focuses on teachers' perceptions of integrated STEM before and after participation in a week-long faculty institute where teachers built electric guitars, received training on implementing integrated STEM lessons, and developed guitar-themed STEM learning activities. Seventeen middle, high school, and community college faculty in various STEM fields participated in this institute. Teachers completed a Likert-type survey focusing on teachers' perceived barriers of STEM implementation, level of preparation, and perceptions of integrated STEM. Teachers strongly agreed teaching integrated STEM was important. The teachers agreed their integrated STEM preparation was adequate. The teachers most commonly cited, "Lack of experience in STEM integration, insufficient background in integrated STEM, and insufficient time and support to plan for implementation" as barriers to implementing integrated STEM concepts in their classroom. These results shed light on how this particular professional development changed teachers' perceptions of STEM and will inform the development of future workshops.

PST3A16: 4:15-5 p.m. Teacher and School Factors in K-12 Math and Science Learning

Poster – Bruce R. Patton, The Ohio State University, 191 West Woodruff Ave., Columbus, OH 43210; patton.1@osu.edu

Andrew W. Dougherty, The Ohio State University

The role of factors impacting effective student learning of core math and science content is investigated within the context of a K-12 professional development program modeled on Physics by Inquiry. A rigorous evaluation model with a quasi-experimental design is used to examine extent and depth of teacher content knowledge, teaching pedagogical knowledge and as well as relevant cognitive research. Teacher instruments include reliable and validated content diagnostics, scientific reasoning tests, MOSART assessments as well as the SEC, STEBI, OCI, and classroom observations with ICOP. Student level data involve nationally normed math and science formative assessments (NWEA MAP tests) and state math and science assessments. Examples discussed include correlation between higher order student and teacher conceptual reasoning, ANCOVA controlling for student backgrounds, item response and comparative student gain analysis of common formative assessments to inform teachers, and possible application of regression discontinuity analysis.

PST3A17: 3:30-4:15 p.m. Viewing Gender Differences on the FCI Through a Psychometric Lens

Poster – Alexis Papak, UIUC/Purdue University, 108 E John St., Champaign, IL 61820; papak2@illinois.edu

Adrienne Traxler, Wright State University

Rebecca Lindell, Purdue University

While many studies have investigated why men out-perform women on the Force Concept Inventory (FCI), no study has examined it from a basic psychometric perspective. According to psychometric theory, it is essential for inventory developers to establish the fairness of the instrument for any population for which it is intended. When creating any physics instrument, the population intended is the standard physics classroom where men outnumber women four to one. When field-testing items for appropriateness, it is easy to miss any gender differences on items due this imbalance of men to women in the sample population. This study utilizes classical test theory to examine the FCI for both men and women students independently in hopes to determine the appropriateness of each item on the FCI for each gender. This poster will present results from this study as well as discuss the findings and provide implications for future study.

PST3A18: 4:15-5 p.m. Student Responses in Interdisciplinary Physical Science and Global/Cultural Awareness Course

Poster – R. Steven Turley, Brigham Young University, N345 ESC, Provo, UT 84602-0002; turley@byu.edu

Brian Jackson, Brigham Young University

Brigham Young University has introduced a set of General Education/Honors classes called "Unexpected Connections." These courses explore ideas from the perspective of two different disciplines, in our case physical sciences and global/cultural awareness. Our course was taught by a physics and an English professor with the topic of time as our unifying theme. From the physical science side we discussed Newton's Laws, Relativity, geological time, astronomical time and distance, and cosmology. On the global/cultural side we discussed time and nature in pre-modern cultures, factory time and time in modern life, viewing events from different perspectives (Rashomon, Hiroshima from a U.S. and Japanese perspective), and creation stories. We will present student reactions and insights to their experience learning from two very different disciplinary perspectives in the same class. These include student response to surveys and examples of interdisciplinary insights they shared in their informal writing and term projects.

PST3A19: 3:30-4:15 p.m. A Comparison Between a Traditional Lecture and an Online Version of Introductory Astronomy

Poster – Gina A. Sorci, University of Louisiana Lafayette, 104 Ivy Circle, Lafayette, LA 70508; sorciga@yahoo.com

An introductory astronomy course has been taught for many years in the traditional lecture hall fashion. The number of students usually ranges from 130 to 180. Recently our department has added an online version of the course. At our institution student teacher interaction is required for online courses so the number of students in these courses is kept low no larger than 30 in most instances. A comparison between these two types of courses will be made by looking at test, homework and quiz scores to determine student success. Student participation will also be examined by comparing several different formats such as clicker quizzes in the face to face and forums in the online course

PST3A20: 3:30-4:15 p.m. High Altitude Balloon Experience at RCTC; Lessons Learned

Poster – Andrea Walker, Rochester Community and Technical College, 851 30th Ave., SE Rochester, MN 55904; Andrea.Walker2111@mb.rctc.edu

Nate Brown, Rod Milbrandt, Rochester Community and Technical College

Three community college students prepared and successfully launched a high altitude balloon (HAB) this spring for a team project in our calculus-based physics class. This poster will discuss our experiences, including preparation, materials, cost, troubleshooting and other details along with data analysis, pictures, and ideas for improvements and extensions. The project generated a lot of excitement and interesting data and we highly recommend HAB experiments for other colleges and high schools.

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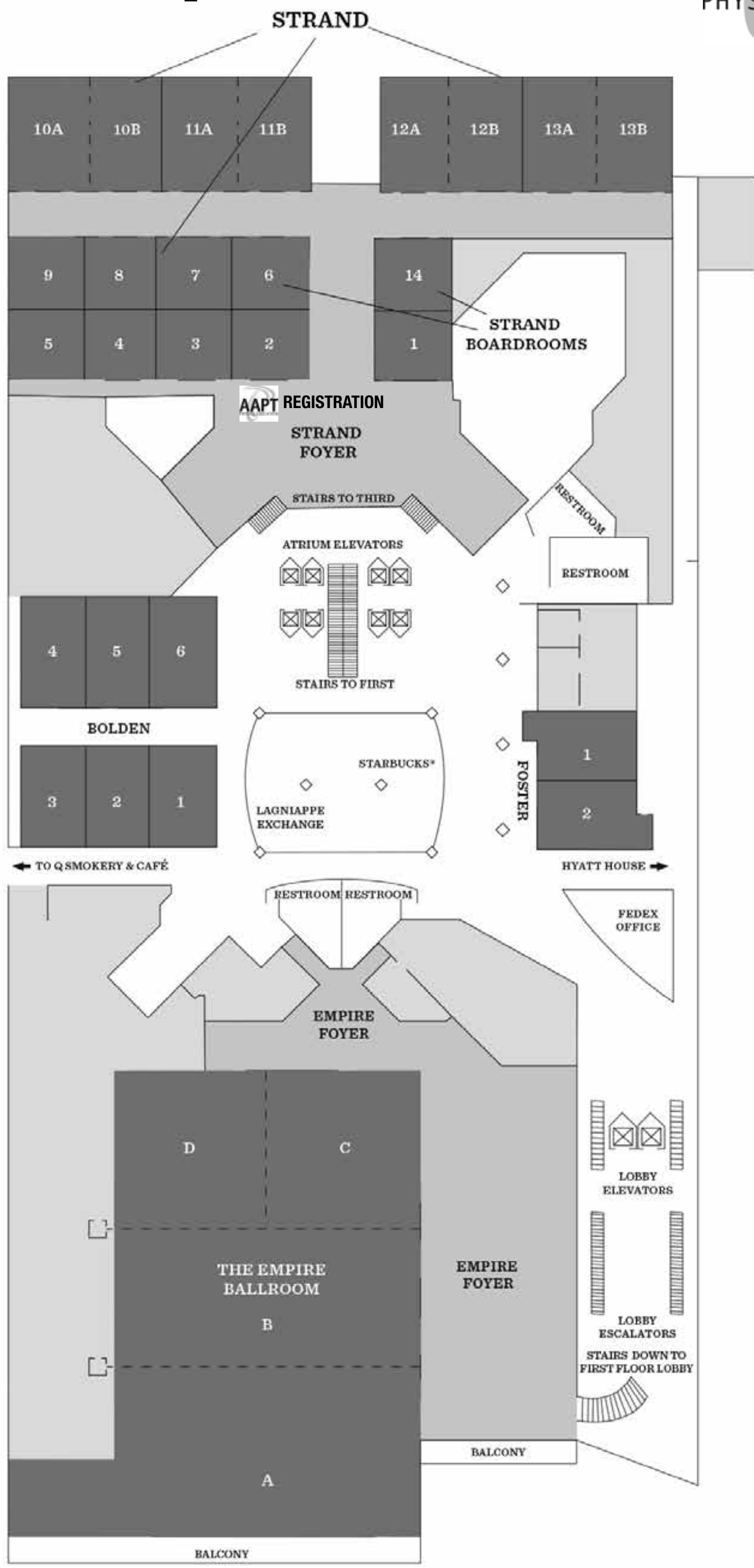
Hyatt Regency Hotel Map – Level 2



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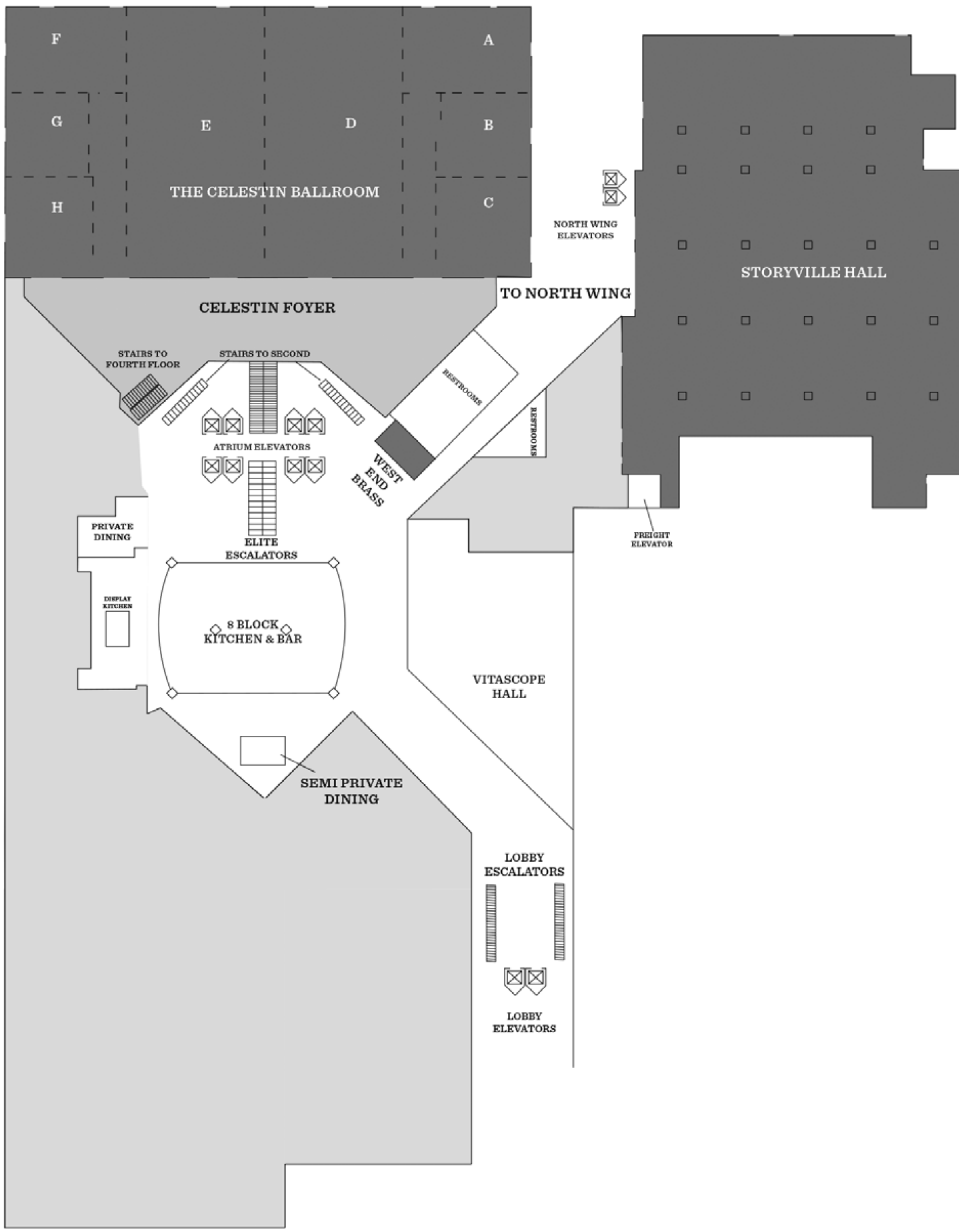

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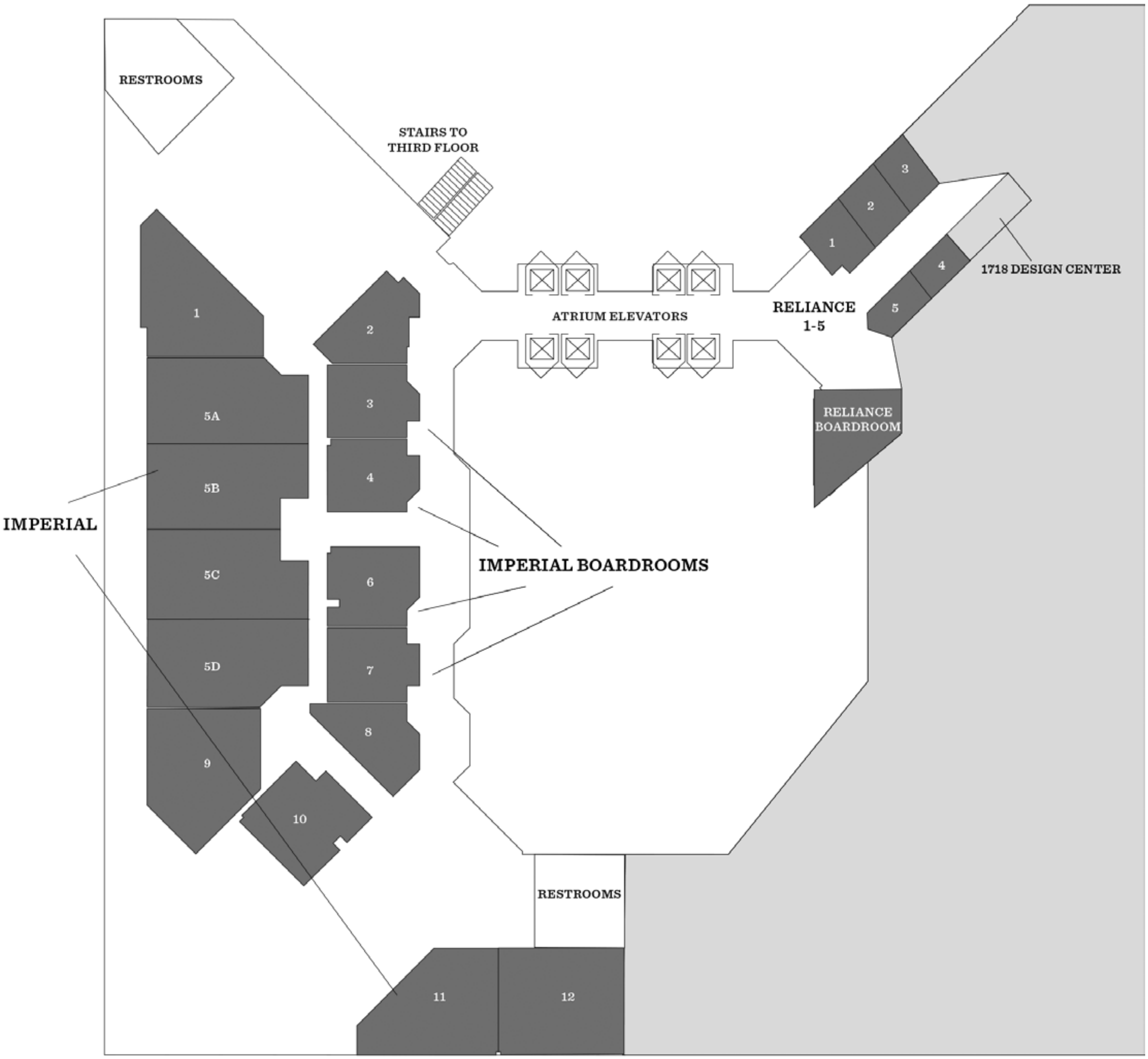

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The Bauder Fund will consider applications that request funds for:

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- The Bauder fund will reimburse approved expenses supported by original receipts and claimed on a report of the activity submitted to the AAPT Programs Department.
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