2012 AAPT Summer Meeting

Philadelphia 2012
Physics: The Experimental Core

Philadelphia, PA
July 28–August 1, 2012

University of Pennsylvania

AAPT PHYSICS EDUCATION

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

Welcome to Philadelphia!

You are in for a treat. Philadelphia, Pennsylvania, was the home of the first great American experimental physicist, Ben Franklin. Our meeting venue is one of America's oldest college campuses, the University of Pennsylvania. The 5K AAPT Walk/Run, a fundraiser that supports our meetings and conferences, will tour this beautiful campus!

Attendees will also have a chance to visit area attractions. Don't miss the trolley tour of downtown Philadelphia. Experience the sights and hear the tales of a city that forged a nation, cheered for Rocky, and is home to the oldest natural science research institution and museum in the western hemisphere, the Liberty Bell and Independence Hall! The city is known for its hoagies, scrapple, soft pretzels, Philadelphia Water Ice, Tastykake, and is home to the cheesesteak. Be sure to visit the two most famous cheesesteak vendors in Philly, Pat's and Geno's. These two vendors have a highly publicized rivalry and are located across the street from each other on 9th St. and Passyunk Ave. in South Philadelphia, just three miles from campus.

Like Philadelphia, the 2012 AAPT Summer Meeting has much to offer. Our celebration of Physics: The Experimental Core will feature an opportunity to watch a live performance and learn more about the life and times of Benjamin Franklin, one of the leading figures of early American history. Physics is an experimental science. Encouraging and empowering the next generation to embrace the art of experimentation that lies at the core of physics will ensure that our field remains vibrant and alive. Our plenary sessions will explore our field across the scales of size, from the very small to the very large, with a stop at the human scale. Schools of fish, flocks of birds, and stampeding elephants are examples of phenomena from the natural living world that can be described using the tools of physics. Biological physics is a rapidly developing field of research that lies at the boundaries of physics, chemistry, and biology, and seeks to contribute to our understanding of life.

Our 17 area committees span interests from Apparatus, to Women in Physics, to Science Education for the Public to Teacher Preparation to Professional Concerns. All interested members are welcome to attend these committee meetings, which are listed in the schedule, to get involved!

We'll hear talks that cross time, from "Experience, Experiment, Entertainment: Electrostatic Apparatus in the Age of Franklin" to looking to the future of our field with the "APS Bridge Program: Enhancing Diversity in Physics Graduate Education." Speakers will answer questions such as "Can computational modeling be accessible to introductory students?" and how can we provide quality laboratory experiences in these days of tight budgets? We can look outward to "Frontiers in Astronomy and Space Science" and inward to "Faculty Peer Mentoring." We can explore ways to innovate our laboratory instruction and gain "International Perspectives on Laboratory Instruction." We can learn more about "Leadership Models in Science" and "Mentoring Minority Students." We can learn from the results of the "Two-Year College New Faculty Experience." We can also relax and be amazed, even though we understand the science, by demonstrations from Third Eye.

Preceding this meeting, July 25-27, ALPhA will host the 2012 Topical Conference, "Laboratory Instruction Beyond the First Year of College." And "The New Faculty Commencement Conference," part of AAPT's New Faculty Experience for Two-Year College Faculty will take place July 27-30. Directly following this meeting, the Physics Education Research Conference (PERC) is scheduled August 1-2, 2012. It will be a busy meeting and I'm excited to have you here! Please send me your feedback and stories from the Summer Meeting.

Gay Stewart, gstewart@uark.edu

2012 Program Chair

AAPT Sustaining Members

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

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Special Thanks

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

Our Philadelphia organizers:

- From the University of Pennsylvania: Larry Gladney, Physics Department Chair, Asante Barr, Bill Berner, Bryan Boulden, Erin Fallon, Lauren Gala, Vivian Hasiuk, Stephanie Heminger, Jane Horowitz, Chris Leary, Millicent Minnick, Jim Nixon, and Harriet Slogoff
- Darnell Belford, of the Philadelphia Convention and Visitors Bureau

Paper sorters: Kathleen Falconer
Brittney Johnson
Dyan Jones
Mary Bridget Kustusch

AAPT Executive Board

Facebook/Twitter at Meeting

We will be tweeting and posting upates to our Facebook page before and during the meeting to give you all the details of the meeting. Participate in the conversation by reading the latest tweets here, or placing the hashtag **#aaptsm12** in your tweets! We will also be tweeting and posting to Facebook any changes to the schedule, cancellations, and other announcements during the meeting. Follow us to stay up to the minute!

(facebook.com/physicsteachers and @physicsteachers on Twitter)

Contacts:

AAPT Programs & Conferences Dept:
301-209-3340; programs@aapt.org

Tiffany Hayes, Director, Programs & Conferences

Cerena Cantrell, Associate Director, Programs & Conferences

Janet Lane, Programs Administrator

Pearl Watson, Meetings Logistics & Registration Coordinator

American Association of Physics Teachers
One Physics Ellipsethy
College Park, MD USA 20740-3845
301-209-3340, fax: 301-209-0845
programs@aapt.org, www.aapt.org

Dear Dr. Huggins,

Thank you for your very interesting workshop and demonstration of the real possibility of starting with relativity in an introductory level class. It's hard to make such a fundamental change, but I am greatly intrigued, since special relativity is what got me really hooked on physics when I was first exposed to it in high school.

Thanks again, K.C., 17 Feb 2010
AAPT Southeast Pennsylvania

To:<lish.huggins@dartmouth.edu>

I just received Physics2000 in the mail. Thank you very much. I am really enjoying it. It is a good read, and I agree with the concept of doing SR first for the same reasons you state in the book. I have done it that way for the past 2 years in my high school class, and it has been fairly well received. I find that teaching it is greatly improving the depth of my own understanding.

The simultaneity and causality thought experiments are presented clearly - better than the presentations I have seen in other books. The same applies to the discussion of wave speeds, and the derivation of gamma.

Kind Regards, R. L. 30 Aug 2009

Professor Huggins,

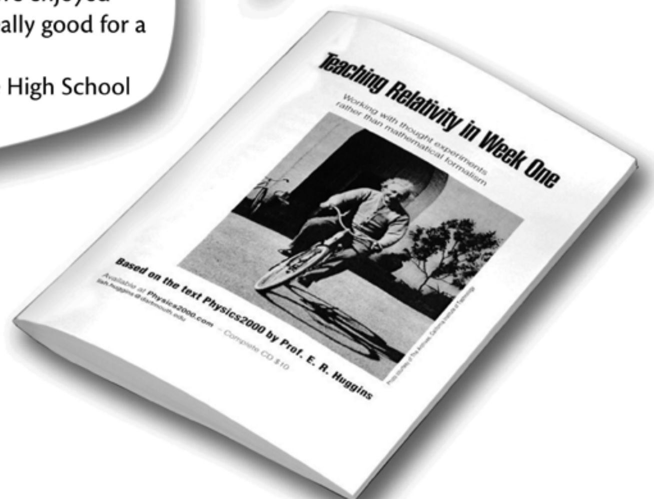
I am truly enjoying reading your textbook. I must admit that this is the first physics text that I have enjoyed reading - most text are really good for a bad case of insomnia.

M.C., Bentonville High School
11 Aug 2005

Monday, July 30
12:15–1:15 p.m.
Houston Hall - Golkin

Free Workshop: Physics2000.com

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



Dr. Huggins,

I teach high school chemistry and physics and have obtained your complete Physics 2000 package, which I am reading. I like it very much! Thanks for an incredible piece of work and for making it available at a very reasonable price!

B.N., R.N., M.S. 2 Jun 2006
Corpus Christi, Texas

Physics2000 workshop

on introductory physics.

This summer we will focus on:

- The **lack of simultaneity**
- The time energy form of the **uncertainty principle**, and
- **Vacuum energy** in cosmology

To: lish.huggins@dartmouth.edu

I concider your texbock the best physics book so far. Electrodynamics must be your faible.

Greeting from Germany, F.F. 11 May 2009

Come to the **Physics2000** booth where we plan to demonstrate vacuum energy with negative pressure.

First time at an AAPT meeting?

Welcome to the 2012 AAPT Summer Meeting in Philadelphia! 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 19 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 7:15–8:20 a.m. on Monday in the Irvine Auditorium, Cafe 58. It is a wonderful way to learn more about the meeting and about AAPT. This is the first time it will be held in our Exhibit Hall!
- Awards and other plenary sessions have distinguished speakers and are especially recommended. Invited speakers are experts in their fields and will have half an hour or more to discuss their subjects in some depth. Posters will be up all day and presenters will be available during the times indicated in the schedule. Contributed papers summarize work the presenters have been doing. You are encouraged to talk to presenters at the poster sessions or after the contributed paper sessions to gain more information about topics of interest to you. Informal discussion among those interested in the announced topic typically will follow a panel presentation, and crackerbarrels are entirely devoted to such discussions.
- Be sure to make time to visit the exhibits in Houston Hall. This is a great place to learn what textbooks and equipment are available in physics education.

Philadelphia – "Brotherly Love"

Philadelphia was founded in 1682 by William Penn and laid out by him at a prime spot between the Delaware and Schuylkill rivers. The area was already inhabited by the Lenape Native Americans as well as Swedish and Dutch settlers, who had arrived in the early 1600s to establish a colony. It became an important Colonial city, and during the American Revolution Philadelphia was the site of the First and Second Continental Congresses. It was chosen to be the temporary capital of the United States from 1790-1800.

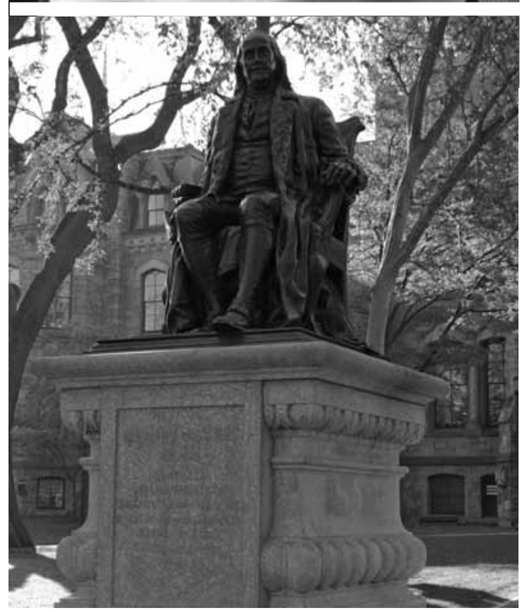
Philadelphia had a large free black community which aided fugitive slaves and founded the first independent black denomination in the nation, the African Methodist Episcopal Church. Philadelphia became one of the first U.S. industrial centers with a variety of industries.

In the 19th century, Philadelphia had a variety of industries and businesses, the largest being textiles. Major corporations in the 19th and early 20th centuries included the Baldwin Locomotive Works, William Cramp and Sons Ship and Engine Building Company, and the Pennsylvania Railroad. The U.S. Centennial was celebrated in 1876 with the Centennial Exposition, the first official World's Fair in the United States.

The population grew dramatically at the end of the 19th century, through immigration from Europe, as well as the Great Migration of blacks from the rural South and Puerto Ricans from the Caribbean, all attracted to the city's industrial jobs. The Pennsylvania Railroad hired 10,000 workers from the South. Manufacturing plants and the U.S Navy Yard employed tens of thousands of industrial workers along the rivers, and the city was also a center of finance and publishing. By the 1950s, population decline accompanied the industrial restructuring and the loss of tens of thousands of jobs in the mid 20th century. With increasing poverty and social dislocation in the city, gang and mafia warfare plagued the city in the mid-20th century.

By the end of the 20th century and beginning of the 21st, revitalization and gentrification of historic neighborhoods attracted more middle-class people who began to return to the city. It is now the fifth most populous city in the United States, with an information and service-based economy, attracting up to 2 million visitors each year for its history. *–wikipedia.org*

Education



The history of education began with Benjamin Franklin's founding of the University of Pennsylvania in 1743 as a European-styled school and America's first university. Today the Philadelphia area is home to nearly 300,000 college students. There are more than 80 colleges, universities, trade, and specialty schools in the region. The city contains three major research universities: the University of Pennsylvania, Drexel University, and Temple University; and the city is home to five schools of medicine: Drexel University College of Medicine, Philadelphia College of Osteopathic Medicine, Temple University School of Medicine, Thomas Jefferson University, and the University of Pennsylvania.

The Philadelphia suburbs, especially those along the Main Line, are home to a number of other colleges and universities, including Villanova University, Bryn Mawr College, Haverford College, Swarthmore College, Cabrini College, and Eastern University.

Things to do in Philadelphia:

◆ **The Franklin Institute:** Features touchable attractions exploring science ranging from sports to space. Highlights: The Sports Challenge, which uses virtual-reality technology to illustrate the physics of sports; The Train Factory's climb-aboard steam engine; Space Command's simulated Earth-orbit research station; a fully equipped weather station; and exhibits on electricity. Located in Center City, at the intersection of 20th Street and the Benjamin Franklin Parkway. *www2.fi.edu.*

◆ **Philadelphia Museum of Art:** The vast collections make it the third-largest art museum in the country and a must-see on the city's cultural circuit. Holdings in Renaissance, American, Impressionist and Modern art. Highlights: Rogier van der Weyden altarpiece, a large "Bathers" by Cezanne, Marcel Duchamp's notorious mixed-media "Bride Stripped Bare by her Bachelors" (The Large Glass). Also check out the Rocky Statue located near the famous steps! *www.philamuseum.org.*

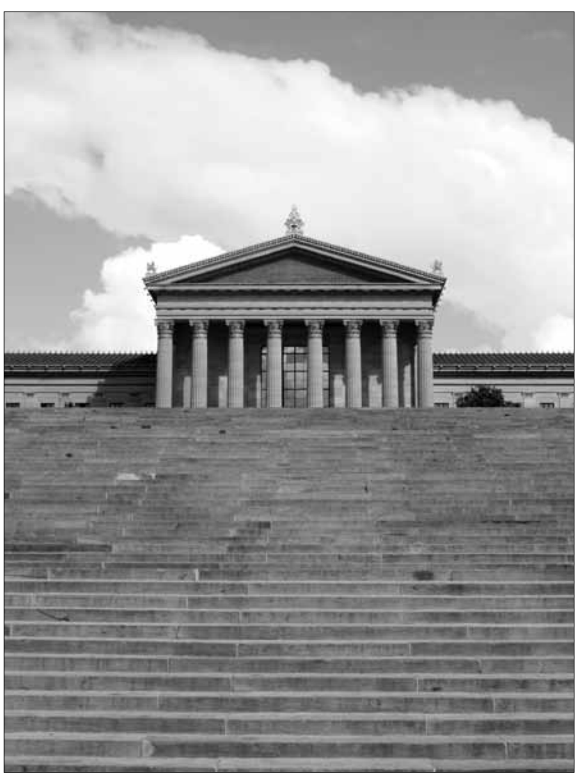
◆ **Independence Hall/ Liberty Bell Center:** Independence Hall is located at the south side of Chestnut Street between 5th and 6th Streets. Free, walk-up tickets are available for pick up at the Independence Visitor Center on the day of your visit starting at 8:30 a.m. Arrive early—during the busy season, tickets are often gone by 1 p.m. The Liberty Bell has a new home, and it is as powerful and dramatic as the Bell itself. Throughout the expansive Center, larger-than-life historic documents and graphic images explore the facts and the myths surrounding the Bell.

◆ **The Barnes Foundation:** The Barnes Collection features 181 Renoirs, 69 Cézannes and 59 Matisses, along with works by Manet, Degas, Seurat, Prendergrast, Titian and Picasso. Located at 2025 Benjamin Franklin Parkway. Go to website to reserve timed tickets: *www.barnesfoundation.org/visit.*

◆ **National Constitution Center:** An interactive history museum located just two blocks from the Liberty Bell and Independence Hall, devoted to the U.S. Constitution and the story of "We, the People." Now showing: "From Asbury Park to the Promised Land: The Life and Music of Bruce Springsteen" and "On My Honor: 100 Years of Girl Scouting." Go to *constitutioncenter.org* for information.

◆ **Valley Forge National Historical Park:** Valley Forge is the story of an army's epic struggle to survive against terrible odds, hunger, disease, and the unrelenting forces of nature. With the British army occupying Philadelphia, Continental commander George Washington had to find a place to encamp for the winter. He chose what seemed to be a strategic high-ridged area to the west. The winter was fierce, and 2000 men died without a shot fired, yet they emerged in mid-1778 to win significant battles. Located near King of Prussia, PA. *www.nps.gov/vafo/index.htm.*

◆ **Longwood Gardens:** A place to see dazzling displays that elevate the art of horticulture... a place to enjoy performances that inspire... a place to watch majestic fountains spring to life. This summer, enjoy *Light Installations by Bruce Munro,* an evocative and imaginative art display by the British artist and light designer. Located 30 miles from Philadelphia. For tickets: *www.longwoodgardens.org.*



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 buildings on the University of Pennsylvania Campus. Workshops on Saturday and Sunday will be in the **Physics Department in David Rittenhouse Labs Building (DRL).***

KEY: HH = Houston Hall IA = Irvine Auditorium CCH = Claudia Cohen Hall DRL = David Rittenhouse Labs

FRIDAY, July 27

4–7 p.m.		**REGISTRATION**	**HH- Reading Room**

SATURDAY, July 28

7 a.m.–4 p.m.		**REGISTRATION**	**HH - Reading Room**
8 a.m.–12 p.m.	W08	LivePhoto Physics: Advanced Projects with Video Analysis	DRL - 3W2
8 a.m.–12 p.m.	W09	CASTLE Workshop - Model Building Investigations of Electromagnetic Field Production	DRL - 3C8
8 a.m.–12 p.m.	W11	New RealTime Physics and Interactive Lecture Demonstration Tools and Curricula	DRL - 3N20
8 a.m.–12 p.m.	W12	Teaching Physics in Urban Schools	DRL - 3N12
8 a.m.–12 p.m.	W13	Using FPGAs in the Digital Lab	DRL - 3N16
8 a.m.–5 p.m.	W01	Building Scientific Apparatus and Invention Prototypes	DRL - 3N9
8 a.m.–5 p.m.	W02	Grant Writing	DRL - Computer Lab
8 a.m.–5 p.m.	W03	Learning Physics While Practicing Science	DRL - 3W5
8 a.m.–5 p.m.	W04	Make, Take, and Do: Homemade Physics Equipment	DRL - 3N17
8 a.m.–5 p.m.	W05	Physics By Design	DRL - 3N15
8 a.m.–5 p.m.	W06	PIRA Lecture Demonstration I	DRL - A1
1–5 p.m.	W14	Ben Franklin is My Lab Partner	DRL - 3N12
1–5 p.m.	W15	Introductory Laboratories	DRL - 3W7 and 11
1–5 p.m.	W16	Lab Experiments that (can) Re-appear Across the Curriculum	DRL - 3N16
1–5 p.m.	W17	Modeling Physics for University Physics	DRL - 3C6
1–5 p.m.	W18	Science and Religion: Teaching Critical Thinking	DRL - 3W2
1–5 p.m.	W19	Skepticism in the Classroom	DRL - 3C2
4–5:15 p.m.		Awards Committee	HH - Griski
5:15–7:15 p.m.		Meetings Committee	Sheraton - Chestnut
6:30–10 p.m.		AAPT Executive Board I	Sheraton - William Penn

SUNDAY, July 29

7 a.m.–4 p.m.		**REGISTRATION**	**HH - Reading Room**
8–10 a.m.		Publications Committee	Sheraton – William Penn
8 a.m.–12 p.m.	W25	Real-time Assessments of Student Understanding	DRL - 3C2
8 a.m.–12 p.m.	W26	PRISMS – A High School Physics Curriculum	DRL - 3W2
8 a.m.–12 p.m.	W27	Activities for Teaching About Weather and Climate	DRL - 3N15
8 a.m.–12 p.m.	W28	Can You Teach Radioactivity Using Inquiry? Yes!	DRL - 3N12
8 a.m.–12 p.m.	W29	ClassAction: Interactive Classroom Materials for Introductory Astronomy	DRL - 3C6
8 a.m.–12 p.m.	W30	How to Make Significant, Lasting Changes in Intro. Physics for Life Science Course	DRL - 3N14
8 a.m.–12 p.m.	W31	From Ptolemy to Einstein: Using Computer Simulations in Astronomy	DRL - PC Lab 1
8 a.m.–12 p.m.	W32	Sound & Music, Ways to Teach It (Free Kit!)	DRL - 3W5
8 a.m.–12 p.m.	W33	PTRA Workshop: Using Children's Literature to Teach Science	DRL - 3N22
8 a.m.–5 p.m.	W20	PIRA Lecture Demonstration II	DRL - A1
8 a.m.–5 p.m.	W21	The Physics of Energy	DRL - 3N17
8 a.m.–5 p.m.	W22	UTeach Observation Protocol (UTOP)	DRL - 3C8
8 a.m.–5 p.m.	W23	Computation and the Modeling Curriculum	DRL - 3N16
8 a.m.–5 p.m.		PIRA Resource Room/Apparatus Competition Set-up	HH - Platt Rehearsal
8 a.m.–5 p.m.		High School Physics Photo Contest Viewing & Voting	HH - Hall of Flags Balcony
9 a.m.–12 p.m.	T01	Research-based Teaching Strategies to Close the Gap	DRL- 3C4
10 a.m.–5:10 p.m.		Executive Board II	Sheraton - William Penn
10:30 a.m.–12 p.m.		Nominating Committee	IA - G01 Green
11:30 a.m.–2 p.m.		Resource Letters Committee	IA - G7
1–5 p.m.	W10	"Hands-on" on the Road	DRL - 3N15
1–5 p.m.	W35	Simple Experiments for Learning the Strategies that Mirror Scientific Practice	DRL - 3N9
1–5 p.m.	W36	Advanced & Intermediate Laboratories	DRL - 3W7 and 11
1–5 p.m.	W37	Biology-Inspired Labs for Introductory Physics	DRL - 3N12
1–5 p.m.	W38	Cosmology in the Classroom	DRL - 3W10
1–5 p.m.	W39	Free Online Integrated Learning Environment for Mechanics	DRL - 3N14
1–5 p.m.	W40	Heliophysics Applications for Physics Teaching	DRL - 3N22

1–5 p.m.	W42	LEAP: Learner-Centered Environment for Algebra-based Physics	DRL - 3W5
1–5 p.m.	W43	Physics and Toys II: Energy, Momentum, Electricity, and Magnetism	DRL - 3W2
1–5 p.m.	W45	Video Resource for Learning Assistant Development	DRL - 3C4
1–5 p.m.	PTRA-4	Sound and Music: H.S. Materials Plus Updates for Grades	RNL - 3N6
5:15–6:30 p.m.		Programs Committee I	HH - Golkin
5:30–6:30 p.m.		Section Officers Exchange	CCH - Terrace
6–8 p.m.		High School Share-a-Thon	IA - Amado Recital Hall
6:30–8 p.m.		Section Representatives	CCH - Terrace
6:30–8 p.m.		Research in Physics Education Committee (RiPE)	HH - Class of 47
6:30–8 p.m.		Committee on Laboratories	IA - G16
6:30–8 p.m.		Committee on Graduate Education in Physics	HH - Griski
6:30–8 p.m.		Committee on SI Units and Metric Education	IA - G7
7:30–9 p.m.		**REGISTRATION**	**HH - Reading Room**
8–10 p.m.		**Exhibit Hall Opening / Welcome Reception**	HH - Bodek/Hall of Flags
8–10 p.m.		SPS Undergraduate and Graduate Research Poster Session / Reception	HH - Bistro
MONDAY, July 30			
7 a.m.–5 p.m.		**REGISTRATION**	**HH - Reading Room**
7–8:30 a.m.		Committee on Teacher Preparation	IA - G7
7–8:30 a.m.		Committee on Women in Physics	IA - G16
7–8:30 a.m.		Committee on Educational Technologies	IA - G01 Green
7:15–8:20 a.m.		First Timers' Gathering	IA - Cafe 58
7:15–8:15 a.m.		Two-Year College Breakfast (ticket required)	HH - Ben Franklin
8–10 a.m.		Poster Session I Set-up	HH - Bistro
8 a.m.–5 p.m.		High School Physics Photo Contest Viewing & Voting	HH - Hall of Flags Balcony
8 a.m–5 p.m.		TYC Resource Room	HH - Reading Room Alcove
8 a.m–5 p.m.		PIRA Resource Room	HH - Platt Rehearsal
8:30–10:30 a.m.	AA	Assessing Student Learning in Upper-Division Labs	Sheraton - Ben Franklin I
8:30–10:30 a.m.	AB	Panel: The Good and the Bad of Video Lectures	Sheraton - Ben Franklin II
8:30–10:30 a.m.	AC	Frontiers in Astronomy and Space Science	Sheraton - Ben Franklin III
8:30–10:30 a.m.	AD	Textbooks and Labs Suitable for Ninth Grade Physics	Sheraton - Ben Franklin IV
8:30–10:30 a.m.	AE	PER: Topical Understanding - Introductory Level	HH - Class of 49
8:30–10 a.m.	AF	Teacher Preparation Around the World	Sheraton - Ben Franklin V
8:30–10:30 a.m.	AG	Two-Year College New Faculty Experience	IA - Amado Recital Hall
8:30–10:30 a.m.	AH	PER in the High School	CCH - Claudia Cohen Terrace
8:30–10:30 a.m.	AI	Teaching Physics to the Liberal Arts Major	HH - Golkin
8:30–10:30 a.m.	PTRA-1	Explorations and Practicums, co-presented by George Amann and Pat Callahan	DRL - 3N6
10 a.m.–6 p.m.		**Exhibit Hall Open (coffee break, 10:30 a.m.)**	HH - Bodek and Hall of Flags
10:30–11:30 a.m.		Spouses/Guest Gathering	IA - Cafe 58
10:45 a.m.		Monday Amazon Kindle Drawing	HH - Bodek Lounge
11 a.m.–12:10 p.m.	**Awards**	**AAPT Excellence in Teaching Awards**	**Inn at Penn - Woodlands**
12:15–1:15 p.m.	**CW04**	**Pearson Commercial Workshop**	Inn at Penn - Reg./St. Marks
12:15–1:15 p.m.	**CW05**	**Klinger Educational Products Corp. Commercial Workshop**	Sheraton - University Suite
12:15–1:15 p.m.	**CW06**	**Physics2000.com Workshop in Introductory Physics**	HH - Golkin
12:15–1:15 p.m.	Crkbrl-01	Vidshare: Motivating and Elucidating Short Videos You Can Use!	IA - Amado Recital Hall
12:15–1:15 p.m.	Crkbrl-02	Crackerbarrel: Physics and Society	Sheraton - Ben Franklin I
12:15–1:15 p.m.		Early Career Professionals Speed Networking Event	Sheraton - Fairmount
12:15–1:15 p.m.		Retired Physicists' Luncheon (ticket required)	Sheraton - Chestnut
12:15–1:15 p.m.		H.S. Teachers' First Timers Luncheon/ AAPT: What's in it for H.S. Teachers?	HH - Ben Franklin
12:15–1:15 p.m.		Membership and Benefits Committee	IA - G7
12:15–1:15 p.m.		PERG Town Hall Meeting	CCH - Terrace
12:15–1:15 p.m.		AAPT Board /APS FEd Members Luncheon	TBD
1:30–3 p.m.	**Plenary**	APS Division of Biophysics: Birds, Brains, and Physics	**Inn at Penn - Woodlands**
3 p.m.–3:30 p.m.		**Exhibit Hall: Afternoon Snack Break**	HH - Hall of Flags/Bodek
3:15 p.m.		Monday Amazon Kindle Raffle Drawing	HH - Hall of Flags
3:30–5:30 p.m.	BA	Panel: Physics First Discussion – Success Stories in the Delaware Valley	Sheraton - Ben Franklin I
3:30–5 p.m.	BB	Leadership Models in Science	Sheraton - Ben Franklin II
3:30-5:30 p.m.	BC	The Art and Science of Teaching	Sheraton - Ben Franklin III
3:30–5:30 p.m.	BD	PER: Attitudes	HH - Class of 49
3:30–5:10 p.m.	BE	Video Analysis in Undergraduate Education	Sheraton - William Tell Suite
3:30–5:30 p.m.	BF	Innovations in Teaching Astronomy	Sheraton - Ben Franklin V
3:30–5:30 p.m.	BG	PER Around the World	CCH - Claudia Cohen Terrace
3:30–5:30 p.m.	BH	Continuing Teacher Preparation: Inservice Professional Development	Sheraton - Ben Franklin IV
3:30–5:30 p.m.	BI	What Works in the Pre-College Classroom	IA - Amado Recital Hall

3:30–5:30 p.m.	BJ	Introductory Labs/Apparatus	HH - Golkin
5:30-6:30 p.m.		Undergraduate Awards Reception	IA - Cafe 58
5:30–7 p.m.		Committee on Physics in Two-Year Colleges	HH - Golkin
5:30–7 p.m.		Committee on Professional Concerns	IA - G7
5:30–7 p.m.		Committee on Space Science and Astronomy	IA - G01 Green
5:30–7 p.m.		Committee on Physics in High Schools	HH - Class of 47
5:30–7 p.m.		PIRA Business Meeting	IA - Amado Recital Hall
5:30–7 p.m.		**Benjamin Franklin Performance**	**CCH - Claudia Cohen Terrace**
7–8:30 p.m.	CA	Can Computational Modeling be Accessible to Introductory Students?	Sheraton - Ben Franklin I
7–8:30 p.m.	CB	Labs at Many Levels	Sheraton - Ben Franklin II
7–8:30 p.m.	CC	Teaching Environmental Physics in the Undergraduate Curriculum	Sheraton - Ben Franklin III
7–8 p.m.	CD	iPad & iPhone Apps and Mobile Devices in the Classroom	Sheraton - Ben Franklin IV
7–8:30 p.m.	CE	Panel: Writing for Academic Journals	Sheraton - Ben Franklin V
7–8:30 p.m.	CF	Video Analysis in the High School and Introductory College Classroom	Sheraton - William Penn Suite
7–8:20 p.m.	CG	Mentoring Minority Students	CCH - Claudia Cohen Terrace
7–8:30 p.m.	CH	Oral History – Methods and Examples	HH - Class of 49
7–8:30 p.m.	CI	Different Research-based Curricula Promote Different Agendas in Research	HH - Golkin
7–7:20 p.m.	CJ	Undergraduate Research	IA - Amado Recital Hall
7:30–8:30 p.m.	CK	Assessing Student Learning in the Introductory Lab	IA - Amado Recital Hall
8:30–10 p.m.	PST-1	Poster Session 1	HH - Bistro

TUESDAY, July 31

7–8 a.m.		AAPT Fun Run/Walk	31st and Walnut
7 a.m.–4:30 p.m.		**REGISTRATION**	**HH - Reading Room**
7:30–8:30 a.m.		Physics Bowl Advisory Committee	IA - G01 Green
8 a.m.–5 p.m.		High School Physics Photo Contest Viewing & Voting	HH - Hall of Flags Balcony
8 a.m–5 p.m.		TYC Resource Room	HH - Reading Room Alcove
8 a.m–5 p.m.		PIRA Resource Room	HH - Platt Rehearsal
8–10 a.m.		Poster Session II Set-up	HH - Bistro
8:30–10:30 a.m.	DA	International Perspectives on Laboratory Instruction	Sheraton - Ben Franklin I
8:30–10:30 a.m.	DB	Physics and Society	Sheraton - Ben Franklin II
8:30–10:30 a.m.	DC	Teaching Scientific Programming from Intro to Upper Level Physics	Sheraton - Ben Franklin III
8:30–10:20 a.m.	DD	Preparing Teachers to Serve Diverse Communities	Sheraton - Ben Franklin IV
8:30–10:20 a.m.	DE	Upper Division Undergraduate Education	Sheraton - Ben Franklin V
8:30–10:30 a.m.	DF	PER: Topical Understanding Intro to Advanced	HH - Class of 49
8:30–10:30 a.m.	DG	Physics of Entertainment	Sheraton - William Penn Suite
8:30–10:30 a.m.	DH	PER: Problem Solving I	CCH - Terrace
8:30–10:30 a.m.	DI	PER: Student Reasoning I	IA - Amado Recital Hall
8:30–10:30 a.m.	DJ	Using Research-based High School PER Curriculum in Teacher Preparation	HH - Golkin
8:30–10:30 a.m.	PTRA-2	PTRA presents Everyday Einstein: GPS & Relativity	DRL - Room 3N6
10 a.m.–4 p.m.		**Exhibit Hall Open (coffee break, 10 a.m.)**	HH - Bodek and Hall of Flags
10:45 a.m.		Tuesday B&N NOOK Raffle Drawing	HH - Hall of Flags
11 a.m.–12 p.m.	**Plenary**	**Sizing Up the Universe: *J. Richard Gott***	**Inn at Penn - Woodlands Ballroom**
12–1 p.m.	**CW01**	**Expert TA Commercial Workshop**	Sheraton - University Suite
12–1:30 p.m.		Committee on Science Education for the Public	HH - Branchfeld
12–1:30 p.m.		Committee on the History & Philosophy of Physics	IA - G7
12–1:30 p.m.		Committee on Minorities in Physics	IA - G16
12–1:30 p.m.		Committee on International Physics Education	HH - Golkin
12–1:30 p.m.		Past Officers Luncheon	HH - Ben Franklin
12–1:30 p.m.	Crkbrl-03	Crackerbarrel for Solo PERs	Sheraton - Ben Franklin I
12–1:30 p.m.	Crkbrl-04	Common Core Framework and Physics Standards for College Success	Sheraton - Ben Franklin II
12–1:30 p.m.	Crkbrl-05	YouTube Sharathon Crackerbarrel	Sheraton - Ben Franklin V
12:15–1:15 p.m.		**Book Signing by J. Richard Gott**	Inn at Penn - Woodlands Foyer
12:15–1:15 p.m.		ALPhA Meeting	IA - G01 Green
12:30–1:30 p.m.	**CW02**	**Pearson Commercial Workshop**	Inn at Penn - Regent/St. Marks
1:30–1:50 p.m.	EA	The Coolest Experiment You Teach (beyond the first year)	Sheraton - Ben Franklin I
1:30–2:30 p.m.	EC	Faculty Peer Mentoring	Sheraton - Ben Franklin II
1:30–3 p.m.	ED	Preparing Teachers to Integrate Labs into Instruction	Sheraton - Ben Franklin III
1:30–3 p.m.	EE	Antique Electrostatic Apparatus	Sheraton - Ben Franklin IV
1:30–2:40 p.m.	EF	PER in the Pre-college Classroom	HH - Class of 49
1:30–2:40 p.m.	EG	Using a Planetarium to Teach Astronomy	IA - Amado Recital Hall
1:30–3 p.m.	EH	PER: Problem Solving II	Sheraton - Ben Franklin V
1:30–3 p.m.	EI	Using ISLE to Analyze Simple Experiments	Sheraton - William Penn Suite

1:30–3 p.m.	EJ	Two-Year Colleges Poster Session	HH - Reading Room Alcove
1:30–3 p.m.	EK	LHC Data for Physics Teachers and Students	CCH - Claudia Cohen Terrace
2–2:50 p.m.	EB	Continuing Teacher Preparation: Inservice Professional Development II	Sheraton - Ben Franklin I
3:15–3:45 p.m.		**Exhibit Hall: Afternoon Snack Break**	HH - Hall of Flags/ Bodek
3:15 p.m.		Tuesday B&N NOOK Raffle Drawing	HH - Bodek Lounge
3:30–4:30 p.m.	**Plenary**	**Space-Time, Quantum Mechanics, Large Hadron Collider–N. Arkani-Hamed**	Inn at Penn - Woodlands Ballroom
4:30–6 p.m.		Committee on Physics in Undergraduate Education	IA - G01 Green
4:30–6 p.m.		Committee on Physics in Pre-High School Education	IA - G7
4:30–6 p.m.		Committee on Apparatus	HH - Class of 47
4:30–6 p.m.		Committee on the Interests of Senior Physicists	IA - G16
4:30–6:30 p.m.	**CW03**	**Vernier Software: New Data Collection Tools for Physics**	Inn at Penn - Regent/St. Marks
6–6:30 p.m.		New Faculty Reunion	IA - G16
6–7:30 p.m.		Poster Session II	HH - Bistro
7:30–8:30 p.m.		**Philadelphia Trolley Tour**	HH pickup
9–10 p.m.		AAPT Demo Show	Inn at Penn - Woodlands Ballroom

WEDNESDAY, August 1

7–8:30 a.m.		Programs Committee II	Sheraton - Chestnut
7–8:30 a.m.		Governance Structure Committee (COGS)	IA - G01 Green
8 a.m.–3 p.m.		PIRA Resource Room	HH - Platt Rehearsal
8 a.m.–3 p.m.		**REGISTRATION**	**HH - Reading Room**
8 a.m.–3 p.m.		TYC Resource Room	HH - Reading Room Alcove
8:30–10 a.m.	FA	Bridge Experiences: Increasing Participation of Underrepresented Minorities	Sheraton - Ben Franklin I
8:30–10:30 a.m.	FB	PER: Investigating Classroom Strategies I	HH - Class of 49
8:30–10:30 a.m.	FC	Panel: Multi-Disciplinary-based Education Research Groups	Sheraton - Ben Franklin II
8:30–10:30 a.m.	FD	Reforming the Introductory Physics Course for Life Science Majors VII	IA - Amado Recital Hall
8:30–8:50 a.m.	FE	Developing Student's Scientific Literacy	Sheraton - Ben Franklin IV
8:30–10:30 a.m.	FG	Introductory Courses	Sheraton - Ben Franklin V
8:30–10:30 a.m.	FH	Teacher Preparation	Sheraton - William Penn Suite
8:30–10:30 a.m.	FI	Teaching Physics Around the World	Sheraton - Ben Franklin III
8:30–10 a.m.	FJ	PIRA Session: International Outreach	CCH - Claudia Cohen Terrace
8:30–10:30 a.m.	FK	Assessing Pedagogical Content Knowledge in Teacher Preparation	HH - Golkin
8:30–10:30 a.m.	PTRA-3	Using & Adapting OSP- & Physlet-based Materials for an Interactive Class	RNL - 3N6
9–10 a.m.	FF	Interactive Lecture Demonstrations—What's New?	Sheraton - Ben Franklin IV
10:30–11 a.m.		Great Book Giveaway; Kickoff for 2013 Winter Meeting New Orleans	HH - Reading Room
11 a.m.–12:15 p.m.	**Awards**	**Millikan Medal – Phil Sadler; Distinguished Service Citations**	Inn at Penn - Woodlands Ballroom
12:15–1:15 p.m.	Crkbrl-06	Do We Have Standards? Moving Towards a Definition of Physics Mastery	HH - Class of 49
12:15–1:15 p.m.	Crkbrl-07	Crackerbarrel for PER Graduate Students	CCH - Claudia Cohen Terrace
12:15–1:15 p.m.	Crkbrl-08	Crackerbarrel for Faculty in Small Departments	IA - Amado Recital Hall
12:15–1:15 p.m.		Nominating Committee II	IA - G01 Green
12:15–1:15 p.m.		Fredrick and Florence M. Bauder Endowment Committee	IA - G7
12:15–1:30 p.m.		Audit Committee	IA - G16
1:30–3 p.m.	GA	Teaching Physics in Urban and Suburban Settings	Sheraton - Ben Franklin I
1:30–3 p.m.	GB	PER: Investigating Classroom Strategies II	Sheraton - Ben Franklin II
1:30–2:50 p.m.	GC	Technologies	Sheraton - Ben Franklin III
1:30–1:50 p.m.	GD	Great Teachers	Sheraton - Ben Franklin IV
1:30–3 p.m.	GE	The Third Eye Returns	Sheraton - Ben Franklin V
1:30–3 p.m.	GF	PER: Student Reasoning II	HH - Class of 49
1:30–3 p.m.	GG	Dollar Store Labs	Sheraton - William Penn Suite
1:30–3 p.m.	GH	PER: Teacher Preparation and Development	CCH - Claudia Cohen Terrace
1:30–3 p.m.	GI	Physics for All	IA - Amado Recital Hall
1:30–3 p.m.	GL	Advanced Physics Topics / Post Deadline Session	HH - Golkin
1:30–3 p.m.	GM	Panel: Giving Voice in the Classroom	Sheraton - University Suite
2–3 p.m.	GK	Middle and High School Teaching	Sheraton - Ben Franklin IV
3–6 p.m.	PER	Physics Education Research (PER) Bridging Session	Inn at Penn - Woodlands Ballroom
6:30–8 p.m.		Physics Education Research Conference (PERC) Banquet	Sheraton - Ben Franklin Ballroom
8:30–10 p.m.		PERC Poster Session	HH - Hall of Flags

Special Events at AAPT 2012 Summer Meeting

Sunday, July 29

◆ **AAPT Welcome Reception & Exhibit Hall Opening**
8–10 p.m.
Houston Hall – Hall of Flags / Bodek Lounge

Monday, July 30

◆ **First Timers' Gathering**
7:15–8:20 a.m. Monday
Irvine Auditorium – Cafe 58

Learn more about AAPT and the Summer Meeting. Meet and greet new friends. High School Teacher Day attendees encouraged to check in here!

◆ **Two-Year College Breakfast**
7:15–8:15 a.m. Monday
Houston Hall – Ben Franklin Room

Pre-register and enjoy your time and breakfast with like-minded attendees.

◆ **Spouses' Gathering**
10:30–11:30 a.m. Monday
Irvine Auditorium – Cafe 58

Connect with other spouses and guests of AAPT attendees.

◆ **Exhibit Hall Kindle Drawing Monday**
– 10:45 a.m.
Houston Hall – Bodek Lounge
– 3:15 p.m.
Houston Hall – Hall of Flags

Tickets $1, purchased at Registration. Must be present to win!

◆ **Early Career Professionals Speed Networking Event**
12:15–1:15 p.m. Monday
Sheraton – Fairmount

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.

◆ **Retired Physicists' Luncheon**
12:15–1:25 p.m. Monday
Sheraton – Chestnut Room

Renew and create alliances by networking and exchanging ideas with our long-served and deserving supporters of AAPT.
Pre-register for this event.

◆ **H.S. Teachers' First Timers Luncheon**
12:15–1:15 p.m. Monday
Houston Hall – Ben Franklin Room

Pre-register for this event. Join this special luncheon for high school physics teachers attending the conference for the first time. Also, *AAPT: What's in it for H.S. Teachers?*

◆ **Ben Franklin Performance**
5:30–7 p.m. Monday
CCH - Claudia Cohen Terrace

Come and meet this most famous Philadelphian, explore his thoughts, share his observations, experience the essence of his being and have your picture taken with him. *Ticket required.*

Tuesday, July 31

◆ **AAPT Fun Run / Walk**
7–8 a.m. Tuesday

Join us for the 4th Annual AAPT Fun Run/Walk on the campus of University of Pennsylvania. Meet at 31st and Walnut Street (Lower Level) Entrance to Penn Park .Water will be provided.

◆ **Exhibit Hall B&N NOOK Drawing Tuesday**
– 10:45 a.m.
Houston Hall – Hall of Flags
– 3:15 p.m.
Houston Hall – Bodek Lounge

Tickets $1 apiece, purchased at Registration. You must be present to win!

◆ **Philadelphia Trolley Tour**
7:30–8:30 p.m. Tuesday

Allow Philadelphia's Premier Tour Company to show you the sights and tell you the tales of a city that forged a nation, cheered for Rocky, and is home to the Liberty Bell and Independence Hall! The tour will begin at Houston Hall and ends at the Inn at Penn, just in time to catch the AAPT Demo Show.
A limited number of tickets are available and are selling fast.

◆ **AAPT Demo Show**
9–10 p.m. Tuesday
Inn at Penn – Woodlands Ballroom

Open to all: Be astounded one more time at fantastic physics demonstrations and effects by *The Third Eye*, a group of Chinese physics teachers and educators who were also at the AAPT 2000 Summer Meeting.

Wednesday, August 1

◆ **Great Book Giveaway & Kick-off for 2013 Winter Meeting in New Orleans**
10:30–11 a.m. Wednesday
Houston Hall – Registration area

Get your raffle ticket from the AAPT booth and attend this popular event to claim your book.

Committee Meetings

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

Saturday, July 28

Awards Committee	4–5:15 p.m.	HH - Griski
Meetings Committee	5:15–7:15 p.m.	Sheraton - Chestnut
Executive Board I	6:30–10 p.m.	Sheraton - Wm. Penn

Sunday, July 29

Publications Committee	8–10 a.m.	Sheraton - Wm. Penn
Nominating Committee	10:30 a.m.–12 p.m.	IA - G01 Green
Executive Board II	10 a.m.–5:10 p.m.	Sheraton - Wm. Penn
Resource Letters Committee	11:30 a.m.–2 p.m.	IA - G7
Programs Committee I	5:15–6:30 p.m.	HH - Golkin
Section Officers Exchange	5:30-6:30 p.m.	CCH - Terrace
Section Representatives	6:30–8 p.m.	CCH - Terrace
Research in Physics Educ. Committee (RiPE)*	6:30–8 p.m.	HH - Class of 47
Committee on Laboratories*	6:30–8 p.m.	IA - G16
Committee on Graduate Education in Physics*	6:30–8 p.m.	HH - Griski
Committee on SI Units and Metric Education*	6:30–8 p.m.	IA - G7

Monday, July 30

Committee on Teacher Preparation*	7–8:30 a.m.	IA - G7
Committee on Women in Physics*	7–8:30 a.m.	IA - G16
Committee on Educational Technologies*	7–8:30 a.m.	IA - G01 Green
PERG Town Hall meeting	12:15–1:15 p.m.	CCH -Terrace
Membership and Benefits Committee	12:15–1:15 p.m.	IA - G7
Committee on Physics in Two-Year Colleges*	5:30–7 p.m.	HH - Golkin
Committee on Professional Concerns*	5:30–7 p.m.	IA - G7
Committee on Space Science and Astronomy*	5:30–7 p.m.	IA - G01 Green
Committee on Physics in High Schools*	5:30–7 p.m.	HH - Class of 47
PIRA Business Meeting	5:30–7 p.m.	IA - Armado Recital Hall

Tuesday, July 31

Physics Bowl Advisory Committee	7:30–8:30 a.m.	IA - G01
Committee on Science Education for Public*	12–1:30 p.m.	HH- Branchfeld
Committee on History & Philosophy of Physics*	12–1:30 p.m.	IA - G7
Committee on Minorities in Physics*	12–1:30 p.m.	IA -G16
Committee on International Physics Education*	12–1:30 p.m.	HH - Golkin
ALPhA Meeting*	12:15–1:15 p.m.	IA - G01 Green
Committee on Physics in Undergrad. Educ.*	4:30–6 p.m.	IA - G01 Green
Committee on Interests of Senior Physicists*	4:30–6 p.m.	IA - G16
Committee on Apparatus*	4:30–6 p.m.	HH - Class of 47
Committee on Physics in Pre-H.S. Education*	4:30–6 p.m.	IA - G7

Wednesday, August 1

Programs Committee II	7–8:30 a.m.	Sheraton - Chestnut
Governance Structure Committee	7–8:30 a.m.	IA - G01 Green
Nominating Committee II	12:15–1:15 p.m.	IA - G01 Green
Bauder Endowment Committee	12:15–1:15 p.m.	IA - G7
Audit Committee	12:15–1:30 p.m.	IA - G16

KEY: IA = Irvine Auditorium HH = Houston Hall CCH = Claudia Cohen Hall

Philip M. Sadler
Harvard-Smithsonian Center for Astrophysics
Cambridge, MA

Separating Facts From Fads: How Our Choices Impact Students' Performance and Persistence in Physics

Wednesday, August 1

11 a.m.–12:15 p.m.

Inn at Penn – Woodlands Ballroom

Robert A. Millikan Medal

The Robert A. Millikan Medal for 2012 is presented to **Philip M. Sadler** for his notable and creative contributions to the teaching of physics. Sadler's work on student conceptions led to the production of the award-winning documentary series, "A Private Universe" and "Minds of Our Own," with colleague Matthew Schneps, videos that continue to influence classroom practice. This work has also furthered scholarly knowledge on students' understanding of physical science and astronomy.

Sadler earned a BS in Physics from MIT in 1973 and taught middle school science and mathematics for several years before earning a PhD in education from Harvard in 1992. Sadler has taught Harvard's courses for new science teachers and for the next generation of professors, doctoral students in science. As F. W. Wright Senior Lecturer in Astronomy, he teaches Harvard's oldest undergraduate course in science, Celestial Navigation.

He directs one of the largest research groups in science education in the U.S., based at the Harvard-Smithsonian Center for Astrophysics. In 1999, Sadler won the Journal of Research in Science Teaching Award for work on assessing student understanding in science. His research interests include assessment of students' scientific misconceptions and how they change as a result of instruction, the development of computer technologies that allow youngsters to engage in research, and models for enhancement of the skills of experienced teachers.

Sadler's and Robert Tai's (University of Virginia) landmark study on college physics success (*Sci Ed* **85**:111-135, 2001) provided the first hard evidence that the way high school physics is taught makes a difference when students study physics in college. Over the past 30-plus years Phil has been a prolific contributor to both research and development related to physics and astronomy education. His contributions include the study of the high school coursework and out-of-school-time activities on STEM persistence, the impact of teacher professional development, affective experiences of male and female physics students (with Zahra Hazari of Clemson University), and how teachers' pedagogical decisions can make or break instruction. He won the Astronomical Society of the Pacific's Brennan Prize for contributions to astronomy teaching in 2002. The American Astronomical Society awarded him their Education Prize for 2010. His invention, the Starlab Portable Planetarium, has enabled many schools to provide active learning experiences for students who are studying astronomy.

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

Mark D. Greenman
Marblehead High School
Swampscot, MA

Interactive Laboratory Experiences (ILE) – A Professional Development Recipe for Success

Monday, July 30

11 a.m.–12:10 p.m.

Inn at Penn – Woodlands Ballroom

Paul W. Zitzewitz Excellence in Pre-College Teaching Award

The Paul W. Zitzewitz Excellence in Pre-College Teaching Award for 2012 is presented to **Mark D. Greenman** in recognition of his career-long concern for and attention to quality education at the pre-college level. Greenman's career included 30 years of service at Marblehead High School where he served as a physics teacher, teacher mentor, computer director, mathematics director, and science director. He earned his BA in Physics from Hofstra University and his MS in Physics from Syracuse University. Honors include induction into Sigma Pi Sima, the physics national honor society, and Kappa Mu Epsilon, the mathematics national honor society. Greenman has recently served for two years as an Albert Einstein Distinguished Educator Fellow at the National Science Foundation within the Division of Undergraduate Education (2009-2011). He is a recipient of the 2009 Presidential Award for Excellence in Mathematics and Science Teaching, the Massachusetts' Council for Technology Education Path Finder Award, and the Massachusetts Association of Science Teachers (MAST) Teacher of the Year Award from Essex county. He is an inductee into the Massachusetts Hall of Fame for Science Educators.

Greenman is currently serving as science consultant to the Massachusetts' "Race to the Top Developing Model Curriculum & Curriculum Embedded Performance Assessments" initiative. He continues to provide, as recipient of several grants from the Massachusetts Department of Elementary and Secondary Education, content institutes, "Physics I: Mechanics and Energy," and "Physics II: E&M and Waves." The objectives of these institutes are to deepen content knowledge and improve the use of research-based pedagogy by Massachusetts' science educators.

Greenman also sits on the board of the newly formed American Council of STEM Educators (the ACSE is presently composed of former and current Einstein Fellows dedicated to making a positive impact in STEM teaching and learning on the National level). He also serves on the American Public Land-Grant University (APLU) Advisory Board for their Mathematics Teacher Education (MTE) Partnership initiative and is current president of the North Shore Science Supervisors Association. Greenman has been an AAPT Physics Teaching Resource Agent since 1985 and also shares best practices and his enthusiasm for teaching and learning through presentations and workshops at national and regional conferences.

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

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

Kevin M. Lee
University of Nebraska Lincoln Center for Science, Mathematics, and Computer Education and the Department of Physics and Astronomy

Letting Technology do What Technology Is Good at

Monday, July 30

11 a.m.–12:10 p.m.

Inn at Penn – Woodlands Ballroom

The 2012 David Halliday and Robert Resnick Award for Excellence in Undergraduate Physics Teaching Award is presented to **Kevin M. Lee,** in recognition of his contributions to undergraduate physics teaching and his extraordinary accomplishments in communicating the excitement of physics to students. John Wiley & Sons is the principal source of funding for this award.

Lee is Research Associate Professor at the University of Nebraska – Lincoln Center for Science, Mathematics, and Computer Education and the Department of Physics and Astronomy. He earned his BS in Astronomy at the University of Michigan, MS at Central Michigan University, and his PhD in Physics and Astronomy at the University of Nebraska.

Lee has dedicated himself to elevating the teaching and learning of astronomy and physics at the college, state, national, and international level. He has distinguished himself as a college instructor and developer of instructional technologies for use in space-science classrooms. The teaching and learning innovations pioneered by the astronomy education group run by Lee at the University of Nebraska – Lincoln is recognized as being of the highest pedagogical value by those in the astronomy and space science community.

Beyond this work on the development of instructional strategies and tools that bridge the gap between cutting edge pedagogy and current technologies, Lee has also made significant contributions to AAPT programs leading to increased visibility of and participation in AAPT activities associated with teaching astronomy and the use of technology. As a longtime member and two-year chair of the AAPT Committee on Space Science and Astronomy (CSSA) he elevated the role of research and teaching of astronomy for the sessions/talks sponsored by CSSA.

Lee's work in astronomy education has been remarkable and innovative. His accomplishments include the development of numerous simulations and peer instruction questions, resulting in many workshops. His two seminal works, to date, are The Nebraska Astronomy Applet Project and ClassAction, the clicker question database which is designed to help make large lecture-format astronomy courses more interactive. He freely shares these materials on his web site http://astro.unl.edu.

Established as the Excellence in Undergraduate Teaching Award in 1993; it was renamed and substantially endowed in 2010 by John Wiley and Sons. Named for David Halliday and Robert Resnick, authors of a very successful college-level textbook in introductory physics, the award recognizes outstanding achievement in teaching undergraduate physics. The recipient delivers an address at an AAPT Summer Meeting and receives a monetary award, an Award Certificate, a copy of the citation, and travel expenses to the meeting.

2012 AIP Science Communication Award: Writing for Children – Pat Murphy

Pat Murphy

The Science Communication Awards of the American Institute of Physics (AIP) were founded in 1968 to promote effective science communication in order to improve the general public's appreciation of physics, astronomy, and allied science fields. Winning authors receive a prize of $3,000, an engraved Windsor chair, and a certificate of recognition. The 2012 award in the Writing for Children category goes to Pat Murphy for her book *The Klutz Guide to the Galaxy.* Like other Klutz books, this winning entry comes with the tools children need to experiment and explore. Pat was a senior writer at the Exploratorium, San Francisco's museum of science, art, and human perception. Today, Pat writes and manages the creation of science books and products for Klutz. She also is an award-winning science fiction and fantasy author.

AAPT Awards nominations are accepted online at http://www.aapt.org/Programs/awards/

AAPT Distinguished Service Citations

Wednesday, August 1, 11 a.m.–12:15 p.m. • Inn at Penn – Woodlands Ballroom

Eugenia Etkina

Eugenia Etkina

Eugenia Etkina started her teaching career as a high school physics teacher in Moscow, Russia, where she taught for 13 years before coming to the U.S. In 1995-1997 she taught physics courses for at-risk students at Rutgers University. In 1997 she received her PhD in physics education from Moscow State Pedagogical University and was appointed an assistant professor at the Rutgers University Graduate School of Education. She became a full professor in 2010 and is now chair of the Department of Learning and Teaching in the GSE. She runs one of the largest programs in physics teacher preparation in the United States. She is a co-creator of the Investigative Science Learning Environment (ISLE) and Physics Union Mathematics (PUM)—physics learning systems used in college and 8-12 schools.

An AAPT member since 1997, she has served AAPT on the Focus Group on the Draft Framework, as chair of the Committee on Teacher Preparation, as a member of the Nominating Committee, and as a member of the National Task Force on Teacher Education in Physics. She is currently chair of the Physics Education Research Leadership Organizing Council (PERLOC). She has also conducted more than 15 workshops for AAPT members at the national meetings. In addition, Etkina has been recognized with the 2012 New Jersey Distinguished Faculty Showcase of Exemplary Practices Award, 2011 Rutgers University Graduate School of Education Alumni Association Outstanding Faculty Teaching Award, 2010 Rutgers University Warren I Susman Award for Excellent Teaching, and the 2007 Rutgers University Graduate School of Education Alumni Association Outstanding Faculty Research Award.

J. D. Garcia

Jose D. Garcia

J. D. Garcia is Professor of Physics Emeritus at the University of Arizona, Tucson. Throughout his career, his research interests included time-dependent quantum models for collisions, quantum electrodynamics, physics education research, and improving science teacher education. He earned his PhD in Physics at the University of Wisconsin. His career has included a Fulbright Scholarship in Germany, and a NORDITA Fellowship in Sweden. Garcia is a Fellow of the APS and was the recipient of the APS' Bouchet Award. He has served as a Program Officer in the Division of Undergraduate Education at the National Science Foundation, was the Charter President of the National Society of Hispanic Physicists (NSHP), and has just finished a term as President of the Society for the Advancement of Chicanas and Native Americans in Science (SACNAS). A long-time member of AAPT, Garcia has served as a member of the Committee on Professional Concerns, Committee on Minorities in Physics, Committee on Undergraduate Physics, and the Meetings Committee. He has also served on several task force groups: as a member of the National Task Force on Undergraduate Physics (SPIN-UP), the Joint AAPT-APS Task Force on Graduate Education, and recently on the Task Force on Teacher Education in Physics (TTEP). A life member of the Arizona Section of AAPT, he has coordinated the meetings of the Tucson Area Physics Teachers (TAPT), for more than 20 years, and is still active in promoting physics outreach efforts in Tucson.

Chandralekha Singh

Chandralekha Singh

Chandralekha Singh earned her BS and MS in Physics at the Indian Institute of Technology, Kharagpur, and her MA and PhD in Physics at the University of California, Santa Barbara. A Life Member of AAPT, Singh has served as a member of the Committee on International Physics Education, Committee on Graduate Education in Physics, and the Programs Committee. Her work in physics education research has produced high-quality papers that have been published in journals such as the *American Journal of Physics*, *Physics Today,* and *Physical Review.* Singh co-edited three Physics Education Research Conference (PERC) proceedings and the May 2010 theme issue of *American Journal of Physics* focusing on the Gordon Conference on Experimental Research and Labs in Physics Education.

Singh's pioneering research in the teaching and learning of quantum mechanics has played a significant role in advancing physics education research in advanced courses. In addition to educational research in advanced courses, she has conducted research on cognitive issues in learning physics and improving student problem solving and reasoning skills. For a decade, she has conducted workshops at the national AAPT meetings on "What every physics teacher should know about cognitive research" and on "Strategies to help women succeed in physics related professions." She has conducted workshops at the national and regional AAPT meetings on "Quantum Interactive Learning Tutorials." Singh has conducted workshops on teaching quantum mechanics during New Faculty workshops. She is also the co-organizer of the first conference on Graduate Education in Physics.

Established in 1953, Distinguished Service Citations are presented to AAPT members in recognition of their exceptional contributions to AAPT at the national, sectional, or local level.

APS Division of Biophysics Plenary Session

Monday, July 30, 1:30–3 p.m. • Inn at Penn – Woodlands Ballroom

Birds, Brains, and Physics – The Fascinating Field of Biological Physics

William Bialek

Schools of fish, flocks of birds, and stampeding elephants are examples of phenomena from the natural living world that can be described using the tools of physics. Biological physics is a rapidly developing field of research that lies at the boundaries of physics, chemistry, and biology, and seeks to contribute to our understanding of life. Professor William Bialek from the Physics Department at Princeton University uses statistical mechanics to describe a wide range of living phenomena, from amino acids in a protein molecule to networks of neurons to birds in flight. Professor Dezhe Jin from the Physics Department at Penn State University studies how complex bird songs, which share many common features with human speech, are controlled by the emergent dynamics of neurons in brains of songbirds. Understanding how birds sing will help to resolve the language-centric pathways in the brain.

– ***Statistical Physics Approaches to Real Biological Systems,*** William Bialek, Princeton University

Dezhe Jin

William Bialek is the John Archibald Wheeler/Battelle Professor in Physics at Princeton University. He also is a member of the multidisciplinary Lewis–Sigler Institute. In addition to his responsibilities at Princeton, he is Visiting Presidential Professor of Physics at the Graduate Center of the City University of New York, where he is helping to launch an Initiative for the Theoretical Sciences. He attended the University of California at Berkeley, receiving the AB (1979) and PhD (1983) degrees in Biophysics. After post-doctoral appointments at the Rijksuniversiteit Groningen in the Netherlands and at the Institute for Theoretical Physics in Santa Barbara, he returned to Berkeley to join the faculty in 1986. In late 1990 he moved to the newly formed NEC Research Institute (now the NEC Laboratories) in Princeton, where he eventually became an Institute Fellow. Professor Bialek's research interests have ranged over a wide variety of theoretical problems at the interface of physics and biology, from the dynamics of individual biological molecules to learning and cognition.

– ***The Emergent Neural Dynamics of Bird Song Syntax,*** Dezhe Z. Jin, Penn State University

Dezhe Z. Jin is an associate professor of physics at the Pennsylvania State University. He earned a BS and MS in Physics at Tsinghua University, Beijing, China, and his PhD at the University of California, San Diego in 1999. He was awarded an Alfred P. Sloan Research Fellowship, 2006-2008. His research has focused on theoretical analysis of the biophysical properties of neural networks; this includes their application to computational models of neurobiological functions such as song generation and recognition in songbirds, motor control in basal ganglia, olfaction in insects and mammals, and feature selectivity and map formation in visual cortex. The theoretical modeling is done in close collaboration with experimental groups. Consisting of a large number of intricately connected neurons, the brain is one of the most sophisticated dynamical systems in nature. Understanding how the brain computes is at the forefront of current scientific research.

Space-Time, Quantum Mechanics and the Large Hadron Collider – Nima Arkani-Hamed

Nima Arkani-Hamed

Tuesday, July 31, 3:30–4:30 p.m. • Inn at Penn - Woodlands Ballroom

Nima Arkani-Hamed is a theorist with wide-ranging interests in fundamental physics, from quantum field theory and string theory to cosmology and collider physics. Formerly on the faculty at Berkeley and Harvard, he has been a professor in the school of natural sciences at the Institute for Advanced Study since 2008. He has taken a lead in proposing new physical theories that can be tested at the Large Hadron Collider at CERN in Switzerland.

University of California, Berkeley, PhD, 1997; SLAC National Accelerator Laboratory, Postdoctoral Fellow 1997–99; University of California, Berkeley, Assistant Professor 1999–2001, Associate Professor 2001; Harvard University, Visiting Professor 2001–02, Professor 2002–07; Institute for Advanced Study, Professor 2008–; Sloan Fellowship 2000–02; Packard Fellowship 2000–05; American Academy of Arts and Sciences, Member; European Physical Society, Gribov Medal 2003; Raymond and Beverly Sackler Prize in Physics 2008.

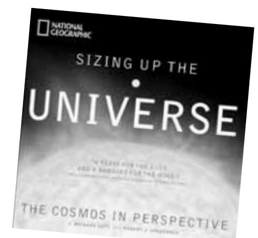
J. Richard Gott

Sizing Up the Universe – J. Richard Gott

Tuesday, July 31, 11 a.m.–12 p.m. • Inn at Penn – Woodlands Ballroom

J. Richard Gott is a professor of astrophysical sciences at Princeton University is noted for his contributions to cosmology and general relativity. He has received the Robert J. Trumpler Award, an Alfred P. Sloan Fellowship, the Astronomical League Award, and Princeton's President's Award for Distinguished Teaching. He was for many years Chair of the Judges for the Westinghouse and Intel Science Talent Search. His paper "On the Infall of Matter into Clusters of Galaxies and Some Effects on Their Evolution," co-authored with Jim Gunn, has received over 1500 citations. He proposed that the clustering pattern of galaxies in the universe should be spongelike—a prediction now confirmed by numerous surveys. He discovered exact solutions to Einstein's field equations for the gravitational field around one cosmic string (in 1985) and two moving cosmic strings (in 1991). This second solution has been of particular interest because, if the strings move fast enough, at nearly the speed of light, time travel to the past can occur. His paper with Li-Xin Li, "Can the Universe Create Itself?" explores the idea of how the laws of physics may permit the universe to be its own mother. His book *Time Travel in Einstein's Universe* was selected by Booklist as one of four "Editors' Choice" science books for 2001. He has published papers on map projections in *Cartographica*. His picture has appeared *Time, Newsweek,* and *The New York Times*. He wrote an article on time travel for *Time* magazine as part of its cover story on the future (April 10, 2000). His and Mario Juric's Map of the Universe appeared in *The New York Times* (Jan. 13, 2004), *New Scientist,* and *Astronomy*. Gott and Juric are in *Guinness World Records 2006* for finding the largest structure in the universe: the Sloan Great Wall of Galaxies (1.37 billion light years long). Gott's Copernican argument for space colonization was the subject of an article in *The New York Times* (July 17, 2007).

J. Richard Gott will be available for a book signing of his book
Sizing Up the Universe



Tuesday, July 31, 12:15-1:15 p.m. • Inn at Penn

(copies of the book will be available for sale)

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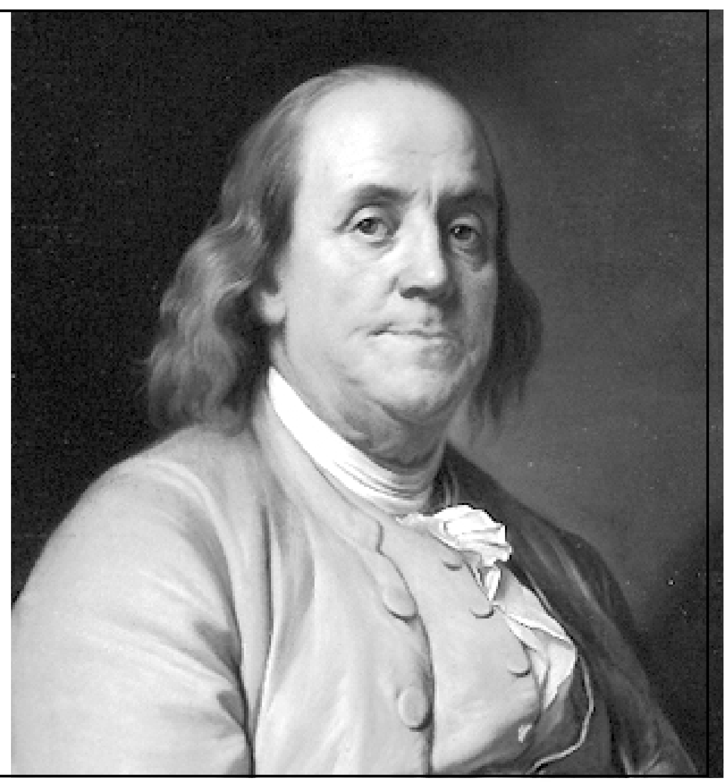
Monday, July 30
5:30 - 7 p.m.
CCH - Claudia Cohen Terrace



Free Commercial Workshops

CW01: Expert TA Commercial Workshop

Location: Sheraton - University Suite
Date: Tuesday, July 31
Time: 12–1 p.m.
Sponsor: Expert TA

Leader: Jeremy Morton

Expert TA is a commercial online homework and tutorial system for introductory-level physics courses. It was designed to grade problems the way instructors do; considering more than just a student's final answer. Solving physics problems involves numerous steps such as applying equations, drawing free-body diagrams, etc; to solve for numeric answers. Expert TA's problems are all multi-step and involve these aspects of problem solving. With a sophisticated math engine, Expert TA is able to grade student equations in detail, in a manner similar to how you or your TA would. It identifies detailed mistakes with equations, deducts points, and provides specific feedback. In Homework Mode, students are provided with a detailed grade report after the assignment due date. In Tutorial mode, students can access hints, and feedback is provided instantaneously. Expert TA has partners with talented professors, leaders in physics education, to develop a rich library of original problems. Users of Expert TA have discovered the power of detailed/sophisticated grading over simple right vs. wrong grading. Instructors are provided with a much more accurate assessment of a student's work and students are provided with feedback required to help them master concepts. Join us and learn how Expert TA can help you and your students.

CW02: Pearson Commercial Workshop

Location: Inn at Penn - Regents/St. Marks
Date: Tuesday, July 31
Time: 12:30–1:30 p.m.
Sponsor: Pearson

Leader: Eugenia Etkina

Eugenia Etkina (Rutgers University, Graduate School of Education – GSE) was born and educated in Russia, where she was awarded her PhD in Physics Education from Moscow State Pedagogical University. She has 30 years of physics teaching experience (teaching middle school, high school, and university physics). In 1993 she developed a system in which students learn physics using processes that mirror scientific practice. That approach was enriched when she began collaborating with Alan Van Heuvelen in 2000 and now is known as Investigative Science Learning Environment (ISLE). Since 2000, Professors Etkina and Van Heuvelen have developed curricula based on ISLE, conducted over 60 workshops for physics instructors, and published *The Active Learning Guide* (second edition available from Pearson in January 2013). Please join Prof. Etkina for a discussion on the ISLE method and how it can be put into practice in your classroom using the new textbook, *College Physics*, by Etkina, Gentile, and Van Heuvelen.

CW03: Vernier Software: New Data Collection Tools for Physics

Location: Inn at Penn - Regents/St. Marks
Date: Tuesday, July 31
Time: 4:30–6:30 p.m.
Sponsor: Vernier Software & Technology

Leaders: David Vernier
John Gastineau, Matt Athes-Washburn

Vernier Software: New Data Collection Tools for Physics, including LabQuest 2 — Attend this hands-on, drop-in workshop to learn about LabQuest 2 and other new data collection tools from Vernier Software & Technology. If you need an overview of data collection, we'll be happy to show you the basics. Use the new LabQuest 2 interface and see its large color touch screen with the upated LabQuest App. Collect data on an iPad, with a LabQuest 2 serving its data to Graphical Analysis. Next, analyze and store the experiment with Graphical Analysis for the iPad. Collect data in a browser, with a LabQuest 2 serving its data, and then analyze the data right in the browser. The browser can be on an Android tablet, or even your own smart phone. Collect data with the new Vernier Diffraction Apparatus, and see just how easy it is to map out intensity for single-slit and double-slit patterns. Fire the new Vernier Projectile Launcher. Check out Malus with the new Vernier Polarizer/Analyzer Kit for our Optics Expansion Kit. Add mirrors to your optics experiments with the Mirror Set for Optics Expansion Kit. Page through the new Advanced Physics with Vernier-Beyond Mechanics book.

CW04: Pearson Commercial Workshop

Location: Inn at Penn - Regents/St. Marks
Date: Monday, July 30
Time: 12:15–1:15 p.m.
Sponsor: Pearson

Leader: Paul Hewitt

Please join us for a discussion with Pearson author Paul Hewitt regarding his textbooks in conceptual physics, physical science and integrated science as well as Mastering Physics.

CW05: Klinger Educational Products Corp.

Location: Sheraton - University Suite
Date: Monday, July 30
Time: 12:15–1:15 p.m.
Sponsor: Klinger Educational Products

Leader: Walter Luhs

Open Frame Helium Neon Laser —The humble HeNe Laser is still important for education in Photonics. We demonstrate an open cavity training system with components like the HeNe tube with Brewster windows on sides, the two cavity mirrors and line tuning elements are placed onto the optical rail. The basic alignment is demonstrated and the beam diameter inside the cavity is measured to verify the nature of Gaussian beams. By means of a Littrow prism the line tuning is demonstrated. The power of the laser is determined by measuring the current of the provided photodiode. Cleaning of optical components is trained as well as the proper use of sensitive optical components. Diode Pumped Solid State Laser (DPSSL) Step by step the modules needed for a DPSSL using a Nd:YAG crystal will be explained and arranged on an optical rail. Spectroscopic measurements of the Nd:YAG are performed. The operation of a the Nd:YAG laser with demonstration of the so called "spiking" is shown by means of an oscilloscope. Frequency doubling to visible green radiation and the stability criteria of the optical cavity is verified. Higher transverse modes are demonstrated and the reduction to the TEM00 mode is performed by using an intra-cavity iris. Glass Fibre Optics Within this hands on training the stripping and cutting of a telecom optical fiber will be learned.

CW06: Physics2000.com Workshop in Introductory Physics

Location: Houston Hall - Golkin
Date: Monday, July 30
Time: 12:15–1:15 p.m.
Sponsor: Physics2000.com

Leader: Elisha Huggins

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

AAPT Exhibitor Information

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Leybold's newest development, Tomography module, will be demonstrated. This unit works with the X-ray machine, recording a 2D image while a computer generates a 3D-object.

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In the May 2012 *The Physics Teacher*, page 305, we placed an ad announcing ***Physics2012***, the second edition of the calculus-based version of Physics2000. We promised that it would have an Epilog on advances in physics and astronomy that occurred since 1998, when we finished writing the earlier text. At the **Physics2000.com** booth we plan to supply preprints of the Epilog sections on dark energy and inflation, and we expect to demonstrate *vacuum energy* and *negative pressure* using equipment that would be familiar to Benjamin Franklin.

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SHARED BOOK EXHIBIT

Take a look at the books exhibited near the AAPT booth.

Harvard University Press

- *A Short History of Physics in the American Century,* David C. Cassidy
- *101 Quantum Questions,* Kenneth W. Ford
- *The 50 Most Extreme Places in Our Solar System,* David Baker

Rutgers University Press

- *Physics: The First Science*, Peter Lindenfeld, Suzanne White Brahmia

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AAPT PHYSICS EDUCATION

Monday, July 30, 2012 – Session Schedule

Poster Session I is in Houston Hall - Bistro, 8:30 to 10:00 p.m.

	Sheraton-Ben Franklin Ballroom I	**Sheraton-Ben Franklin Ballroom II**	**Sheraton-Ben Franklin Ballroom III**	**Sheraton-Ben Franklin Ballroom IV**	**Houston Hall-Class of 49**	**Sheraton-Ben Franklin Ballroom V**	**Irvine Aud.-Amado Recital Hall**	**Sheraton-William Penn Suite**	**Claudia Cohen Hall - Terrace**	**Houston Hall - Golkin**	**Inn at Penn - Woodlands Ballroom**
8:30 a.m.	**AA** Assessing Student Learning in Upper-Division Labs	**AB** *Panel:* The Good and the Bad of Video Lectures	**AC** Frontiers in Astronomy and Space Science	**AD** Textbooks and Labs Suitable for Ninth Grade Physics	**AE** PER: Topical Understanding – Introductory Level	**AF** Teacher Preparation around the World	**AG** Two-Year College New Faculty Experience		**AH** PER in the High School	**AI** Teaching Physics to the Liberal Arts Major	
9:00 a.m.											
9:30 a.m.											
10:00 a.m.											
10:30 a.m.											
11:00 a.m.											**AAPT Teaching Awards:** M. Greenman K.M. Lee
11:30 a.m.											
12:05 p.m.											
12:15 p.m.	**Crkrbrl 2** Physics and Society Crackerbarrel						**Crkrbrl 1** Vidshare: Motivating and Elucidating Short Videos You Can Use!				
12:30 p.m.											
1:00 p.m.											
1:15 p.m.											
1:30 p.m.											**APS Division of Biophysics Plenary**
2:30 p.m.											
3:00 p.m.											
3:30 p.m.	**BA** *Panel:* Physics First – Success Stories in the Delaware Valley	**BB** Leadership Models in Science	**BC** The Art and Science of Teaching	**BH** Continuing Teacher Preparation : Inservice Professional Development	**BD** PER: Attitudes	**BF** Innovations in Teaching Astronomy	**BI** What Works in the Pre-College Classroom	**BE** Video Analysis in Undergraduate Education	**BG** PER Around the World	**BJ** Introductory Labs/Apparatus	
4:30 p.m.											
5:00 p.m.											
5:30 p.m.											
7:00 p.m.	**CA** Can Computational Modeling be Accessible to Intro. Students?	**CB** Labs at Many Levels	**CC** Teaching Environmental Physics in the Undergraduate Curriculum	**CD** iPad & iPhone Apps & Mobile Devices	**CH** Oral History – Methods and Examples	**CE** *Panel:* Writing for Academic Journals	**CJ** Under. Research	**CF** Video Analysis in the High School and Introductory College Classroom	**CG** Mentoring Minority Students	**CI** Different Research-based Curricula Promote Different Agendas	
7:30 p.m.							**CK** Assessing Learning in Introductory Lab				
8:00 p.m.											
8:30 p.m.											

Tuesday, July 31, 2012– Session Schedule

Poster Session II is in Houston Hall - Bistro, 6:00 to 7:30 p.m.

	Sheraton-Ben Franklin Ballroom I	Sheraton-Ben Franklin Ballroom II	Sheraton-Ben Franklin Ballroom III	Sheraton-Ben Franklin Ballroom IV	Houston Hall-Class of 49	Sheraton-Ben Franklin Ballroom V	Irvine Aud.-Amado Recital Hall	Sheraton-William Penn Suite	Claudia Cohen Hall - Terrace	Houston Hall - Golkin	Houston Hall - Reading Room Alcove	Inn at Penn Ballroom
8:30 a.m.	**DA** International Perspectives on Laboratory Instruction	**DB** Physics and Society	**DC** Teaching Scientific Programming from Intro to Upper Level Physics	**DD** Preparing Teachers to Serve Diverse Communities	**DF** PER: Topical Understanding Intro to Advanced	**DE** Upper Division Undergraduate Education	**DI** PER: Student Reasoning I	**DG** Physics of Entertainment	**DH** PER: Problem Solving I	**DJ** Using Research-based H.S. PER Curriculum in Teacher Preparation		
9:00 a.m.												
9:30 a.m.												
10:00 a.m.												
10:30 a.m.												
11:00 a.m.												**Plenary:** J. Richard Gott III
11:30 a.m.												
12:00 p.m.	**Crkrbrl 3** Crackerbarrel for Solo PERs	**Crkrbrl 4** Common Core Framework and Phys. Standards for College Success				**Crkrbrl 5** YouTube Sharathon						
12:15 p.m.												
12:30 p.m.												
1:30 p.m.	**EA** Coolest Experiment	**EC** Faculty Peer Mentoring	**ED** Preparing Teachers to Integrate Labs into Instruction	**EE** Antique Electrostatic Apparatus	**EF** PER in the Pre-college Classroom	**EH** PER: Problem Solving II	**EG** Using a Planetarium to Teach Astronomy	**EI** Using ISLE to Analyze Simple Experiments	**EK** LHC Data for Physics Teachers and Students		**EJ** Two-Year College Poster Session	
1:45 p.m.												
2:00 p.m.	**EB** Professional Development II											
2:30 p.m.												
3:00 p.m.												
3:30 p.m.												**Plenary:** Nima Arkani-Hamed
4:00 p.m.												
4:30 p.m.												
5:00 p.m.												
5:30 p.m.												
6:00 p.m.												
6:30 p.m.												
7:00 p.m.												

Wednesday, August 1, 2012– Session Schedule

	Sheraton-Ben Franklin Ballroom I	Sheraton-Ben Franklin Ballroom II	Sheraton-Ben Franklin Ballroom III	Sheraton-Ben Franklin Ballroom IV	Houston Hall-Class of 49	Sheraton-Ben Franklin Ballroom V	Irvine Aud.-Amado Recital Hall	Sheraton-William Penn Suite	Claudia Cohen Hall - Terrace	Houston Hall - Golkin	Sheraton – University Suite	Inn at Penn - Woodlands Ballroom
8:30 a.m.	**FA** Underrepresented Minorities in Doctoral Education	**FC** *Panel:* Multi-Disciplinary-based Education Research Groups	**FI** Teaching Physics Around the World	**FE** Scientific Literacy	**FB** PER: Investigating Classroom Strategies I	**FG** Introductory Courses	**FD** Reforming the Introductory Physics Course for Life Science Majors VII	**FH** Teacher Preparation	**FJ** PIRA Session: International Outreach	**FK** Assessing Pedagogical Content Knowledge in Teacher Preparation		
9:00 a.m.				**FF** Interactive Lecture Demonstrations								
9:30 a.m.												
10:00 a.m.												
10:30 a.m.												
11:00 a.m.												**Awards:** *Millikan Medal:* Phil Sadler *DSCs*
11:30 a.m.												
12:15 p.m.					**Crkrbrl 6** Do We Have Standards? Moving Towards a Definition of Physics Mastery		**Crkrbrl 8** Crackerbarrel for Faculty in Small Departments		**Crkrbrl 7** Crackerbarrel for PER Graduate Students			
12:30 p.m.												
1:00 p.m.												
1:15 p.m.												
1:30 p.m.												
1:30 p.m.	**GA** Teaching Physics in Urban and Suburban Settings	**GB** PER: Investigating Classroom Strategies II	**GC** Technologies	**GD** Great Teachers	**GF** PER: Student Reasoning II	**GE** The Third Eye	**GI** Physics for All	**GG** Dollar Store Labs	**GH** PER: Teacher Preparation and Development	**GL** Advanced Physics Topics/ Post Deadline	**GM** *Panel:* Giving Voice in the Classroom	
1:45 p.m.												
2:00 p.m.				**GK** Middle and High School Teaching								
2:30 p.m.												
3:00 p.m.												**PERC** PERC Bridging Session
3:30 p.m.												
4:00 p.m.												
4:30 p.m.												
5:00 p.m.												
5:30 p.m.												
6:00 p.m.												

Workshops – Saturday, July 28

All workshops are held at the University of Pennsylvania, Physics Department building

W01: Building Scientific Apparatus and Invention Prototypes

Sponsor: Committee on Laboratories
Co-sponsor: Committee on Apparatus
Time: 8 a.m.–5 p.m. Saturday
Member Price: $105 **Non-Member Price:** $130
Location: 3N9

Randy Tagg, University of Colorado Denver, PO Box 173364, Denver, CO 80217-3364; randall.tagg@ucdenver.edu

A variety of resources and skills are needed to build scientific apparatus and to develop prototypes for inventions. These include mechanical design, use of motors and other actuators, analog and digital electronics, and optics. Learning such skills is an excellent way to merge physics with real-world applications and to widen the realm of experiments achievable by students and teachers. The workshop will give a "grand tour" of the practical knowledge for such prototyping and point to pathways for further development, including ideas about how to incorporate such training into curriculum at both high school and college levels. Examples will be drawn from student and teacher research projects as well as experience in running a community prototyping center. Participants are encouraged to contribute some of their own prototyping objectives for discussion.

W02: Grant Writing

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on Professional Concerns
Time: 8 a.m.– 5 p.m. Saturday
Member Price: $80 **Non-Member Price:** $105
Location: Computer Lab

Paula Engelhardt, Tennessee Technological University, Cookeville, TN 38505; engelhar@tntech.edu

Ellie Sayre, Warren Christensen

This workshop is intended for individuals who are in their last year of graduate school, in a post-doctoral position, or are new faculty members. The workshop will focus on navigating the National Science Foundation (NSF) website, finding alterative funding sources such as Fund for the Improvement of Postsecondary Education (FIPSE) and state and local funding agencies, and preparing the grant proposal. Tips and suggestions for developing ideas and seeing them through to the development of the grant proposal will be discussed. Participants are encouraged to bring with them grant ideas to discuss with the group.

W03: Learning Physics While Practicing Science

Sponsor: Committee on Physics in Undergraduate Education
Co-sponsor: Committee on Physics in Two-Year Colleges
Time: 8 a.m.–5 p.m. Saturday
Member Price: $95 **Non-Member Price:** $120
Location: 3W5

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

David Brookes, Alan Van Heuvelen

Participants* will learn how to modify introductory physics courses to help students acquire a good conceptual foundation, apply this knowledge effectively in problem solving, and develop the science process abilities needed for real life work. We provide tested curriculum materials including: *The Physics Active Learning Guide* with 30 or more activities per textbook chapter for use with any textbook in lectures, recitations and homework; (b) a website with over 200 videotaped experiments and associated questions for use in lectures, recitations, laboratories, and homework; and (c) a set of labs with inexpensive equipment that can be used to construct, test and apply concepts to solve practical problems. During the workshop we will illustrate how to use the materials not only in college and high school physics courses but also in courses for future physics teachers to have an explicit emphasis on using the processes of science and various cognitive strategies.

* Participants who own laptops should bring them to the workshop. The computer should have Quicktime installed. If you do not own a computer, you will be paired with somebody who does.

W04: Make, Take, and Do: Homemade Physics Equipment

Sponsor: Committee on Apparatus
Co-sponsor: Committee on Physics in High Schools
Time: 8 a.m.–5 p.m. Saturday
Member Price: $95 **Non-Member Price:** $120
Location: 3N17

Tom Senior, 355 Dell Lane, Highland Park, IL 60035-5310; tomseniorphysics@yahoo.com

Pat Callahan, George Amann, Al Gibson

A chance to make apparatus tested and approved by the PTRAs over the years of the program. We will make a Soda Can Van de Graaff, a holiday light circuit puzzle, a color addition Ping Pong ball, a pendulum wave machine for the desk or overhead, a homopolar motor, and several other items. Brush up on some simple soldering and other skills useful in the physics class. All items will be easily transported home.

W05: Physics By Design

Sponsor: Committee on Physics in Pre-High School Education
Time: 8 a.m.–5 p.m. Saturday
Member Price: $108 **Non-Member Price:** $133
Location: 3N15

Julia Olson, Math and Science Teacher Education & Retention Industry Partnerships (MASTER-IP) Program, The University of Arizona College of Education, Tucson, AZ 85721; jkolson@arizona.edu

What is understanding? What is the relationship between knowledge and understanding? What does "teaching for understanding" look like in the physics classroom? How can we implement reformed teaching along with new standards? These and other important questions will be explored as participants design, develop, and refine a cohesive unit plan based on the principles found in Understanding by Design (UbD). In the UbD classroom, there are high expectations and incentives for all students while exploration of big ideas and essential questions is differentiated, so students who are able delve more deeply into the subject matter than others. This workshop is appropriate for instructors from pre-high school through college levels. Participants will receive a copy of UbD, 2nd Ed. ***Note:*** participants are strongly encouraged to bring their own laptops to the workshop.

W06: PIRA Lecture Demonstration I

Sponsor: Committee on Apparatus
Time: 8 a.m.–5 p.m. Saturday
Member Price: $115 **Non-Member Price:** $140
Location: A1

Dale Stille and Sam Sampere, Rm 58, Van Allen Hall, Dept. of Physics and Astronomy, University of Iowa, Iowa City, IA 52242

Topics in this workshop cover the standard first semester of physics instruction from Mechanics to Thermal. It is taught by an experienced team of lecture demonstrators. The format allows for and encourages interplay between instructors and participants. It is recommended that both Lecture Demonstrations 1 and 2 be taken as this will cover the complete year of demonstrations needed for a typical course. The demonstrations used and exhibited will be based on, but not limited to, the PIRA top 200 list of demonstrations. See http://www.pira-online.org for more info on this list. Please note that this workshop is intended to expose as many demonstrations and ideas as possible to the participants. Since we will be doing approximately 100 demos during this workshop, time restraints DO NOT allow for extensive or in-depth discussions of each demonstration. We will make every effort to answer all questions and concerns.

W08: LivePhoto Physics: Advanced Projects with Video Analysis

Sponsor: Committee on Educational Technologies
Time: 8 a.m.–12 p.m. Saturday
Member Price: $60 **Non-Member Price:** $85
Location: 3W2

Aaron Titus, High Point University, 833 Montlieu Ave., High Point, NC 27262; titus@mailaps.org

Bob Teese, Pat Cooney

Video analysis is now being used in many ways in introductory physics courses. For example, teachers and students have been analyzing their own high-speed videos or determining whether various YouTube videos or animated games such as Angry Birds are realistic. Many exciting new uses of video analysis require advanced techniques. In this workshop, participants will learn how to capture video segments from games and how to use advanced features in Tracker or Logger Pro video analysis software. Advanced techniques include measuring relative motion, compensating for panning and zooming, or dealing with non-standard frame rates. (Familiarity with basic video analysis is assumed.)

W09: CASTLE Workshop – Model Building Investigations of Electromagnetic Field Production and Transformer Operation

Sponsor: Committee on Physics in High Schools
Time: 8 a.m.–12 p.m. Saturday
Member Price: $85 **Non-Member Price:** $110
Location: 3C8

Dick Feren, 421 Webster St., Manchester, NH 03104; rbferen@comcast.net

Participants will explore complex concepts using simple equipment in straightforward experiments designed to promote image-based understanding of electromagnetic field concepts that are usually developed mathematically. These include using a portable radio to detect an electric field radiated by accelerating charge when a current is turned on or off; using shaped-wire circuits to show that magnetic fields of turned-on current contain energy that radiation carries to the radio; using a transformer with a variable iron core as a dimmer and brightener for a bulb at the output. The current detected in the coil with the moving magnet, and the changing output of the transformer with the variable core are both predicted by Faraday's law.

W11: New RealTime Physics and Interactive Lecture Demonstration Tools and Curricula: Video Analysis, Clickers and E&M Labs

Sponsor: Committee on Educational Technologies
Co-sponsor: Committee on Research in Physics Education
Time: 8 a.m.–12 p.m. Saturday
Member Price: $75 **Non-Member Price:** $100
Location: 3N20

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

Priscilla Laws, Dickinson College; Ronald Thornton, Tufts University

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

W12: Teaching Physics in Urban Schools

Sponsor: Committee on Minorities in Physics
Time: 8 a.m.–12 p.m. Saturday
Member Price: $70 **Non-Member Price:** $95
Location: 3N12

Dan Smith, Dept. of Biological and Physical Sciences, South Carolina State University, Orangeburg, SC 29115; dsmith@scsu.edu

Katemari Rosa, Columbia University; Katya Denisova, Baltimore City Public Schools; Angela M. Kelly, Stony Brook University

Urban educators who have taught high school physics in some of the toughest environments in the U.S. (New York City and Baltimore, MD) will share their challenges and successes in this workshop. Workshop participants will be presented with activities that have engaged student interest as well as the strategies for developing their own activities. In addition, a panel presentation will serve as the springboard for a discussion of extra-curricula difficulties and how to confront them.

W13: Using FPGAs in the Digital Lab

Sponsor: Committee on Laboratories
Co-Sponsor: Committee on Apparatus
Time: 8 a.m.–12 p.m. Saturday
Member Price: $70 **Non-Member Price:** $95
Location: 3N16

Kurt Wick, University of Minnesota, 116 Church St. SE, Minneapolis, MN 55455; wick@umn.edu

As part of an advanced lab course students are exposed to the basics of analog and digital electronics. In the last few years the physical implementation of digital circuits has moved away from the traditional application specific standard products (ASSPs), such as the 4000 or 7400 series chips, toward Field Programmable Gate-Arrays (FPGAs) and Complex Programmable Logic Devices (CPLDs). This workshop covers the experience of converting the three-week digital logic lab segment of an advanced lab course from ASSPs towards FPGAs. Educational hardware and software, options of programming the devices, and some lab exercises and applications suitable for such a lab course are presented. As demonstration and practice, the participants will use their laptops to program and interface the devices. A basic knowledge of digital logic will be assumed.

W14: Ben Franklin is My Lab Partner

Sponsor: Committee on History and Philosophy in Physics
Time: 1–5 p.m. Saturday
Member Price: $72 **Non-Member Price:** $97
Location: 3N12

Robert Morse, 5530 Nevada Ave., NW, Washington, DC 20015; rmorse@cathedral.org

Benjamin Franklin's experiments and observations on electricity established not only his reputation as a scientist, but also our electrical conventions and vocabulary, and the principle of charge conservation. In his letters, Franklin builds, tests, and defends his model with skill and eloquence, arguing from experiment and sharing both his wisdom and doubts, while clearly conveying his fascination with electricity. As Franklin was not formally schooled in mathematics, his theory was qualitative, and is an approachable example of hands-on and minds-on construction of a conceptual model with significant explanatory power. In this workshop, developed by the author at the Wright Center for Science Teaching at Tufts University, working with Franklin's descriptions, we will recreate many of his experiments using modern, inexpensive equipment. Participants will receive equipment and a CD-ROM containing the workshop manual, a collection of Franklin's letters relating to electricity, and movie clips illustrating the experiments.

W15: Introductory Laboratories

Sponsor: Committee on Laboratories
Time: 1–5 p.m. Saturday
Member Price: $70 **Non-Member Price:** $95
Location: 3W7 and 11

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

Scott Shelley, Haverford College; sshelley@haverford.edu

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

W16: Lab Experiments that (can) Re-appear Across the Curriculum

Sponsor: Committee on Laboratories
Co-Sponsor: Committee on Physics in Pre-High School Education
Time: 1–5 p.m. Saturday
Member Price: $100 **Non-Member Price:** $125
Location: 3N16

Paul Dolan, Northeastern Illinois University, 5500 N. St. Louis Ave., Chicago, IL 60625; p-dolan@neiu.edu

Do your favorite lab at any level in the curriculum! This workshop will provide participants with hands-on experience working with equipment from several physics lab exercises that can be adapted to being done at many different levels of the curriculum, potentially from middle school to the advanced lab, thus moving the "spiral curriculum" from the lecture into the lab. Participants will cycle through the various stations to optimize their "hands-on" time. Documentation will be provided for each experiment with sample data, equipment lists, and construction or purchase info. Possible topics include (but are not limited to): the pendulum (in its many various forms), the ballistic pendulum, granular materials, lenses and image formation, NanoTech, and examples of exponential growth and decay, such as population simulations and radiation/counting. The presentations will be active and interactive.

W17: Modeling Physics for University Physics

Sponsor: Committee on Research in Physics Education
Time: 1–5 p.m. Saturday
Member Price: $60 **Non-Member Price:** $85
Location: 3C6

Eric Brewe, Florida International University, College of Education, 11200 SW 8th St., ZEB 259a, Miami, FL 33199 ; eric.brewe@gmail.com

Modeling Instruction is a pedagogical approach to university-level physics that focuses on model development and testing. The Physics Education Research Group at Florida International University has been implementing Modeling Instruction for university physics for the past 10 years. This workshop presents a university version of Modeling Instruction curriculum for the mechanics semester of introductory physics. Participants will engage in inquiry activities that focus on building qualitative and quantitative models, explore the curriculum materials available on an instructional CD, and explore video examples from the Modeling Instruction classroom. Participants in this workshop will receive a CD with weekly planning guides for one semester of introductory physics, activities designed for students, and video clips for instructor use. Participants are encouraged to bring laptop computers to this workshop.

W18: Science and Religion: Teaching Critical Thinking

Sponsor: Committee on Science Education for the Public
Time: 1–5 p.m. Saturday
Member Price: $70 **Non-Member Price:** $95
Location: 3W2

Paul Nienaber, Saint Mary's University of Minnesota, Physics Dept., 700 Terrace Heights #32, Winona, MN 55987; pniebabe@smumn.edu

Matthew B. Koss, College of the Holy Cross

Recent interchanges between science and religion have sparked serious interest and no little heat. Science educators have an investment in these discussions, not just because they impact public school curricular policy—curious students and colleagues often raise questions whose answers require examining subtle distinctions. This workshop seeks to map out a particular approach to the discourse, an explorative juxtaposition of fundamental (and sometimes deeply implicit) characteristics of the two principal disciplines (science and theology). The intent is not to exhaustively survey the current literature, nor to demolish or advocate particular positions. The aim, rather, is to provide an opportunity for participants and presenters to interact in a number of guided discussions and activities on this topic. These directed engagements will help construct a framework that the presenters feel will permit participants to address the issues more productively, and to open avenues to better help students develop critical thinking skills.

W19: Skepticism in the Classroom

Sponsor: Committee on Committee on Physics in High Schools
Time: 1–5 p.m. Saturday
Member Price: $60 **Non-Member Price:** $85
Location: 3C2

Dean Baird, Rio Americano High School, 4540 American River Drive, Sacramento, CA 95864; dean@phyz.org

Matt Lowry, College of Lake County

We will present a variety of lessons, appropriate for the physics classroom, that focus on the skeptical and critical thinking nature of science. Some lessons involve obvious physics content; some bring in examples from the real world. Participants will get ready-to-use lessons and resources designed to bring healthy, scientific skepticism to their classrooms. Topics include fire walking, ghosts and angels, balance bracelets, back masking, the credulity of local media, woo at school, and more.

Workshops – Sunday, July 29

All workshops are held at the University of Pennsylvania Physics Department building.

T01: Research-based Teaching Strategies to Close the Gap

Sponsor: Committee on Women in Physics
Co-Sponsor: Committee on Minorities in Physics
Time: 9 a.m.–12 p.m. Sunday
Member Price: $65 **Non-Member Price:** $90
Location: 3C4

Burrow Kruezter, PO Box 41, Newry, SC 29665; kreutzk@gmail.com

Andrew Boudreaux

Over the past several decades, physics education research (PER) has identified a deficit in the ability of traditional instruction to promote coherent conceptual understanding of topics in introductory physics. Our preliminary study found that when recommendations from educational psychology were introduced the gender gap disappeared. In this workshop we will discuss and model these recommendations as well as work in small groups to brainstorm different techniques to utilize the recommendations with students.

W20: PIRA Lecture Demonstration II

Sponsor: Committee on Apparatus
Time: 8 a.m.–5 p.m. Sunday
Member Price: $115 **Non-Member Price:** $140
Location: A1

Dale Stille and Sam Sampere, Rm 58, Van Allen Hall, Department of Physics and Astronomy, University of Iowa, Iowa City, IA 52242

Topics in this workshop cover the standard second semester of physics instruction from E&M to Modern plus Astronomy. It is taught by an experienced team of lecture demonstrators. The format allows for and encourages interplay between instructors and participants. It is recommended that both Lecture Demonstrations 1 and 2 be taken as this will cover the complete year of demonstrations needed for a typical course. The demonstrations used and exhibited will be based on, but not limited to, the PIRA top 200 list of demonstrations. See www.pira-online.org for more info on this list. Please note that this workshop is intended to expose as many demonstrations and ideas as possible to the participants. Since we will be doing approximately 100 demos during this workshop, time restraints DO NOT allow for extensive or in-depth discussions of each demonstration. We will make every effort to answer all questions and concerns..

W21: The Physics of Energy

Sponsor: Committee on Science Education for the Public
Co-Sponsor: Committee on Women in Physics
Time: 8 a.m.–5 p.m. Sunday
Member Price: $110 **Non-Member Price:** $135
Location: 3N17

Abigail Mechtenberg, Clark University, 950 Main St., Worcester, MA 01602; amechten@umich.edu

Regina Barrera, Lee College

Educators from U.S. high schools, TYCs, and colleges/universities adapt this Physics of Energy workshop for experimental and theoretical Science, Technology, and Society (STS) curriculum. Whether motivated by energy security or environmental stability, physicists at all levels must play a role in the scientific literacy shaping the past as we have known it and the future of the world as we should know it. The academic level is set for undergraduate engineers and physicists; however, the astute teacher can easily apply this to other students. During the workshop 10 laboratories will be executed in groups (starting with cookbook to inquiry through a hybrid approach), project-based implementation. All participants will leave with a CD of resources. Together the workshop will weave a coherent common thread for Physics of Energy from mechanical to electrical energy, thermal to electrical, solar to electrical, and chemical to electrical energy.

W22: UTeach Observation Protocol (UTOP)

Sponsor: Committee on Teacher Preparation
Time: 8 a.m.–5 p.m. Sunday
Member Price: $90 **Non-Member Price:** $115
Location: 3C8

Mary Walker, The University of Texas at Austin, College of Natural Sciences, 1 University Station - G2550, Austin, TX 78712-0549; plisch@aps.org

Candace Walkington, Monica Plisch

The UTeach Observation Protocol (UTOP) is an instrument to observe the classroom practices of in-service teachers. It is based on the Reformed Teaching Observation Protocol (RTOP) and the Inside the Classroom instruments of Horizon Research. This workshop will provide training on how to use the UTOP to assess pedagogical practices shown by research to improve student learning.

W23: Computation and the Modeling Curriculum

Sponsor: Committee on Educational Technologies
Co-Sponsor: Committee on Physics in High Schools
Time: 8 a.m.–5 p.m. Sunday
Member Price: $80 **Non-Member Price:** $105
Location: 3N16

Michael Schatz, School of Physics, Georgia Tech, Atlanta, GA 30332; michael.schatz@physics.gatech.edu

John Burk, The Westminster Schools; John Aiken, Georgia State University

This workshop will describe methods for enhancing Modeling Instruction in high school physics with curricular materials that teach computation (i.e., teach students to simulate, to visualize, and to solve physics problems using the computer). The computation curricular materials are based on the easy-to-learn and use VPython environment; no prior programming experience is assumed or required (either for the workshop or for classroom use). The workshop focuses on computation applied to force and motion; the materials are suitable for any high school physics course ranging from algebra-based physics through AP Physics. The workshop offers the opportunity to become part of a growing community of instructors, who are helping students develop Computational Thinking skills (like computational physics) that are a vital part of all professional STEM disciplines in the 21st century.

W25: Real-time Assessments of Student Understanding

Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Educational Technologies
Time: 8 a.m.–12 p.m. Sunday
Member Price: $60 **Non-Member Price:** $85
Location: 3C2

Scott Franklin, Dept. of Physics, Rochester Institute of Technology, Rochester, NY 14623-5603; svfsps@rit.edu

Eleanor Sayre

This workshop will introduce participants to RAWR, the Rapid Assessment and Web Reports system that allows instructors to get real-time assessment of student understanding. Ideal for larger class sizes, but suitable for all, RAWR administers a between-student testing of physics concepts that compares the results of one group of students at one time with that of another at a later time. Faculty can see when students begin to forget prior knowledge, and adjust their methods accordingly. Faculty can choose from a large set of validated concept questions or generate their own to be incorporated into the database. Results are presented to faculty in multiple forms, and can assist Just-in-Time-Teaching methods. Workshop participants will learn the philosophy behind the between-students method and get hands-on experience with the RAWR interface, and so will be fully capable of implementing RAWR testing, if they so desire, in the coming fall term.

W26: PRISMS – A High School Physics Curriculum

Sponsor: Committee on Physics in High Schools
Time: 8 a.m.–12 p.m. Sunday
Member Price: $145 **Non-Member Price: $170**
Location: 3W2

Lawrence Escalada, 317 Begeman Hall, Dept. of Physics, University of Northern Iowa, Cedar Falls, IA 50614-0150; Lawrence.Escalada@uni.edu

Alison A. Beharka, University of Northern Iowa

Physics Resources and Instructional Strategies for Motivating Students (PRISMS) is a high school physics curriculum and professional development program that utilizes a learning cycle pedagogy. The PRISMS curriculum has been used extensively in UNI teacher preparation and professional development. The original PRISMS materials were a collection of 130 high interest activities related to the real-life experiences of high school physics students designed to develop student conceptual understanding and to cultivate student scientific reasoning and problem skills. The enhanced and revised version, called PRISMS PLUS, focuses on complete learning cycles that provide fully integrated experiences that enable students to develop not only their problem-solving and inquiry skills but also deep, long-lasting understanding of physics concepts. Participants will be introduced to PRISMS PLUS and work through a number of learning cycles. Participants will engage in discussions how the curriculum can be implemented in various high school physics classrooms.

W27: Activities for Teaching about Weather and Climate

Sponsor: **Committee on Science Education for the Public**
Co-Sponsor: Committee on Physics in High Schools
Time: 8 a.m.–12 p.m. Sunday
Member Price: $60 **Non-Member Price: $85**
Location: 3N15

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

Paul Williams, Austin Community College

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

W28: Can You Teach Radioactivity Using Inquiry? Yes!

Sponsor: Committee on Educational Technologies
Co-Sponsor: Committee on Research in Physics Education
Time: 8 a.m.–12 p.m. Sunday
Member Price: $60 **Non-Member Price: $85**
Location: 3N12

Andy Johnson, CAMSE, Unit 9005, Black Hills State University, Spearfish SD 57799-9005; Andy.Johnson@bhsu.edu

Renee Michelle Goertzen

High school or beginning college students can develop meaningful understandings of radioactivity via inquiry! The NSF-supported Inquiry-Based Radiation project has developed a coherent set of over 35 hours of inquiry materials. Topics include basic properties of ionizing radiation, the origins of radiation, interaction of radiation with matter (including health effects), half lives and nuclear waste. These research-based materials resolve numerous student difficulties that we have identified through repeated classroom trials, observations, and interviews with students. Notable problems addressed include differentiating radiation from its source(!), EM vs. ionizing radiation, the behavior and structure of atoms, the process of ionization by radiation, zoom scale thinking, interaction of radiation with matter, and the meaning/microscopic basis of half life. Participants will get a flavor of the materials, learn about learning issues and receive electronic copies of the full current version including homework, teacher information, and three fun and powerful simulators.

W29: ClassAction: Interactive Classroom Materials for Introductory Astronomy

Sponsor: Committee on Space Science and Astronomy
Time: 8 a.m.–12 p.m. Sunday
Member Price: $30 **Non-Member Price: $55**
Location: 3C6

Kevin Lee, 244D Jorgensen Hall, University of Nebraska, Lincoln, NE 68588-0299; klee@unl.edu

Todd S. Young, Wayne State

Educational research has clearly defined the characteristics of the optimal introductory astronomy classroom—one where students are actively engaged in the learning process and frequently receiving timely feedback on their learning progress. The NSF-funded ClassAction project is a computer database of Think-Pair-Share questions designed to be projected in the classroom for student voting and discussion. Instructors have the capability to recast these questions into alternate forms based on their own preferences and formative feedback from the class. The questions are accompanied by simulations and other resources for providing feedback. This workshop will provide teachers with hands-on experience using ClassAction materials and present lessons we have learned about the most effective ways to engage students. All materials will be disseminated through the web (http://astro.unl.edu) before the workshop and attendees will bring their own laptops with the software already installed.

W30: How to Make Significant and Lasting Changes in Your Introductory Physics for Life Science Course

Sponsor: Committee on Physics in Undergraduate Education
Co-Sponsor: Committee on Educational Technologies
Time: 8 a.m.–12 p.m. Sunday
Member Price: $65 **Non-Member Price: $90**
Location: 3N14

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

In recent years there has been much activity focused on major changes in the introductory course for life science students. Prompted by several national policy documents (e.g. Bio 2010 and proposed changes in medical school admissions criteria), changes in the course are aimed at creating a curriculum better suited to the needs and interests of life science students. In this workshop several educators who have been working on this problem will share resources and ideas (rich biology-based problems, texts and lectures; rethinking topic coverage; fundamental differences between biology and physics that must be acknowledged; and institutional challenges to change).

W31: From Ptolemy to Einstein: Using Computer Simulations in Astronomy

Sponsor: Committee on Educational Technologies
Co-Sponsor: Committee on Physics in Undergraduate Education
Time: 8 a.m.–12 p.m. Sunday
Member Price: $60 **Non-Member Price:** $85
Location: PC Lab 1

Mario Belloni, Physics Dept. Davidson College, BOX 6910, Davidson, NC 28036; mabelloni@davidson.edu

Wolfgang Christian, Todd Timberlake

One of the most popular courses in physics is astronomy. However, the topics taught require visualizations that are not familiar to the typical students in these courses. To address this issue, we have created a set of flexible resources for the teaching of introductory astronomy based on two- and three-dimensional simulations. These simulations are created with Easy Java Simulations (EJS) which is a free and open source tool for creating Java simulations. Because EJS allows teachers to easily change simulations, existing simulations can be customized to the type of astronomy course one is teaching. In this workshop, we will describe how to use and modify astronomy simulations such as the celestial sphere, Ptolemaic and Copernican models, Keplerian orbits including eclipses, galactic collisions, and orbits about black holes. All of these materials will be distributed on a CD but are also available on the OSP Collection on the ComPADRE digital library.

W32: Sound & Music, Ways to Teach It (Free Kit !)

Sponsor: Committee on Physics in Pre-High School Education
Co-Sponsor: Committee on Teacher Preparation
Time: 8 a.m.–12 p.m. Sunday
Member Price: $60 **Non-Member Price:** $85
Location: 3W5

Wendy Adams, University of Northern Colorado, CB 127, Greeley, CO 80639; wendy.adams@colorado.edu

The Acoustical Society of America is proud to offer a "Sound and Music Activity Kit" free to K-12 teachers. The kit includes 10 tuning forks (frequencies chosen to address a range of learning goals), a sound level meter, four laminated posters of the inner ear and hair cells (healthy and damaged), Ping Pong balls, fuzzy sticks, straws, and 15 research-based, interactive, student-tested lessons that have been developed to use with the Activity Kit materials. These lessons have been reviewed by the AAPT PTRAs (Physics Teacher Resource Agents). There are lessons that are appropriate for a range of levels K-14. Topics include, but are not limited to, how sound is produced, the basics of waves, how musical instruments work, echolocation, the Doppler effect and Sound Labs. In this workshop the introductory lesson will be demonstrated and we will work with several of the hands-on portions of additional lessons.

W33: PTRA Workshop: Using Children's Literature to Teach Science

Sponsor: Committee on Physics in Pre-High School Education
Co-Sponsor: Committee on Physics in Two-Year Colleges
Time: 8 a.m.–12 p.m. Sunday
Member Price: $80 **Non-Member Price:** $105
Location: 3N22

William Reitz, 2921 Kent Rd., Stow, OH 4424; wreitz@neo.rr.com

Nina Morley Daye, 2921 Kent Rd., Stow, OH 44224; nina.daye@orange.k12.nc.us

Storytime is a magic time—a time of amazement and imagination for pre school-ers to high school-ers (and for many lucky adults). The magic unleashed in children's literature should not disappear when the story is completed. We can bridge the gap from story to experiment by asking "I wonder if ?..." Then investigate those predictions with hands-on activities that capitalize on this magic. 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. The workshop 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 plans.

W10: "Hands-on" on the Road

Sponsor: Committee on Science Education for the Public
Time: 1–5 p.m. Sunday
Member Price: $95 **Non-Member Price:** $120
Location: 3N15

Richard Flarend, Penn State Altoona, 3000 Ivyside Park, Altoona, PA 16601; ref7@psu.edu

Pati Sievert, Northern Illinois University Outreach

Come to this workshop and learn more about hands-on activities suitable for outreach and road programs for a variety of age ranges. Some activities are great for your classroom too. Of course, you will also do the activities yourself! Some activities are great for young kids, while others are for older kids. Activities will come from five different outreach programs in the areas of Electricity, Magnetism, Optics, Lasers, and Sound. Ideas based on experience with thousands of kids will also be presented about how to manage equipment and groups of children with your own "Hands-on" on the road program.

W35: Simple Experiments for Learning the Strategies that Mirror Scientific Practice

Sponsor: Committee on Physics in Undergraduate Education
Co-Sponsor: Committee on Physics in High Schools
Time: 1–5 p.m. Sunday
Member Price: $70 **Non-Member Price:** $95
Location: 3N9

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

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

W36: Advanced & Intermediate Laboratories

Sponsor: Committee on Laboratories
Time: 1–5 p.m. Sunday
Member Price: $95 **Non-Member Price:** $120
Location: 3W7 and 11

Van Bistrow, Dept. of Physics, University of Chicago, Kersten Physics Teaching Center, 5720 S. Ellis Ave., Chicago, IL 60637; vanb@uchicago.edu

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

W37: Biology-Inspired Labs for Introductory Physics

Sponsor: Committee on Physics in Undergraduate Education
Co-Sponsor: Committee on Laboratories
Time: 1–5 p.m. Sunday
Member Price: $80 **Non-Member Price:** $105
Location: 3N12

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

Juan Rodriguez, Phillip Lockett Sytil Murphy, Dyan McBride, Sathappan Ramesh

There is a growing need for introductory physics laboratory activities that allow life science students to explore and deepen their understanding of physics through biological contexts such as physiology, biomechanics, biophysics, and medicine. Individuals and groups who have been developing such introductory laboratory activities will present examples from their labs. After an initial overview by the presenters, participants will break into rotating groups for hands-on experience with laboratory activities and more detailed discussion with each presenter about the pertinent pedagogy and apparatus. A flash drive with resources for the laboratory activities will be given to the participants.

W38: Cosmology in the Classroom

Sponsor: Committee on Space Science and Astronomy
Time: 1–5 p.m. Sunday
Member Price: $70 **Non-Member Price:** $95
Location: 3W10

Daniel Smith, Dept. of Biological and Physical Sciences, South Carolina State University, Orangeburg, SC 29115; dsmith@scsu.edu

Kim Coble, Chicago State University

Recently, powerful observations and advances in computation and visualization have led to a revolution in our understanding of the structure, composition, and evolution of the universe. Experts should not be the only ones, however, who understand the physics and data that provide overwhelming evidence for big bang cosmology and its dark matter-dark energy extensions. The first part of the workshop will introduce participants to (1) results of our research on common alternate student conceptions in cosmology, and (2) a sample of interactive web-based exercises from a curriculum designed to help students master the scientific concepts and processes that led to our current understanding of the universe. In the second part of the workshop we will present classroom-tested labs on the Large Scale Structure, featuring data from the Sloan Digital Sky Survey (SDSS). Participants should bring their own laptops with spreadsheet software and Adobe Flash installed.

W39: Free Online Integrated Learning Environment for Mechanics, with Powerful Problem Solving Pedagogy

Sponsor: Committee on Educational Technologies
Co-Sponsor: Committee on Physics in Undergraduate Education
Time: 1–5 p.m. Sunday
Member Price: $60 **Non-Member Price:** $85
Location: 3N14

Dave Pritchard, Cecil and Ida Green Professor of Physics, MIT, Room 26-241, Cambridge, MA 02139; dpritch@MIT.EDU

Saif Rayyan, MIT; Daniel Seaton, MIT; Yoav Bergner, MIT; Raluca Teodorescu, GWU; Andrew Pawl, UW-Platteville

Use our Integrated Environment for Mechanics (ILEM) in your next mechanics course. Hosted in LON-CAPA, an open source online learning system, ILEM combines multi-level research-based homework sets with an online e-text and discussion boards, and will have a physics library with about 10,000 problems indexed by topic and difficulty that can recommend additional problems like one you like. The system can measure the skill of your students regardless of which particular problems they actually do. This system can implement our successful Modeling Applied to Problem Solving pedagogy that generates problem-solving skills that transfer to a subsequent E&M course. Students also develop more expert-like attitudes toward science, particularly in problem-solving self confidence. Workshop participants should bring a laptop to explore some or all of these features, sample the various teaching materials for in-class use, and participate in innovative activities. We seek users/collaborators for generating/improving open source materials.

W40: Heliophysics Applications for Physics Teaching

Sponsor: Committee on Space Science and Astronomy
Time: 1–5 p.m. Sunday
Member Price: $10 **Non-Member Price:** $35
Location: 3N22

Mary Kadooka, University of Hawaii Institute for Astronomy, 2680 Woodlawn Dr., Honolulu, HI, 96822; kadooka@ifa.hawaii.edu

Katie Whitman

Our Sun has numerous applications for teaching physics such as how the solar wind affects our magnetosphere to interactions of charged particles in space. It provides a wealth of fascinating resources to stimulate student interest and increase motivation to learn physics. From the twisting magnetic field lines of sunspots resulting in solar flares and coronal mass ejections that can cause blackouts on Earth, you will learn about the Sun's central role in space weather. Complementing this background knowledge will be activities using images from the NASA Solar Dynamic Observatory (SDO) developed by physics teachers and heliophysicists. You will use JHelioviewer, a database of Sun images, that will stimulate your thinking to enable you to create your own lessons. Check out http://c2h2.ifa.hawaii.edu for more information about the group sponsoring this workshop.

W42: LEAP: Learner-centered Environment for Algebra-based Physics*

Sponsor: Committee on Research in Physics Education
Time: 1–5 p.m. Sunday
Member Price: $60 **Non-Member Price:** $85
Location: 3W5

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

Steve Robinson

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

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

W43: Physics and Toys II: Energy, Momentum, Electricity, and Magnetism

Sponsor: Committee on Science Education for the Public
Co-Sponsor: Commitee on Professional Concerns
Time: 1–5 p.m. Sunday
Member Price: $62 **Non-Member Price:** $87
Location: 3W2

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

Raymond Turner

This hands-on workshop is designed for teachers at all levels in search of fun physics demonstrations, lab experiments, and interactive materials through the use of ordinary children's toys. More than 50 toys will be demonstrated, and the physical principles related to these toys will be discussed. The workshop will concentrate on toys that illustrate the concepts of kinetic and potential energy, linear and angular momentum, electricity, magnetism, pressure, temperature and properties of materials. You will have the opportunity to participate in both qualitative and quantitative investigations using toys. The workshop leaders have found that toys can be utilized at all grade levels from kindergarten through college by varying the sophistication of the analysis. These same toys can be used for informal presentations to public groups of all ages, whether children or adults.

W45: LEAP: Video Resource for Learning Assistant Development

Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Educational Technologies
Time: 1–5 p.m. Sunday
Member Price: $60 **Non-Member Price:** $85
Location: 3C4

Renee Michelle Goertzen, Florida International University, 11200 SW 8th St., VH 169, Miami, FL 33199; goertzen@gmail.com

Rachel E. Scherr, Seattle Pacific University

The Video Resource for Learning Assistant Development is a package of thematic case-based "video workshops," designed to supplement the University of Colorado's widely disseminated LA development program. In a video workshop, short, compelling video episodes are accompanied by captions, transcript, excerpts from instructional materials, and targeted discussion questions to help LAs and faculty explore the principles and values that inform instructor and student behavior. The video episodes showcase a variety of exemplary (yet real-life) LA-relevant instructional formats including Tutorials in Introductory Physics, Modeling Instruction, Investigative Science Learning Environment, and Open Source Tutorials. After a brief overview of the project, participants will spend most of their time actually participating in a sample video workshop: i.e., watching compelling classroom video of LAs and students interacting, and discussing the observations they make. Participants will be provided with full access to the package of video workshops. Bring a laptop if it's convenient.

Philadelphia Trolley Tour

Tuesday, July 31 • 7:30 - 8:30 p.m.

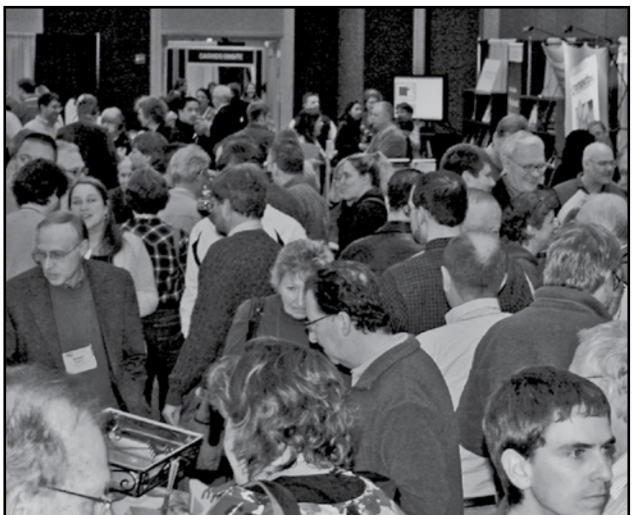
Allow Philadelphia's Premier Tour Company to show you the sights and tell you the tales of a city that forged a nation, cheered for Rocky, and is home to the Liberty Bell and Independence Hall! The tour will begin at Houston Hall and end at the Inn at Penn, just in time to catch the AAPT Demo Show. *A limited number of tickets are available and are selling fast.*

First Timers' Gathering

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

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

Monday, July 30
7:15 - 8:20 a.m.
Irvine Auditorium - Café 58



AAPT Welcome Reception and Exhibit Hall Opening

Sunday, July 29 • 8-10 p.m.

Houston Hall - Hall of Flags/Bodek Lounge

PTRA Workshops

All workshops are held at the University of Pennsylvania Physics Department building.

PTRA1: Explorations and Practicums, co-presented by George Amann and Pat Callahan

Date: Monday, July 30
Time: 8:30–10:30 a.m.
Location: RNL 3N6
Member Cost: $53 **Non-member Cost:** $63

The key to learning is student involvement! This American Association of Physics Teachers/Physics Teaching Resource Agents (AAPT/PTRA) manual presents examples of two techniques that are proven to increase student involvement in your classroom. Based on the "5E" model of learning, exploratories are designed to get your students excited about the material they will explore in your classroom with you. Practicums are a unique method for measuring a class' learning in an "authentic" manner that will ensure the whole class is excited and totally immersed in the process. An AAPT/PTRA resource book provided and included in price.

PTRA2: PTRA Presents Everyday Einstein: GPS & Relativity, co-presented by Damian Pope, Karen Jo Matsler and Elaine Gwinn

Date: Tuesday, July 31
Time: 8:30–10:30 a.m.
Location: RNL 3N6
Member Cost: $35 **Non-member Cost:** $45

What do Einstein and GPS have in common? Find out in the first Perimeter Inspirations module highlighting the power and relevance of one of human's greatest intellectual achievements. 'Everyday Einstein' is an educational resource that includes a five-minute video and an accompanying teacher's guide. Suitable for grades 9 through 12. Lead PTRAs will guide you through using this lesson and prepare you to guide your colleagues.

PTRA3: Using and Adapting OSP- and Physlet-based Materials for an Interactive Classroom, co-presented by Wolfgang Christian and Mario Belloni

Date: Wednesday, August 1
Time: 8:30–10:30 a.m.
Location: RNL 3N6
Member Cost: $35 **Non-member Cost:** $45

Participants will learn how to use and adapt existing Open Source Physics and Physlet-based curricular material in this hands-on workshop. We will distribute Physlets (interactive Java applets written at Davidson College) and ready-to-run Java programs and present examples of how they are used to actively engage students in the classroom. This workshop is based on existing material available at no-cost from the ComPADRE National Digital Library which can easily be adapted for introductory physics. This workshop is supported by the National Science Foundation (DUE-0442581 and DUE-0937731).

PTRA4: Sound and Music: H.S. Materials Plus Updates for Grades 3-8, presented by Wendy Adams

Date: Sunday, July 29
Time: 1:00–5:00 p.m.
Location: RNL 3N6
Member Cost: $35 **Non-member Cost:** $45

Sound and Music: High School materials plus updates for grades 3-8: The Acoustical Society of America is proud to offer a "Sound and Music Activity Kit" free to K-12 teachers. The kit comes with a selection of hands-on materials, as well as a USB containing 32 lessons/labs and two assessments. In this afternoon session, all new materials that have been developed since the 2011 PTRA training will be demonstrated and you will work with several of the hands-on portions of these new materials. The majority of the new materials were designed for AP physics or introductory level college physics courses.

Session SPS: SPS Undergraduate and Graduate Poster Session

Location: Houston Hall - Bistro
Sponsor: Committee on Research in Physics Education
Date: Sunday, July 29
Time: 8–10 p.m.

Presider: Thomas Olsen

SPS01: 8–10 p.m. Instructor Prompting Mechanisms and Student Participation in a Reformed Classroom*

Poster – Maria Paula Angarita, Florida International University, Miami, FLA 33174; angarimp@gmail.com

Sean Stewart, Jared Durden, Florida International University;

Vashti Sawtelle, University of Maryland

Classroom participation has been shown to improve learning gains. However, instructors may at times find it difficult to engage their classrooms in effective discourse. Understanding how instructors effectively engage their students is key to facilitating student participation. Through qualitative video analysis of a Modeling Instruction Introductory Physics I class, we present an analysis of the impact of Instructor prompts on student participation. Using microanalysis of a video segment in which an instructor is engaging students in a series of questions during a large group white board meeting, we identified prompting mechanisms that contribute to student participation in a reformed classroom.

*This work is supported by NSF Grant #0802184

SPS02: 8–10 p.m. Guided Inquiry-based Demonstrations Using Everyday Items: Examples from Electricity

Poster – Roy Prouty, The Richard Stockton College of New Jersey, Galloway TWP, NJ 08234; fang.liu@stockton.edu

Fang Liu, The Richard Stockton College of New Jersey

For most physics for life sciences students, the introductory physics course is a terminal course. Teaching by telling, the traditional approach to instruction in introductory physics, is ineffective for most physics for life sciences students. Subject matter has to be taught in ways that intellectually engage and involve students, foster self-directed learning, and eventually help students develop a coherent conceptual understanding. In this presentation we will share our experience in developing guided inquiry based demonstrations using everyday items for physics for life sciences students. In particular, we will highlight two interesting examples from electricity including producing electricity with a fruit/vegetable battery and electrical heating with a non-conventional resistance, hot dog.

SPS03: 8–10 p.m. Regression Analysis Exploring Teacher Impact on Student FCI Post Scores*

Poster – Jonathan V. Mahadeo, Florida International University, Miami, FL 33199 jmaha001@fiu.edu

Seth R. Manthey, Eric Brewe Florida, International University

In this poster we present the results of a regression analysis exploring teacher impacts on student Force Concept Inventory (FCI) scores. The data were collected from 1,373 students of 22 high school physics teachers. Additionally we collected demographic data; the independent variables in the regression analysis included the teacher, FCI Pre Score, Gender, and Ethnic Representation in an effort to predict the dependent variable, FCI Post Score. The regression analysis returned an effect size of .62 (Cohen's f2) and indicated that 19 out of 22 high school physics teachers had a significant impact in accounting for the variance within student FCI Post Scores. Further analysis showed that of the 19 teachers accounting for a significant amount of the variance, only two had a positive beta coefficient. This indicates that there are dynamic differences between teachers that may be revealed through other measures such as the Reformed Teaching Observation Protocol (RTOP).

*Supported by NSF Award # PHY-0802184 .

SPS04: 8–10 p.m. Students' Beliefs Concerning Different Components of a Calculus-based Physics Course

Poster – Adam O. Szewciw, Purdue University, West Lafayette, IN 47907-2036; aszewci@purdue.edu

Sunday, July 29 Highlights

AAPT Workshops at Physics Department

REGISTRATION	7 a.m.–4 p.m.	HH - Reading Room
Publications Committee	8–10 a.m.	Sher. Wm Penn
Nominating Committee	10:30–12 p.m.	IA - G01
Resource Letters Com.	11:30–2 p.m.	IA - G7
Section Off. Exchange	5:30–6:30 p.m.	CCH -Terrace
Programs Committee I	5:15–6:30 p.m.	HH - Golkin
H.S. Share-a-Thon	6–8 p.m.	IA - Amado Hall
REGISTRATION	7:30–9 p.m.	HH - Reading Room
Section Representatives	6:30–8 p.m.	CCH - Terrace

COMMITTEE MEETINGS, 6:30–8 p.m.

– Research in Physics Education	HH - Class of 47
– Committee on Laboratories	IA - G16
– Graduate Education in Physics	HH - Griski
– SI Units and Metric Education	IA - G7

Exhibit Hall Opens / Welcome Reception

8–10 p.m. (Hall of Flags AND Bodek Lounge)

SPS Undergraduate and Graduate Poster Session

8–10 p.m. HH - Bistro

KEY: IA = Irvine Auditorium
HH = Houston Hall
CCH = Claudia Cohen Hall

Rebecca S. Lindell, Andrew S. Hirsch, Purdue University

The Physics Department at Purdue University offers two sequential introductory calculus-based physics courses utilizing the Matter and Interactions (M&I) curriculum. These courses consist of a lecture twice a week, a one-hour recitation and a two-hour lab. Homework is delivered via WebAssign. Unlike traditional courses, Purdue's calculus-based sequence includes cooperative group problem solving during recitation and computational modeling via VPython during lab. To improve understanding of students' beliefs regarding the educational effectiveness of the different M&I course components, the researchers conducted a series of focus groups consisting of approximately 5-10 students either currently or previously enrolled in M&I 1. The purpose of this qualitative investigation is to provide the researchers with a more complete understanding of where students' believe they learn physics so as to better design instruction. Preliminary results will be discussed.

SPS05: 8–10 p.m. "Learning Arc": The Process of Resolving Concerns through Student-Student Discourse*

Poster – Sean Stewart, Florida International University, Miami, FL 33199; SStew002@FIU.edu

Maria Paula Angarita, Jared Durden, Florida International University

Vashti Sawtelle, University of Maryland

In reformed classrooms that utilize student-student interactions, a student's concerns can often be resolved through student-student discourse with minimal to no direct input from the instructor. To gain insight into such interactions, we used video data from a Florida International University reformed Physics I classroom. We micro-analyzed a segment in which the discourse between a group of three students leads to the resolution of a concern. In this study, we identified a pattern of discourse, which we are calling a "Learning Arc." In this poster, we present the "Learning Arc" as a cyclical process by which students use discourse as a means to achieve a consensus that resolves a concern.

*This work is supported by NSF Grant #0802184

SPS06: 8–10 p.m. Activities in the SPS Chapter of Southeast University

Poster – Zhi-Yong Zhou, Department of Physics, Jiangning Campus, Southeast University Nanjing, Jiangsu 211189 China; zhouzhy@seu.edu.cn

Hong Huang, Hui Zhong, Ying-Hui, Ying Yun, Southeast University

We present the organizations and activities of the SPS chapter in Southeast University of China after its establishment in 2010. As the first one established in China, the chapter has undertaken regular activities in rich and varied forms through the organization of its executive committees. The chapter provides an active atmosphere of learning among the students and helps more students transform themselves into contributing members of the professional community. Some students have started to do some scientific researches by their own under the professional guidance and some enjoyable achievements have been obtained.

SPS07: 8–10 p.m. Mentoring a FIRST Robotics Team and a Middle School Robotics Camp

Poster – Richard Floyd, Coastal Carolina University, Conway, SC 29528 rdfloyd@g.coastal.edu

Cody V. Thompson, James C. Moore, Coastal Carolina University

We discuss the implementation of a mentoring program for local FIRST robotics teams as a Society of Physics Students (SPS) activity at Coastal Carolina University. Also, we present details about the development and implementation of a summer robotics camp for middle school aged children. Activities involving robotics are an excellent way to build interest in the SPS on campus, and provide an important connection with the local community. Working with middle school children in an exciting inquiry-based environment serves a dual purpose: enhancing the reasoning and creative design abilities of the future generation of potential (hopefully!) STEM students, as well as the abilities of the undergraduate mentors.

SPS08: 8–10 p.m. Step into the Mirror

Poster – Cui Du, Southeast University, Chien-Shiung Wu College, Jiangsu Province, Jiangsu Province 211189 China; 1689825787@qq.com

In recent years, people are looking more and more closely at another modality of matter–antimatter. In this article, firstly we will introduce the history of discovery of anti-particle and the basic properties of anti-particles. Next we will talk about how to collect natural antimatter and produce antimatter in laboratories, and then some of the applications and our own hypotheses about antimatter will be shown to you. Thanks to the bilingual physics teaching courses, that was put forward by Professor Yun Yin, for providing me with the chance to study the courses and the project of antimatter and for stimulating my enthusiasm of studying science, mainly about the cosmology.

SPS09: 8–10 p.m. The Harry Potter's Cloak of Invisibility Material

*Poster – Zhiqiang Jiang,*Chien-shiung Wu College, Southeast University Nanjing, Jiangsu 211189 China; tingfengmail@163.com*

Qian Chen, Jian Cao

Imagine that if you put on Harry Potter's invisibility coat and disappeared into thin air, how magical and amazing it would be. Such kinds of invisibility materials or devices seem so attractive not only to sci-fi fans, but also to scientists. As freshmen we have been inspired by professor Yun's thoughts and also thrown new light upon self-study and inquiry learning by taking the Bilingual Physics with Multimedia course, and we decided to research on the invisibility material. By figuring out the principles behind the phenomena, our article will introduce three ways based on the present technology to create invisibility. At the same time, we will simply explore our methods to be invisible and look into the prospect of the invisibility materials.

SPS10: 8-10 p.m. Principles and Prospects of Bose-Einstein Condensate

Poster – Xiao Liang, Chien-Shiung Wu College, Southeast University, Jiangsu 211189 China; vivianlx@126.com

Wenzhen Li, Yifan Ding

Recently, the fifth state of matter, the Bose-Einstein Condensate, has attracted more and more attention in academic circles for its unique physical properties. Inspired by a course called Bilingual Physics with Multimedia, we had a strong curiosity and interest on the topic, principles, and prospects of Bose-Einstein Condensate, and conducted a research study on it. This essay starts with some related concepts and the ultimate principle of Bose-Einstein Condensate, and then we lucubrate some pertinent properties together with the famous experiments on the fifth state. Moreover, the essay also expounds on the applications and prospect of Bose-Einstein Condensate.

SPS11: 8–10 p.m. Exploring the Quantum "Spring"

Poster – Zhigang Peng, Chien-Shiung Wu College, Southeast University, Jiang Ning Campus, Jiang Su Province 211189, China; rexpeng930510@163.com

Ping Luo, Huihui Zou, Chien-Shiung Wu College, the Southeast University

Zero-point energy is supposed to be the possible lowest energy that a quantum physical system may have. When the zero-point energy varies, the Casimir effect then can be observed. Recently, researchers have been more interested in repulsive Casimir force created by artificial methods. Actually, if we can adjust the properties of the materials and the medium independently so that the attractive force and the repulsive force can be obtained freely, we are likely to make an acquisition of restoring Casimir force. Therefore, with the help of quantum effect, the quantum "spring" can be achieved. Inspired by Professor YunYing's idea of education and our interest in this subject, our group studied it through the "Introduction to Bilingual Physics with Multimedia" course initiated by Prof. Yun. This article mainly makes a review of the Casimir effect and the research on the restoring Casimir force.

SPS12: 8–10 p.m. Detection of Small Radioactive Traces of K-40 with NaI(Tl) Scintillation Detector & GM Counter

Poster – Michael Carr, Ramapo College of NJ, Boonton Twp, NJ 07005;

mcarr1@ramapo.edu

Jillian Hauck, Amanda S. Skuriat, Matthew Saur, Daniela Buna, Ramapo College of NJ

We investigated the possibility of determining the absolute activity of radioactive potassium, K-40, in small samples of fertilizers, such as Miracle Gro, 24-8-16, using a scintillation detector with a NaI(Tl) crystal and a multichannel analyzer. We investigated the dependence between the magnitude of the percent error and the temperature variation during the long acquisition time as well as the possibility of calculating a reliable calibration factor between measured and true activity for a given fixed geometry that severely violates the point source approximation. For the calibration samples used, KF, KCl, KNO2 and K2SO4, the percent error in determining the absolute activity was less than 7%. For samples of MiracleGro that have lower concentration of K-40 than the samples above the error was as high as 40%. The main source of error seems to be the temperature variations and the detector efficiency at 1.461MeV.

SPS13: 8–10 p.m. Photocatalysis with Zinc Oxide and Titanium Dioxide Nanowire Films*

*Poster – Cody V. Thompson,** Coastal Carolina University, Conway, SC 29528 cvthomps007@gmail.com*

Robert Louder, James C. Moore, Coastal Carolina University

We have investigated the photocatalyitc activity of zinc oxide (ZnO) and titanium dioxide (TiO2) nanowire films grown in-house. Optimized transparent ZnO and TiO2 films could find use as fingerprint-resistant barriers on touch screen devices, such as cell phones and tablet computers. Furthermore, there is great need for reusable materials with environmental remediation potential. Low-cost films that are easily removed from aqueous environmental systems post-decontamination are ideal candidates. Our research goal is to determine optimal film growth parameters that result in increased photocatalytic activity of organics at the surface. The main challenge has been balancing the need for high surface area as a reaction site for the photocatalytic process, with the typical decrease in optical efficiency that results from polycrystalline films having small particle size. We report a low-temperature process that yields high optical efficiency and high surface area.

*Funding provided by the II-VI Foundation.

**Sponsor: James C. Moore

SPS14: 8–10 p.m. Modeling Gyroscopic Motion in Terms of Linear Momentum

Poster – Harvey B. Kaplan, Purdue University, West Lafayette, IN 47907-2036; hkaplan@purdue.edu*

Andrew S. Hirsch, Rebecca S. Lindell, Purdue University

Gyroscopic motion is often described in terms of torque and angular momentum. This method of describing gyroscopic motion proves to be convenient, but covers up the underpinnings as to what gives rise to those concepts: linear force and linear momentum. Using VPython programming, a simplified version of a gyroscope is depicted with four identical masses in place of a traditional massive disk. The program allows for effective analysis of gyroscopic motion in terms of forces and linear momentum, and permits the user to increase the number of masses until the limit of a physical gyroscope is reached. This program is intended to serve as a pedagogical tool for teaching, analyzing, and visualizing complex mechanical systems as it pertains to the gyroscope.

* Sponsor: A. Hirsch

SPS15: 8–10 p.m. Trapping Electric Charge on the Surface of Semiconductors*

*Poster – James Bevacqua,** Coastal Carolina University, Conway, SC 29528; jjbevacq@live.com*

James C. Moore, Coastal Carolina University

We have investigated the trapping of electric charge and the subsequent bending of electronic energy bands at the surface of several semiconductor material systems. Using a novel combination of conductive atomic force microscopy (AFM) and scanning Kelvin probe microscopy (SKPM) we are able to inject surface charge locally on the nano-scale and measure the resulting change in surface contact potential. By investigating surface charge trapping in various environments, we can learn more about the native electronic energy band bending. We are also interested in further developing the technique for future nano-scale catalytic activity measurements.

*Funding provided by NSF-DMR 1104600

**Sponsor: James C. Moore

SPS16: 8–10 p.m. The Study of Small Scale Features (Fronts) Found in Long Term Temperature Records

Poster – Jeniffer Allen, Richard Stockton College of New Jersey, Galloway, NJ 08205; joseph.trout@stockton.edu

Roy Prouty, Joseph J .Trout, Richard Stockton College of NJ

An atmospheric front can be defined as sloping zones of pronounced transition of thermal, moisture, and/or wind fields in the atmosphere. These transition zones (fronts) are characterized by a strong horizontal temperature gradients and/or large horizontal wind shears. One of the signatures of the front is evident as a large horizontal temperature gradient. Wavelet Analysis is used to analyze the long and short term transition zones in long-term temperature records. The compact nature of the wavelets make them perfect candidates for analyzing the short term transition zones in the thermal field that comprise the fronts. The frequency, intensity, and shape of these transition zones are analyzed to examine long term trends in the number and magnitude of these transition zones.

SPS17: 8–10 p.m. Isolating Motions of a Spinning Tube

*Poster – Keith W. Farrington,** Coastal Carolina University, Conway, SC 29528; moorejc@coastal.edu*

James C. Moore, Coastal Carolina University

We discuss participation in the spinning tubes authentic research experience as detailed by Sikkema et al.,* and we present a student-designed and constructed demonstration apparatus. Students in a conceptual physics course at Coastal Carolina University observed the rotation of a PVC pipe segment marked at opposite ends with different symbols. The symbol at one end is visible while the other symbol is not during the motion. The assignment is to use the scientific inquiry process to determine why. During the student-led investigation, one avenue of inquiry required the isolation and control of the major tube motions: (1) rotation about the center of mass, and (2) cylindrical rotation. An apparatus was designed and constructed that allowed for such control, and provided support for the student-generated model describing why one symbol is not seen.

* A.E. Sikkema et al., *Am. J. Phys.*, **78**(5), 467 (2010).

**Sponsor: James C. Moore

SPS18: 8–10 p.m. Physically Interpreting Equations Workshop at Princeton University

Poster – Elizabeth J. Young, Princeton University, Princeton, NJ 08542 ejtwo@princeton.edu

Dominic J. Voge, Princeton University

We propose a workshop to help the novice learner link together equations presented in different contexts with the same physical principles. The ability to link together this information by physically interpreting equations is a skill that can be taught. Our method involves recognizing familiar terms in the equation and relating them to known effects in physical systems. Reasoning through the steps of tearing down and building back up an equation should help the students' intuition about the physical interpretation of the equation's form. Lessons learned and methods taught can be applied in the classroom and in understanding papers in research areas. Our goals include students gaining confidence when approaching complex, complicated, and seemingly foreign problems. Students can master workshop goals while at the same time achieving deeper levels of understanding through inquiry and the exploration of multiple problems. Specific strategies for implementation of this project are discussed in detail.

Session AA: Assessing Student Learning in Upper-Division Labs

Location: Sheraton - Ben Franklin Ballroom I
Sponsor: Committee on Laboratories
Co-Sponsor: Committee on Research in Physics Education
Date: Monday, July 30
Time: 8:30–10:30 a.m.

Presider: Heather Lewandowski

AA01: 8:30-9 a.m. Assessing Students' Attitudes and Beliefs About Experimental Physics

Invited – Benjamin M. Zwickl, Department of Physics, University of Colorado, Boulder, CO 80309-0390; benjamin.zwickl@colorado.edu

Noah Finkelstein, H. J. Lewandowski, University of Colorado Boulder

National STEM education advocates are calling for redesigned introductory labs that encourage students to persist in STEM majors. Additionally, groups like the Advanced Laboratory Physics Association (ALPhA) have recognized the need for a more coherent four-year laboratory curriculum. As part of a comprehensive effort to transform our labs and evaluate the impacts of these efforts, we have developed the Colorado Learning Attitudes about Science Survey for Experimental Physics (E-CLASS). The E-CLASS assesses the change in students' attitudes about a variety of inquiry and laboratory practices before and after a lab course, and compares it with their perception of the course grading requirements and their self-assessed laboratory practices. We present the development, validation, and results from the initial implementation of the survey. We plan to share the E-CLASS nationally in order to learn about the state of labs at many institutions and to give instructors actionable feedback for modifying their courses.

AA02: 9-9:30 a.m. Data Handling: A Student's Modus Operandi

Invited – James Day, Department of Physics & Astronomy, UBC, Vancouver, BC V6T1Z1 Canada; jday@phas.ubc.ca*

Doug Bonn, Department of Physics & Astronomy, UBC

Motivated by the myriad efforts devoted to appraising the acquisition of skill, knowledge, and comprehension in the classroom, we have attempted to address learning in the lab. In a course where the learning goals focus mostly on managing data, the translation between graphs/numbers/functions, and an operational understanding of uncertainty, we have developed a short diagnostic to probe student abilities related to data handling and to the nature of measurement and uncertainty. The 10-question, multiple-choice test is called the Concise Data Processing Assessment (CDPA). A key component of its development was the use of interviews with students, employed to both uncover common modes of student thinking and validate item wording. Statistical tests indicate that the CDPA is a reliable assessment tool for measuring targeted abilities in undergraduate students. Performance on individual items has informed our pedagogical strategies in the lab, and has served to illuminate future research directions.

*Sponsor: Heather Lewandowski

AA03: 9:30-10 a.m. Assessing Student Understanding in Upper-Division Analog Electronics Courses*

Invited – MacKenzie R. Stetzer, University of Maine, 5709 Bennett Hall, Orono, ME 04469-5709; mackenzie.stetzer@maine.edu

While there are many important goals of laboratory instruction, particularly in upper-division courses, relatively little work has been done to assess the impact of such courses on students. As part of an ongoing, in-depth investigation of student learning in upper-division laboratory courses on analog electronics, we have been examining the extent to which students enrolled in these courses develop a robust conceptual understanding of

Monday, July 30 Highlights

REGISTRATION	7 a.m.–5 p.m.	HH - Reading
First Timers' Gathering	7–8:20 a.m.	IA - Cafe 58
Spouses' Gathering	10:30–11:30	IA - Cafe 58
Early Career Professionals Speed Networking	12:15–1:15 p.m.	Sheraton - Fairmount
PIRA Resource Room		HH - Platt Rehearsal
H.S. Physics Photo Contest Voting		Hall of Flags Balcony
Undergraduate Awards Reception	5:30–6:30	IA - Cafe 58

COMMITTEE MEETINGS, 7–8:30 a.m.

- –Women in Physics — IA - G16
- –Educational Technologies — IA - G01
- –Teacher Preparation — IA - G7

Kindle Raffle 10:45 a.m. HH - Bodek Lounge

TEACHING AWARDS 11 a.m.–12:10 p.m. Inn at Penn - Woodlands Ballroom

AAPT: WHAT'S IN IT FOR H.S. TEACHERS? 12:15–1:15 p.m. HH - Ben Franklin Room

COMMERCIAL WORKSHOPS, 12:15–1:15 p.m.

- –Pearson — Inn at Penn - Regents/St. Marks
- –Klinger Educational — Sheraton - University Suite
- –Physics2000 — HH - Golkin

PLENARY 1:30–3 p.m. Inn at Penn - Woodlands

–APS Division of Biophysics Session - Birds, Brains, & Physics

Afternoon Break	3–3:30 p.m.	Hall of Flags/Bodek
Kindle Raffle	3:15 p.m.	Hall of Flags

COMMITTEE MEETINGS, 5:30-7 p.m.

- –Physics in Two-Year Colleges — HH - Golkin
- –Professional Concerns — IA - G7
- –Physics in High Schools — HH - Class of 47
- –Space Science and Astronomy — IA - G01
- –PIRA Business Meeting — IA - Amado

BEN FRANKLIN PERFORMANCE 5:30-7 p.m. CCH - Claudia Cohen Terrace

Poster Session I 8:30–10 p.m. HH - Bistro

KEY: IA = Irvine Auditorium
HH = Houston Hall
CCH = Claudia Cohen Hall

analog electronics (one of many course goals). I will highlight the development and use of written questions on diode and op-amp circuits that have been instrumental in probing student understanding in sufficient depth to identify specific conceptual and reasoning difficulties. I will also illustrate the role such questions may play in revealing weaknesses in the traditional treatment of certain electronics topics and in informing modifications to instruction.

*This work has been supported in part by the National Science Foundation under Grant No. DUE-0618185.

AA04: 10-10:10 a.m. Hands-on Performance Assessments for Electronics

Contributed – Melissa Eblen-Zayas, Carleton College, Northfield, MN 55057; meblenza@carleton.edu

Lab notebooks, oral presentations, and formal write-ups are often used to evaluate lab work, but these assessments fall short in evaluating some of aspects of students' ability to do hands-on work, including troubleshooting. I will discuss the hands-on performance assessment that I used in my upper-level electronics course, which asks students to make predictions about the response of a circuit and then requires students to build the circuit to test their predictions. In addition to reviewing the benefits and drawbacks of this type of assessment, I will also discuss student opinions about the hands-on performance assessments.

AA05: 10:10–10:20 a.m. Kinder, Gentler Oral Exams

Contributed – Joss Ives, University of the Fraser Valley, Abbotsford, British Columbia, V2S 7M8 Canada; joss.ives@ufv.ca

Oral exams can provide effective assessment of student understanding of theoretical, analysis and experimental details in upper-division labs. Unfortunately the most common implementation involves putting students "on-the-spot" by asking them to put together coherent explanations moments after being asked a question. This talk will discuss some modifications that I have made to address some of the aspects that I found to be the most intimidating and challenging when I was assessed using oral exams during my career as a student. The primary modification used to create my kinder, gentler oral exams was to present the student with three questions and then allow them to have some time to collect their thoughts as well as consult their resources before the formal part of the assessment was started.

AA06: 10:20-10:30 a.m. Delving Deeper: Revitalizing a Modern Physics Laboratory.

Contributed – Christopher A. Hoffmann, Department of Physics and Mallinson Institute for Science Education, Western Michigan University, Kalamazoo, MI 49008-5252; christopher.a.hoffman@wmich,edu

Manuel A. Bautista, Buddhi M. Rai, Asma Ayyad, Gaetan VanGyseghem, Western Michigan University

We recently found a number of concerns with our modern physics laboratory: lack of clear objectives and goals, disconnection from the lecture, and minimal emphasis on data handling and analysis skills. To address these problems we have significantly redesigned our laboratory. The revised laboratory's goals are to develop the students': 1) understanding of physics content, 2) skills in planning experiments, data collection, and analysis, 3) scientific communication skills. To emphasize depth of understanding, each experiment lasted for two weeks: one to collect data and another to reflect and write. Group work is emphasized; students work in small groups and submit a formal group report for each lab. Each member of the group rotates through the leader role. This talk will focus on the structure of the lab and a discussion of what went well and what did not. We are happy to share our materials and would also welcome collaborators.

Session AB: *Panel* – The Good and the Bad of Video Lectures

Location: Sheraton - Ben Franklin Ballroom II
Sponsor: Committee on Educational Technologies
Date: Monday, July 30
Time: 8:30–10:30 a.m.

Presider: Marcos Caballero

Panel – Marcos D. Caballero, University of Colorado, Boulder, CO; marcos.caballero@colorado.edu

–Frank Noschese, John Jay High School

–Noah Podolefsky, University of Colorado Boulder

–Andy Rundquist, Hamline University

Affordable and high-quality video cameras and user-friendly screen-casting software have made it possible to create professional looking lecture videos. A highly visible example of such videos is the Khan Academy (http://www.khanacademy.org/). In the public press and, often, at our own institutions, the utility of these video lectures are debated. Proponents argue there is significantly lower cost associated with producing and archiving these videos when compared to traditional instruction. Others couple these videos to traditional instruction in a "flipped classroom" environment. Still others contend that these videos make it too easy to forego more active engagement (e.g., inquiry). This panel discussion (discussants: Frank Noschese, Noah Podolefsky, and Andy Rundquist) aims to provide attendees with information about this new mechanism for content delivery. A 30-minute wrap-up/open discussion will be held after discussants have presented their views. This session will be video recorded and remotely accessible.

Session AC: Frontiers in Astronomy and Space Science

Location: Sheraton - Ben Franklin Ballroom III
Sponsor: Committee on Space Science and Astronomy
Date: Monday, July 30
Time: 8:30–10:30 a.m.

Presider: Kevin Lee

AC01: 8:30–9 a.m. Physics of Low-Mass Stars and Brown Dwarfs

Invited – John E. Gizis, Department of Physics and Astronomy, University of Delaware, Newark, DE 19716; gizis@udel.edu

The vast majority of stars are smaller, less massive, and less luminous than the Sun. I will discuss the main physical processes that determine the structure and lifetime of a star. Stellar astrophysics makes use of familiar physics, such as gravity, the ideal gas law, and thermodynamics, in an unfamiliar context. I will explain the reasons why many astronomers believe that the first Earth-like world will be detected around a low-mass M dwarf. Physical laws imply that there is a lower mass limit to stars: For less than 7.5% of the mass of the Sun, stable hydrogen fusion is impossible. Known as "brown dwarfs," these very-low-mass objects cool and fade. I will discuss recent discoveries that led to the development of new spectral types (L, T, and Y) and the status of the search for the coldest and nearest brown dwarf.

AC02: 9–9:30 a.m. The Physics of Classical Be Stars

Invited – M. Virginia McSwain, Lehigh University, Bethlehem, PA 18015; mcswain@lehigh.edu

O- and B-type stars are the hottest and most massive classes of stars, and they drive the vast majority of the energy and chemical feedback into the Universe. A category of high mass stars known as classical Be stars have large circumstellar disks that are formed from material ejected from the stellar surface. Be stars are have emerged as fascinating examples of many different astrophysical phenomena: the effects of rapid rotation upon stellar structure and evolution, surface activity and mass loss via nonradial pulsations, and even very high-energy particle acceleration produced by the interactions of the disk with a compact companion. I will review the physical processes that are believed to contribute to the formation of the circumstellar disks, and I will present new results from the Fermi Gamma-ray Space Telescope and other observatories that provide insight on the disk interactions.

AC03: 9:30–10 a.m. What Is a Galaxy?

Invited – Beth Willman, Haverford College, Haverford, PA 19041; bwillman@haverford.edu

In the past five years, more than a dozen dwarf galaxies have been discovered around the Milky Way that are 100 times less luminous than any galaxy previously known and a million times less luminous than the Milky Way itself. These objects have made astronomers question the very meaning of the word "galaxy." These discoveries hint that "ultra-faint" galaxies might actually be the most numerous type of galaxy in the Universe. This talk will highlight 1) how we can see galaxies that are effectively invisible in images of the sky, 2) the brewing controversy of the definition of the term "galaxy", and 3) the implications of these new discoveries for our understanding of dark matter.

AC04: 10–10:30 a.m. The Accelerating Universe

Invited – Masao Sako, University of Pennsylvania, Philadelphia, PA 19104; masao@sas.upenn.edu

Distance measurements with Type Ia supernova have played a central role in modern cosmology, providing the first direct observational evidence for an accelerating universe and the possible existence for the mysterious dark energy. This Nobel Prize-winning discovery, which has profound implications in all branches of physics and astronomy, is now being taught in classrooms of all levels. I will discuss various ways of presenting the basic concepts, the experiments and measurements, as well as difficulties that both instructors and students encounter when teaching and learning about this remarkable phenomenon.

Session AD: *Panel:* Textbooks and Labs Suitable for Ninth-Grade Physics

Location: Sheraton - Ben Franklin Ballroom IV
Sponsor: Committee on Physics in High Schools
Date: Monday, July 30
Time: 8:30–10:30 a.m.

Presider: Barry Feierman

Authors of the major textbooks aimed at ninth graders in a "Physics First" style course will discuss their recent textbooks and lab manuals. Invited speakers will include Arthur Eisenkraft (Active Physics) Paul Hewitt (Conceptual Physics) Tom Hsu (CPO's Physics: A First Course) and Colleen Megowan (Modeling). An introduction and final wrap up will be done by John Hubisz and Barry Feierman.

AD01: 8:30–10:30 a.m. Conceptual Physics – A First Course for all Seasons

Panel – Paul G. Hewitt, City College of San Francisco, San Francisco, CA 94112; Pghewitt@aol.com

My target audience for the high school version of *Conceptual Physics* from the outset has been ninth-grade students—to write a course that would sensibly place physics before chemistry and biology in the science sequence. The mathematical structure of physics is highlighted by treating equations as guides to thinking—creative thinking, before application to algebraic and trig-based problems—which are now large in number. My focus is on delighting students rather than intimidating them. When a learner's first experience with physics is delightful, the rigor of a second course will be meaningful and welcomed.

AD02: 8:30–10:30 a.m. Active Physics and the Next Generation Science Standards

Panel – Arthur Eisenkraft, UMass Boston,100 Morrissey Blvd. W-4-181, Boston, MA 02125; arthur.eisenkraft@umb.edu

The Framework for K-12 science education and the related next generation science standards will require us all to take a fresh look at what we teach and how we teach it. This new approach to physics learning can provide a new opportunity for schools to consider introducing physics into the ninth grade. *Active Physics*' features have always reflected what we know from research on how people learn and align very well with aspects of the new Framework. Active Physics uses a problem-based learning model to structure each chapter, employs a 7E instructional model, broadly assesses students, as well as introducing students to engineering design models and emphasizing the relationship of physics principles to the disciplines of chemistry, biology, and earth science. Active Physics can support the kind of instruction that teachers want to deliver in high school courses.

AD03: 8:30–10:30 a.m. Modeling Physics Curriculum Resources for Ninth Grade Physics

Panel – Colleen Megowan-Romanowicz, American Modeling Teachers Association, 2164 E Ellis Dr., Tempe, AZ 85282; amtaexec@realstem.com

Modeling Instruction is a guided inquiry approach to teaching physics that is centered on a handful of conceptual models that form the content core of physics. While Modeling pedagogy embodies an approach to curriculum design that can be used with any text, most Modelers prefer to use instructional materials designed specifically with the Modeling classroom in mind. Extensive electronic curriculum resources allow the individual teacher to customize the scope and sequence of instruction to suit local needs. These resources include paradigm labs, teachers' notes, student problems and worksheets, lab practica, quizzes and tests and many have been adapted for use in Ninth Grade Physics First setting. In this session I will share course syllabi and a variety of ninth grade Modeling physics materials currently in use across the nation in a variety of settings that are aligned with the draft Next Generation Science Standards due to be finalized this year.

AD04: 8:30–10:30 a.m. Essential Physics: An Innovative Curriculum for Teaching and Learning Physics

Panel – Manos Chaniotakis Ergopedia, 180 Fawcett St., Cambridge, MA 02138; manos@ergopedia.com

Physics education is at an inflection point: changes in technology offer new modes for curriculum delivery and student engagement; differing needs among students present pedagogical challenges; internal and external requirements for professional development strain school resources; and limited school budgets point to new business models for curriculum development and distribution. *Essential Physics* is a new curriculum that addresses these issues through an innovative e-Book technology that integrates the full interactive power of electronic media into the learning process. It incorporates all STEM components and provides multiple learning and enhancement paths. The Essential Physics curriculum includes: embedded multimedia animations and videos; interactive elements and simulations; expanded support for mathematics; interactive problem solving strategies; searchable content; dynamic assessment; cross-indexing; and a page-to-page match between the print and electronic versions. These novel features of Essential Physics provide a new model for science curricula. The features of Essential Physics will be demonstrated and discussed.

Session AE: PER: Topical Understanding – Introductory Level

Location: Houston Hall - Class of 49
Sponsor: Committee on Physics Education Research
Date: Monday, July 30
Time: 8:30–10:30 a.m.

Presider: TBA

AE01: 8:30–8:40 a.m. DC Circuits: Variation of Student Responses to Simple Contextual Changes

Contributed – Ignatius John, Cape Peninsula University of Technology, Bellville, 7533 South Africa; johni@cput.ac.za

Saalih Allie, University of Cape Town

It is common practice when researching student understanding of introductory DC circuits to assume that using the brightness of a light bulb as a proxy for current leads to results that can be generalized. While this conclusion may indeed be consistent with a classic "misconceptions" view, it is not clear that this is true from a "knowledge in pieces" perspective in which context and cognitive "grain-size" are key components. We report on a study with first-year physics students in which we made contextual changes to an "open circuit" in order to measure the effect of such changes to student responses. The eight-question instrument that we designed included representational, linguistic, and (circuit) elemental variations. Our findings indicate that while the changes might appear trivial to an expert they significantly affect the way in which students respond.

AE02: 8:40–8:50 a.m. Exploring Student Difficulties with Buoyancy

Contributed – D. J. Wagner, Grove City College, 100 Campus Dr., Grove City, PA 16127; djwagner@gcc.edu

Elizabeth Carbone, Matthew Goszewski, Kathryn Merrymon, Grove City College

Sam Cohen Dallastown, High School/Grove City College

Our research group is developing a standardized fluids assessment, covering buoyancy and pressure. Understanding buoyancy requires a battery of skills and knowledge, and we have designed questions to probe understanding of background concepts such as density, incompressibility, and volume of fluid displaced. In this talk we will describe some of the buoyancy-related assessment questions, the misconceptions they probe, and the preliminary results from the beta version of the assessment.

AE03: 8:50–9 a.m. Exploring Student Difficulties with Pressure in a Fluid

Contributed – Matthew Goszewski Grove City College 75 Doe Haven Circle Depew, NY 14043 United States mattgoszewski@gmail.com

Adam Moyer, D. J. Wagner, Grove City College

Our research group is developing a standardized fluids assessment, covering buoyancy and pressure. Much of the prior research of student difficulties with pressure involves younger children. Many of the questions on the beta-version of the assessment used this past year were designed to test the prevalence of those difficulties in college students. In this talk we will describe the pressure-related assessment questions, the misconceptions they probe, and the preliminary results from the beta version of the assessment.

AE04: 9–9:10 a.m. How Do Students Learn Graphs?

Contributed – James T. Laverty, Michigan State University, Biomedical and Physical Sciences Building, East Lansing, MI 48824; laverty;1@msu.edu

Gerd Kortemeyer, Michigan State University

Graphs play an important role in all of the sciences, as well as in daily life. Introductory Physics classes are a good place to teach students how to connect graphs to the real world. The obvious question becomes, "What is the best way to teach students to read and use graphs correctly?" This talk will compare student learning of graphs with construction-based homework problems versus with interpretation-based homework problems. This research was carried out using both computer-based (in an online course management system, namely LON-CAPA) and paper-based problems.

AE05: 9:10–9:20 a.m. How Energy Theater Supports Participants in Accounting for Energy*

Contributed – Sarah B. McKagan, Seattle Pacific University, West Seattle, WA 98119; sam.mckagan@gmail.com

Abigail R. Daane, Amy D. Robertson, Rachel E. Scherr, Seattle Pacific University

Energy Theater is an embodied learning activity in which participants act out energy transfers and transformations with their bodies. We have observed that participants in Energy Theater are often surprised by scenarios in which large quantities of energy are transformed from kinetic to thermal. This surprise appears to be a result of an expectation that a quantity of energy should be equally "perceptible" in different forms, an expectation that is violated when easily visible kinetic energy transforms into imperceptible thermal energy. We claim that Energy Theater enforces energy conservation in a way that pushes participants to recognize the presence of forms of energy that they do not expect, and to adjust their models of scenarios to take into account counterintuitive phenomena.

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

AE06: 9:20–9:30 a.m. Understanding Energy with an Embodied Learning Activity*

Contributed – Rachel E. Scherr, Seattle Pacific University, West Seattle, WA 98119 United States rescherr@gmail.com

Hunter G. Close, Texas State University

Sarah B. McKagan, Stamatis Vokos, Seattle Pacific University

A scientific understanding of energy includes (1) differentiating energy from matter, including recognizing that energy dynamics do not uniformly align with matter dynamics, and (2) coordinating theorized energy dynamics with observational evidence of energy changes in physical systems. We describe a learning activity called Energy Theater that is designed to promote a strong conceptual understanding of energy, including energy conservation, localization in objects, transfer between objects, and transformation among forms. We provide evidence that Energy Theater engages learners with deep conceptual issues in the learning of energy, including disambiguating matter flow from energy flow and theorizing mechanisms for energy transformation. We attribute the effectiveness of this learning activity partly to the special cognitive and interactional affordances of embodied learning activities, in which human bodies represent physical entities in a phenomenon.

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

AE07: 9:30–9:40 a.m. New Ways of Investigating the Canonical Ball Toss Problem

Contributed – Michael C. Wittmann, University of Maine 5709 Bennett Hall Orono, ME 04469-5709 mwittmann@maine.edu

Jeffrey M. Hawkins University of Maine

Asking students about the acceleration of a tossed object is a well-studied problem in physics education research. Students frequently respond using reasoning that describes the velocity of the ball, in particular that acceleration is zero at the top. We created new versions of the canonical multiple-choice Force and Motion Conceptual Evaluation ball-toss questions to investigate what other reasoning students might use. Some students were asked "is the acceleration zero at the top?" These students were half as likely to give a velocity-like response (that a=0) as were students answering the canonical form. Other students were told "the acceleration is not zero" and asked to explain. Roughly 75% of these students could explain why acceleration is not zero. This is in contrast to the 60% who say it is zero at the top. We discuss implications for instruction based on these data.

AE08: 9:40–9:50 a.m. Probing the Origins of Students' Naïve Preconceptions: Force and Motion*

Contributed – Lei Bao, The Ohio State University, Columbus, OH 43210; bao.per@gmail.com

Aaron M. Adair, Ohio State

A significant consideration in PER is student preconceptions at variance with modern physics, but also worthy of examination is the development of these erroneous notions. The preconceptions come about from the real-world interactions students have had before physics instruction, which lead to complex network intuitive thoughts on how they feel and what they believe. During learning there are complex interactions between these prior beliefs and what students learn in class, which need to be understood if educators are to be successful. We examine a collection of first-term calculus-based physics students using a set of linear motion questions along with interviews and further questions during one-on-one interview sessions. We investigate how students' preconceptions are manifested within the contexts of physical settings and personal feelings. The results shed lights on how such preconceptions are formed through students' experiencing the world and how instruction may be informed to better address such preconceptions.

*Supported in part by NIH Award RC1RR028402 and NSF Awards DUE-0633473 and DUE-1044724

AE09: 9:50–10 a.m. Student Understanding of "Force-of-Motion" and Net Force in Various Contexts

Contributed – Rebecca J. Rosenblatt, The Ohio State University, Columbus, OH 43210 rosenblatt.rebecca@gmail.com

Andrew F. Heckler, The Ohio State University

We have previously reported that, when given a single force opposite to the direction of motion, students were more likely to invoke a "force-of-motion" than when given two forces, one force in the direction of motion and a larger force opposite. Here we elaborate on this finding, reporting on student responses from a set of contextual situations with varying numbers of forces on an object, both in the direction of motion and opposite to the direction of motion. This comparison allows for a better understanding of the students' perceptions of the similarities and differences between net force and force-of-motion. This also allows for a better understanding of the nature of the well-known student confusion between force and velocity. Results indicate that attention must be paid to various combinations of forces so that students may better understand the concept of net force and overcome the incorrect notion of force-of-motion.

AE10: 10–10:10 a.m. Making Sense of Friction as an Interaction Using System Schema

Contributed – Brant Hinrichs, Drury University, Springfield, MO 65802; bhinrichs@drury.edu

After learning Newton's second law, students in a university modeling-based introductory physics class are asked to imagine a box sliding across a floor and slowing to a stop. Although they've had extensive experience with friction in the context of energy, this is their first exposure to friction within the context of forces. They are asked to make different representations for this scenario, including a system schema, and force diagram. During their small group work, students quickly run into a difficulty: there are only two interactions with the box (contact, gravitational), so there should only be two forces, yet the box is slowing, which means it must have unbalanced forces in the direction of acceleration. In this talk, I present evidence from the student-lead whole class discussion showing how the class uses the System Schema to help reason about this problem in a productive manner and come to a useful consensus.

AE11: 10:10–10:20 a.m. Investigating Students' Understanding of the Fundamental Theorem of Calculus*

Contributed – Rabindra R. Bajracharya, University of Maine, Orono, ME 04469; ab_study@yahoo.com

John R. Thompson, University of Maine

The Fundamental Theorem of Calculus (FTC) is an extremely useful computational tool widely used for solving various physics problems. It is implicitly invoked in the evaluation of integral problems. Research in mathematics education has documented student difficulties with the underlying concepts of the FTC. We are investigating student difficulties with the FTC, and extending the work in mathematics to include relevant situations in physics. Questions administered as written surveys and individual interviews in calculus-based introductory physics and multivariable calculus classes focused on the determination of signs of integrals, primarily in graphical representations. Negative integrals in particular provided a rich context for FTC application. We find that students use the FTC as a computational tool without understanding the underlying concepts. One observed difficulty is an operational confusion between the function endpoints and the antiderivative endpoints when determining the integral signs.

*This work is partially supported by NSF grant DUE-0817282.

AE12: 10:20–10:30 a.m. Sines and Signs – Student Difficulties with Trigonometric Vector Component Problems

Contributed – Brendon D. Mikula, The Ohio State University, Columbus, OH 43210; bdmikula@gmail.com*

Andrew Heckler, The Ohio State University

We investigated student understanding of simple vector component problems. Students in a calculus-based introductory physics class were given a variety of vector component questions, with the angle placed in various orientations. For example, the angle could be given with respect to vertical/horizontal, or with respect to the tip/tail of the vector. While some angle configurations were almost error-free, on many configurations students often confused sine with cosine and committed sign errors. The types of errors observed were found to depend on the configuration of the given angle. Overall results suggest that many students based their answers on the most commonly seen canonical angle configuration, regardless of which angle was actually given in the problem. This suggests that students need repeated practice on a variety of orientations, so that students do not become tied down to one familiar configuration.

*Sponsor: Andrew Heckler

Session AF: Teacher Preparation Around the World

Location: Sheraton – Ben Franklin Ballroom V
Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on International Physics Education
Date: Monday, July 30
Time: 8:30–10 a.m.

Presider: Bob Poel

AF01: 8:30–9 a.m. Physics Education Research-based Activities in Teacher Formation in Italy

Invited – Marisa Michelini, Physics Section, DCFA University of Udine via delle Scienze, 208 Udine, IT 33100 Italy; marisa.michelini@uniud.it

The teacher formation scenario in Italy is changing. It started very late (1999-2000) with a very good curricular plan at the university level organized in four areas (teaching professional formation, subject-related education, education labs, apprenticeship). Primary teacher formation will be structured in a five-year degree, after four-year degree up to now. The certification to teach in secondary school will come after a specific biannual Master for Teaching (MT), plus an extra year integrated with apprenticeship (total = three years, 180 ECT). Specific subject degrees (180 cts) are required for each MT. The research-based physics teacher formation experience carried out in the biannual Specialization School for Secondary Teaching SSST active until 2008 and some pilot Masters will inspire the way to form the Pedagogical Content Knowledge of future teachers. The contribution will discuss the characteristics of some significant PER Models implemented for physics teacher formation.

AF02: 9-9:30 a.m. Physics Teacher Preparation at University of Helsinki, Finland

Invited – Ari O.J. Hämäläinen, Department of Physics, University of Helsinki, FI-00014 Helsinki, Finland; Ari.Hamalainen@helsinki.fi

Dan MacIsaac, SUNY-Buffalo State College

The standard physics teacher preparation program consists of a three-year Bachelor's degree in Physics, followed by a two-year Master's degree in Physics Education. Bachelor's degree physics content courses are the same as for all physics students, with laboratory experience, pedagogical methods and two written reports on physics education. Bachelor's degree students also complete a minor in a second teaching discipline (usually mathematics or chemistry). Master's degree coursework continues extensive laboratory coursework, physics PCK, teaching practice, and a graduate thesis in physics teaching. Most Mathematics Education Bachelor's degree students complete a physics education minor. In Finnish schools, mathematics teachers qualified to teach physics outnumber those who have a Master's Degree in Physics Education. Finnish physics teachers do not complete upper-division physics courses common to U.S. Physics Bachelor's degrees such as Classical Mechanics, Mathematical Methods, etc. Physics content targets fostering deep conceptual understanding of the physics studied in grade school.

AF03: 9:30–10 a.m. Secondary Physics Teacher Preparation at Hubei University

Invited – Weining Wu, Physics Department, Hubei University, 368 Youyi Avenue of Wuchang Wuhan, Hubei 430062, China; palmer8888@163.com

Dan MacIsaac, SUNY-Buffalo State College

Yimin Ding, Hubei University

Physics teacher preparation programs in China are largely specified by the Central Government's Ministry of Education, and the four year BS in Physics Education program in Hubei contains similar physics coursework (including upper lever coursework) to typical BS Physics degree programs for regular physics majors in the U.S. Additionally, candidates complete courses in educational methods, Physics PCK, five weeks of student teaching, and a thesis in physics education. Most undergraduates do not have the opportunity to complete a minor, and most physics teachers do not complete our two-year MEd in Physics program. Like general grade school teaching in China, physics teaching in Hubei is significantly test-driven and suffers a lack of laboratory and phenomenological experiences. There is a surplus of physics teachers in most Chinese main cities like Wuhan, the capital city of Hubei Province. I will further describe specifics of these programs, success, and problems.

Session AG: Two-Year College New Faculty Experience

Location: Irvine Auditorium - Amado Recital Hall
Sponsor: Committee on Physics in Two-Year Colleges
Date: Monday, July 30
Time: 8:30–10:30 a.m.

Presider: Thomas O'Kuma

AG01: 8:30-9 a.m. Overview: New Faculty Experience for Two-Year College Physics Instructors*

Invited – Scott F. Schultz, Delta College, University Center, MI 48710; sfschult@delta.edu

Todd Leif, Cloud County Community College

The American Association of Physics Teachers has developed an 18-month experience to transform undergraduate physics programs at two-year colleges by developing newly hired physics instructors. The program seeks to equip these new faculty members with the tools, skills, and theory of active engagement techniques that have been developed based on Physics Education Research and successfully implemented at Two-Year Colleges. The lead presenters of the experience are all master two-year college faculty that also serve as mentors for the participants as the new faculty work to implement novel techniques and strategies in the classroom. The culmination of the experience is the commencement conference held in tandem with this national meeting. This talk will discuss the professional development delivered to the participants, the diversity of the group, and the lessons we as leaders have learned from the experience.

*Funding supported by NSF grant # 0940857

AG02: 9-9:10 a.m. The TYC-NFE and Me: One Physics Instructor's Evolution from a Sage on the Stage to a Guide on the Side

Contributed – Brooke Haag, Hartnell College, Salinas, CA 93901; bhaag@hartnell.edu

Four years ago I was the newly minted full-time physics professor at Hartnell Community College in Salinas, CA. I started with the idea of carrying on in the great tradition of my mentor as a renowned lecturer. However, I soon developed a nagging feeling. Was there more to teaching physics than lecturing? The Two-Year College New Faculty Experience definitively answered that question. As a participant in the TYC NFE I have undergone a dramatic evolution. In this talk, I'll describe that process, namely strategies adopted as a result of the experience, what has worked and what still needs work. I'll also discuss outcomes and future plans.

AG03: 9:10-9:20 a.m. Experiences of TYC Professor from Bismarck State College During the New Faculty Experience (NFE)

Contributed – Anthony M. Mwene, Bismarck State College, Bismarck, ND 58506; tony.musumba.mwene@bismarckstate.edu

The focus of my talk is on the changes I have made in my pedagogy due to NFE and ATE project for Physics Faculty (TYC and high school) Workshops. I continue in the tradition of most TYC faculty to modify and adapt curriculum (from different PER groups) to meet my students' needs. I will also present some projects that my students have done mostly in the area of video analysis--some as an end of semester project and others as lab assignments.

AG04: 9:20-9:30 a.m. Emphasizing a Collaborative Classroom Environment in a Studio Classroom

Contributed – Anthony Escuadro, Department of Physical Science, Harold Washington College, Chicago, IL 60659; aescuadro@ccc.edu

Jaime Millan, Harold Washington College

Since 2010, we have taught all of the introductory physics courses at Harold Washington College in an integrated lecture/lab format in a studio classroom equipped with computers. Since the introduction of the studio classroom, we have successfully implemented several interactive-engagement methods and assessed these methods using a variety of research-based assessment instruments. After participating in the 2011-2012 Two-Year College New Faculty Experience, I attempted to enhance these activities by introducing classroom structures intended to foster a greater sense of collaboration and community among the students. This talk will describe how I incorporated elements of the modeling discourse management technique into our studio classroom setting, as well as detail some of the challenges I faced in fostering a learning community among our students. I will also present my attempts to measure the impact of these collaborative activities using both standard assessment tools and student feedback.

AG05: 9:30-9:40 a.m. Effects of the NFE on New Two Year Physics Teachers

Contributed – Adrienne Battle, 30157 50th Ln., S. Auburn, WA 98001; drabattle@gmail.com

The presenter will discuss how the New Faculty Experience (NFE) has affected participants, using responses to a simple survey. Discussion will focus on how the NFE affected the participants' views of Physics Education Research, and how the NFE affected the participants' views of teaching at two-year colleges.

AG06: 9:40-9:50 a.m. Making Active Learning Work in Traditional Spaces

Contributed – Darlene Brake, Anne Arundel Community College, Arnold, MD 21012; dmbrake@aacc.edu

At Anne Arundel Community College a section of algebra-based introductory physics lecture and lab was offered in a combined lecture/lab active-learning format during fall 2011 and spring 2012. The class met for two hours three days a week and was held in a 24-seat physics lab, whose 40-year-old traditional layout presented logistical challenges. As one of five sections, the course needed to cover a common list of lecture topics and lab activities. In this talk I will discuss the successes and failures I had in adapting the physical space and curriculum to incorporate the active-learning techniques I discovered through the New Faculty Experience, and the impact these changes had on student learning.

AG07: 9:50-10 a.m. Studio Calculus-based Physics Implemented at a Two-Year College

Contributed – Kristine PH Lui, Montgomery College, Germantown, MD 20876; kris.lui@montgomerycollege.edu

While it has been known that active-learning strategies increase learning gains, often implementation is challenging for a novice and requires administrative support. Participation in the New Faculty Experience at Two-Year Colleges (NFE-2YC) during 2011-2012 gave me hands-on skills in several active-learning methods. Support from my institution allowed me resources with which to develop and implement a workshop-based format for the first calculus-based physics course. At my institution, this course has no associated lab component; the workshop format allows students to gain experimental experience as well as develop scientific deduction skills necessary for current and future academic success. This talk will focus on the transition to the workshop format, give some example activities, and describe student feedback.

AG08: 10-10:10 a.m. Going YouTubing

Contributed – Evan Richards, Lee College, Baytown, TX 77522-0818; erichards@lee.edu

Multimedia resources can be useful tools to meet certain needs of course activities. YouTube can be a particularly versatile resource given the wide variety of video clips available. I have come to view YouTube (no pun intended...) as a handy tool for a few specific purposes that I will discuss.

AG09: 10:10-10:20 a.m. Identifying and Changing Students' Preconceptions in DC Circuits

Contributed – Krista E. Wood, University of Cincinnati, Blue Ash College, Cincinnati, OH 45236; Krista.Wood@uc.edu

Inspired by the TYC New Faculty Experience, I implemented a DC circuit activity into my algebra/trig-based introductory physics class and lab. The classroom activity used bulbs and batteries to (a) let students discover how current flows through a circuit by using evidence (bulb brightness) to distinguish the difference in current through series or parallel circuits, and (b) learn to measure voltage and compare voltage drops across bulbs in various arrangements. A new series and parallel lab addressed students' preconceptions and filled a need for an introductory lab to supplement a combination circuit lab. This session will discuss the students' preconceptions revealed during the new DC circuit lab and classroom activity, compare these preconceptions to the literature, and discuss the results on students' conceptual understanding of DC circuits. It will also address the value of learning about your own students' thinking which becomes visible during active engagement learning.

AG10: 10:20-10:30 a.m. Teaching Enhancements at LCCC as a Result of the TYC-NFE

Contributed – Brian Uzpen, Laramie County Community College, Cheyenne, WY 82007; buzpen@lccc.wy.edu

As a participant in the Two-Year College New Faculty Experience (TYC-NFE), I will discuss how I have modified my courses and teaching methods. I will provide anecdotal evidence of my perceived results from the experience, a sample in-class and a sample modified laboratory activity based upon methods discussed in the TYC-NFE. I will discuss student reactions using end-of-semester surveys and analysis of student learning will be discussed using gains on the FCI in a limited number of courses.

Session AH: PER in the High School

Location: CCH - Claudia Cohen Terrace
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Physics in High Schools
Date: Monday, July 30
Time: 8:30–10 a.m.

Presider: Daniel Crowe

AH01: 8:30-9 a.m. The Missing Disciplinary Substance of Classroom Assessment*

Invited – David Hammer, Tufts University, Paige Hall, Medford, MA 02155; david.hammer@tufts.edu

Janet Coffey Gordon and Betty Moore Foundation

Daniel M. Levin, University of Maryland

Terry Grant, The Catholic High School

There has been a great deal of discussion about strategies for "formative assessment" among educators and education researchers. Much of it, unfortunately, sets aside the disciplinary substance of science, as we illustrate with examples from prominent publications. The discipline of science centrally involves assessment, in particular of the quality and validity of ideas about the natural world. The assessment practices students experience in schools should be continuous with the assessment practices of the discipline, not at odds with it. We offer an alternative image of formative assessment centered on attention to disciplinary substance, which we illustrate with an example from a high school class discussion about the question of whether air is matter. (Coffey, Hammer, Levin & Grant, 2011)[1]

*This work was supported in part with a grant from the National Science Foundation. The views we express, however, do not necessarily reflect those of the Foundation.

1. J. Coffey, D. Hammer, D. Levin, & T. Grant, "The missing disciplinary substance of formative assessment," *Journal of Research in Science Teaching* (2011).

AH02: 9-9:30 a.m. Challenging Traditional Assumptions of Secondary Science through the PET Curriculum

Invited – Mike Ross, University of Colorado, Boulder, CO 80504; michael.j.ross@colorado.edu

Shelly Belleau, Mapleton Expeditionary School of the Arts

Valerie Otero, University of Colorado - Boulder

This physics education research examines the role of high school students' participation, positioning, and views of themselves in relation to physics learning. Two classes of students traditionally underrepresented in physics were observed and interviewed in an urban high school using the Physics and Everyday Thinking (PET) curriculum. In the PET classroom, students collect and analyze data to produce, and come to consensus on, the ideas that are the targets for instruction. Findings indicate that students came to value and positively identify with the activities of physics through instruction that fosters a more dignified student experience than traditional approaches. Using the methodology of participant observation, we offer convincing evidence that students' motivation and positive relationships with physics are attributable to the positioning of students as valued contributors to the learning community. Inferences were made about essential elements of a "critical science curriculum," and implications for curriculum development will be discussed.

AH03: 9:30-9:40 a.m. Physics Pedagogy and Assessment in Secondary Schools: Overview

Contributed – Gordon P. Ramsey, Loyola University, Chicago, IL 60626; gpr@hep.anl.gov

Melissa M. Nemeth, Bogan HS, Chicago

David W. Haberkorn, Loyola University Chicago

Physics education has recently undergone major changes. Pedagogy, uses of technology, and assessment in physics courses have become important areas of study. PER progress has been made at the college level, while little has been done at the secondary level. This level is important as a preparation for advanced training in science and knowledge for the general public. Our research investigated what physics teachers in secondary education are doing in and out of the classroom to effectively educate their students. We studied pedagogical differences in high school physics courses with regard to location, school type and student populations. Our survey of secondary physics teachers compared demographics, student backgrounds, teaching methods and assessment techniques. I will outline the research and our key results. See posters by David Haberkorn on demographics and pedagogy correlations and by Melissa Nemeth on key results and recommendations.

AH04: 9:40-9:50 a.m. Tourism Attitudes from Travel Analysis and their Possible Impact in Phys.Classroom

Contributed – Anne Tabor-Morris, Georgian Court University, Lakewood, NJ 08701; tabormorris@georgian.edu

Timothy Briles, Georgian Court University

"What are the learning strategies of the students sitting in my classroom?"physics teachers may ask. In this talk a comparison is made between the psychologies behind tourism, whose research is anthropologically and sociologically rooted, and physics students' learning strategies as they visit new material, including insight into how those strategies can change. When students navigate a new area of learning, they may take allocentric, midcentric, or psychocentric attitudes, as defined by tourism research, which provide the tendency of students to preferentially choose either route-learning or survey-learning of the material presented. It is postulated that the understanding of these attitudes by the teacher can enhance the physics classroom learning experience.

AH05: 9:50-10 a.m. Students' Views on Learning Physics from a Tourism Perspective

Contributed – Timothy M. Briles, Georgian Court University, Lakewood, NJ 08701; brilest@georgian.edu

Anne Tabor-Morris, Georgian Court University

In this session, the presenters will discuss the results of their research on high school physics students and their attitudinal dispositions towards the learning the subject matter. Specifically, the researchers asked the students to compare themselves to travelers touring a new area for the first time. In addition, the researchers asked the students by which means they are "navigating" their physics class and tried to see if there were any correlations to travelers and the way they choose to find their way around a new place. Finally, the researchers investigated the potential relationships between students' self-reported confidence in their understanding and the methods they feel most comfortable using to learn the material.

AH06: 10-10:10 a.m. Students' Beliefs About their Role in the Learning Process

Contributed – Douglas H. Reed, Pulaski Academy, Little Rock, AR 72212; doug.reed@pulaskiacademy.org

John Eggebrecht

Gay Stewart, University of Arkansas, Fayetteville

Students' beliefs about their role in the learning process and about the nature of knowledge affect their ability to learn. The importance of their beliefs may be amplified when instructional activities are more student directed. In this study, learning is measured with performance gains on a subset of items taken from the DIRECT concept inventory. These items were specifically targeted by a sequence of inquiry-based activities derived from the CASTLE approach to the study of DC circuits. Student-learner characteristics were measured along five dimensions: self-efficacy, teacher/student roles, simplicity of knowledge, quickness of knowledge, and self-regulation. Comparisons of performance gains are made among groups of students with more or less productive beliefs along each of these dimensions.

AH07: 10:10-10:20 a.m. TOCUSO: Test of Conceptual Understanding on High School Optics Topics

Contributed – Bayram Akarsu, Erciyes University, School of Education, Kayseri, 38038 Turkey; bakarsu@erciyes.edu.tr

Physics educators around the world often need reliable diagnostic materials to measure students' understanding of physics concepts in high school. The purpose of this study is to evaluate a new diagnostic tool on high school optics concepts. The Test of Conceptual Understanding on High School Optics (TOCUSO) consists of 25 conceptual items that measure fundamental topics learned in high school curriculum. TOCUSO was designed with the use of various optics textbooks, Turkish University exam questions, and questions generated by the author. TOCUSO items were structured as multiple-choice questions. 12 physics faculty members at the school of science and education validated questionnaire items. SPSS program was utilized to calculate reliability values of the test. KR-20 value was found around 7.3, which shows TOCUSO is a reliable measurement questionnaire. TOCUSO was applied to 183 high school students enrolled in 10th grade at the time of data collection process in Kayseri providence in Turkey.

AH08: 10:20-10:30 a.m. Promoting Excellence Amongst Under-Achieving Students in a "Physics & Industry" Program

Contributed – Zvika Arica, Weizmann Institute of Science, Rehovot, Israel 76100; zvi.arica@weizmann.ac.il

Bat-Sheva Eylon, Weizmann Institute of Science

"Physics & Industry" is a two-year Project Based Learning program in which high achiever 11th grade student pairs are tutored by expert physics teachers and high-tech engineers. The project focuses on an authentic technological problem and the design of a functional artifact (e.g. an electro-optics' based cane for the blind). During the past six years, the instructional model has been implemented with groups of under-achieving high school students, with a view to promoting physics knowledge and learning skills as well as developing self-efficacy, self-regulation skills and creativity. We will focus on students' learning difficulties and patterns and how the instructional model and the mentors keep the delicate balance between challenging students and providing appropriate support. We will report how in the process of micro-analyzing selected scenarios we refined the "Pintrich SRL model" (Pintrich, 2000) for characterizing students' learning and their interaction with artifacts, peers and mentors.

Session AI: Teaching Physics to the Liberal Arts Major

Location: Houston Hall - Golkin
Sponsor: Committee on Physics in Undergraduate Education
Date: Monday, July 30
Time: 8:30–10:30 a.m.

Presider: Louis Rubbo

This is an invited and contributed session on teaching conceptual physics to non-STEM majors. This population of students enters the physics classroom with dramatically different motivations, perspectives, and preparations compared to their STEM colleagues.

AI01: 8:30-9 a.m. Scientific Reasoning Can Affect Learning in the Conceptual Physics Classroom

Invited – James C. Moore, Coastal Carolina University, Conway, SC 29528-6054; moorejc@coastal.edu

College students not in science, technology, engineering and/or mathematics (STEM) majors enter the physics classroom with dramatically different motivations, perspectives, and preparations in comparison to their STEM colleagues. This dramatic difference in student population may necessitate a completely different approach to instruction. In this talk, we will discuss the scientific reasoning abilities of the average non-STEM student, how preparation in reasoning impacts potential gains in content knowledge, and the implications for instruction in the conceptual physics classroom. Specifically, non-STEM students demonstrate significant difficulty with proportional and hypothetico-deductive reasoning, and struggle to demonstrate learning gains in abstract content lacking directly observable exemplars (such as force and energy). The growing body of research demonstrates that development of scientific reasoning requires explicit intervention, and we present some preliminary results with taking an explicit approach. We also will discuss the potential need for a reassessment of the canonical sequence of topics in conceptual physics.

AI02: 9-9:30 a.m. General Education Astronomy, A Very Potent Science Literacy Transformation Cocktail*

Invited – Edward E. Prather, University of Arizona, Center for Astronomy Education (CAE), Tucson, AZ 85721; eprather@as.arizona.edu

Are you doing the job that our society needs you to do? Are you successful at it? How do you know? Over the past decade we have worked closely with hundreds of college instructors, postdocs, graduate students, and undergrads in collaborative research projects designed to help us understand fundamental issues of teaching and learning in college-level general education astronomy and space science courses. The results from these multi-institutional research collaborations have been used to transform classrooms all over the country. We are creating learning environments that significantly improve the science literacies and engagement in STEM of the many thousands of students taking these general ed. courses each year. By moving students along the continuum from non-science majors, to peer instructors, to researchers and curriculum developers, to STEM and STEM education degree seeking students, we are creating the next generation's "Ambassadors of Science."

*Work supported by NSF Grant No. 0715517

AI03: 9:30-9:40 a.m. Where Physics Meets Art: Spelman College's Natural Science Core

Contributed – Marta L. Dark, Spelman College, Atlanta, GA 30314; mldark@spelman.edu*

Derrick J. Hylton, Spelman College

Physics and the Arts is a recent addition (in its third offering) for liberal arts majors at Spelman College. The course is an introduction to connections and interplay between the divergent disciplines of physics and art. Physics topics include light and color, sound, special relativity, forces, equilibrium and gravity. These physics topics are connected to developments in the arts, for example the Impressionists and Cubism. This paper will address effective strategies used in the course, such as being "gentle" with mathematics and weaving the arts theme throughout laboratory activities. For example, students determine the dependence of harmonic frequencies on string length and tension in a lab about standing waves. They use their data to interpret the reasoning behind a piano's shape and the tuning of a guitar. The culminating activity in the lab involves students designing their own artistic pieces, the purpose being to display physical principles.

*Sponsor: Paul Camp.

AI04: 9:40-9:50 a.m. Student Understanding of Mechanics in a Sports Themed Physics Course

Contributed – Samuel Cook, Wheelock College, Boston, MA 02215; scook@wheelock.edu*

Chuck Fidler, Wheelock College

The engagement of non-science majors in introductory physics courses is an issue in any introductory STEM course. Quantifying the effectiveness of a course with a constant semester-long theme may change the way departments offer introductory science courses. The literature suggests that themed-based curriculum improves students engagement on a topical basis (Wiseman and Chatterjee, 1997); however, the study of a semester long course with a constant theme has seen very little attention. In this preliminary report, we will report on students' understanding of mechanics in a sports-themed introductory physics course. The students enrolled in this class were liberal arts and education students who primarily enrolled in the course to fulfill a general education science requirement. Their understanding of mechanics is measured through the "Force Concept Inventory" (Hestenes, Wells & Swackhamer) and interviews and is presented in this report.

*Sponsor: Charles Fidler

AI05: 9:50-10 a.m. Evolution of Hybrid Conceptual Physics Course for Non-STEM Majors

Contributed – Paul G. Ashcraft, Penn State Erie, The Behrend College, Erie, PA 16563; pga106@psu.edu

Jonathan C. Hall, Penn State Erie, The Behrend College

Faculty at a branch campus of a large research institute were encouraged to develop hybrid courses to match the changing technology resources of the student population, enhancing the student's learning experience. The conceptual physics course was modified, replacing the Friday afternoon lectures with virtual lab activities, either video analysis or working with computer simulations. While student course satisfaction increased, an unintended consequence was a drop in student enrollment for the course. This fosters a new debate: Should there be a course that meets the needs of the few students who sign up for it, or should the course become more traditional so more students will enroll?

AI06: 10-10:10 a.m. Using Student-Formulated Sample Exam Questions in the Classroom

Contributed – Jack Dostal, Wake Forest University, Winston-Salem, NC 27109; dostalja@wfu.edu

In survey physics classes primarily for non-science majors, teachers often use questions at the bottom levels of Bloom's Taxonomy (Remembering, Understanding) as homework or examination questions. These questions tend to have little cognitive substance and are often memorized just for the short-term by students. We wanted to try something that improved upon this process. During the past year we asked students in a "How Things Work" course to write sample examination questions related to the material we covered during the past week. We'll describe some of the benefits of such an approach, identify some things that have worked well in our class (and others that haven't), and share some of the questions that students have written.

AI07: 10:10-10:20 a.m. Teaching Online vs. Teaching in-Class: Are They Really Similar?

Contributed – Mike Mikhaiel, William Paterson University, Wayne, NJ 07470; mikhaielm@wpunj.edu

Teaching in an online environment contains many of the same issues found in teaching in a traditional classroom. Teachers must know their content area and be able to adjust the curriculum to best meet the needs of their students. Over the past decade, technology has grown tremendously and has created new methods that can greatly enhance learning for students. This growth in technology made the teaching of an online physics class as efficient as traditional in-class physics. The two most important issues to consider in teaching in an online environment are communication and organization. Just like traditional classrooms, lesson plans are critical. Getting the message across to students is the ultimate goal. In this discussion, I am going to show the similarities between my online physics lecture and my traditional in-class lecture. Also, I am going to show how I conduct my online physics experiments and compare that with my traditional physics laboratory experiments.

Ceremonial Session: AAPT Teaching Awards

Location: Inn at Penn - Woodlands Ballroom
Date: Monday, July 30
Time: 11 a.m.–12:10 p.m.

Presider: Jill Marshall *Presenter: David Sokoloff*

Mark Greenman

Paul W. Zitzewitz Award for Excellence in Pre-College Teaching – Mark D. Greenman

Mark D. Greenman, Marblehead High School, Marblehead, MA 01945; mgreenman2@verizon.net

Interactive Laboratory Experiences (ILE) – A Professional Development Recipe for Success:

The speaker will discuss an in-service program that consistently resulted in substantial gains in physics content knowledge and discipline-based pedagogical knowledge for participating teachers. This professional development model was used during the summers of 2008 through 2011 with four cohorts of 23 secondary school teachers responsible for teaching physics concepts. The Force and Motion Conceptual Evaluation (FMCE) was used in a pre-post-post-test format to assess teacher gains. Teachers were compared based on certification, grade level assignment, undergraduate degree major, and district type. Teacher fractional gains ranged from .5 to .7 with teachers in every comparison group showing strong gains. Just as encouraging, these gains showed little or no decay overtime.

Kevin Lee

David Halliday and Robert Resnick Award for Excellence in Undergraduate Physics Teaching – Kevin M. Lee

Kevin M. Lee, University of Nebraska, Lincoln Center for Science, Mathematics, and Computer Education and the Department of Physics and Astronomy, Lincoln, NE 68588-0111; klee6@unl.edu

Letting Technology do what Technology is Good at!

This presentation will provide an overview of many of the ways that I have applied technology in teaching introductory astronomy. These include many simulations, a database of dynamic visual peer instruction questions known as ClassAction, and a library of interactive ranking and sorting tasks. All of these NSF-funded tools are publicly available on the Astronomy Education at the University of Nebraska website: http://astro.unl.edu.

Technology can also be used to move the imparting of information to the student outside of the classroom—in a pedagogy known as “flipping.” Several technologies allow an instructor to post their lectures on the web and ask students to prepare before class. Instructors can assess the level of preclass preparedness by using web-based assessment software to quiz over the lecture. Students will then come to class prepared to spend considerable time on peer instruction, lecture tutorials, and other group activities—an approach that lets people do what people are good at!

CRKBRL 1: Vidshare: Motivating and Elucidating Short Videos You Can Use!

Location: Irvine Auditorium - Amado Recital Hall
Sponsor: Committee on Educational Technologies
Date: Monday, July 30
Time: 12:15–1:15 p.m.

Presider: Mike Meyer

Send the coordinator the URLs for your favorite short (less than three minutes) online videos to be used for motivating students or giving examples – or just bring them along! We will take turns showing videos and explaining and discussing how they can be used in class. All URLs will be sent to all session participants after completion.

CRKBRL 2: Physics and Society Crackerbarrel

Location: Sheraton - Ben Franklin Ballroom I
Sponsor: Committee on Science Education for the Public
Date: Monday, July 30
Time: 12:15–1:15 p.m.

Presider: Steve Shropshire

Join your colleagues for a discussion of how AAPT members can contribute to the teaching of such physics-related societal issues as energy use, global warming, nuclear power, resource extraction, and pseudoscience.

Plenary: APS Division of Biophysics

Location: Inn at Penn - Woodlands Ballroom
Date: Monday, July 30
Time: 1:30–3 p.m.

Presider: Philip Nelson, University of Pennsylvania

Birds, Brains and Physics – the Fascinating Field of Biological Physics

Schools of fish, flocks of birds, and stampeding elephants are examples of phenomena from the natural living world that can be described using the tools of physics. Biological physics is a rapidly developing field of research that lies at the boundaries of physics, chemistry, and biology, and seeks to contribute to our understanding of life. Professor William Bialek from the Physics Department at Princeton University uses statistical mechanics to describe a wide range of living phenomena, from amino acids in a protein molecule to networks of neurons to birds in flight. Professor Dezhe Jin from the Physics Department at Penn State University studies how complex bird songs, which share many common features with human speech, are controlled by the emergent dynamics of neurons in brains of songbirds. Understanding how birds sing will help to resolve the language-centric pathways in the brain.

William Bialek

Statistical Physics Approaches to Real Biological Systems

William Bialek, Department of Physics, Princeton University, Princeton, NJ 08544

Statistical mechanics gives us a language for describing the emergence of collective behavior. These phenomena can be exotic, as with superconductivity and superfluidity, or mundane (but subtle!), such as the rigidity of solids. Biological systems offer many examples of collective behavior, from the interactions among many amino acids that stabilize the structure of a protein molecule to the beautifully coordinated flight of birds in flocks. For decades, physicists have speculated that statistical mechanics should provide us with a way of thinking about these systems, but there was a huge gap between these theoretical ideas and experiment. In the last decade, it has been possible to close the gap, and move beyond metaphor to detailed calculations and quantitative comparison with data. I'll review this work, leaning heavily on the flock of birds as an example, but also looking at proteins and networks of neurons. Astonishingly, all of these systems seem to be poised near a critical point in their natural parameter space, hinting at some deeper principles.

Dezhe Z. Jin

The Emergent Neural Dynamics of Bird Song Syntax

Dezhe Z. Jin, Department of Physics, The Pennsylvania State University, University Park, PA 16802

Songbirds learn to sing songs like humans learn to speak. The songs of many species follow syntax crudely similar to the rules of human speech, and consist of stereotypical syllables strung together into variable sequences. Experimental and computational works, many by physicists, start to unveil how the collective dynamics of connected neurons in the songbird brain control the syntax. Neurons form unidirectional chain networks that drive the syllables. The chains are connected into branched networks. Neural activity flows along the branched pathway to produce syllable sequences. At a branching point, one of the connected chains is selected to carry on the activity, producing a probabilistic syllable transition. These results may shed light on how human speech is encoded in the brain.

Session BA: *Panel* – Physics First: Success Stories in Delaware Valley

Location: Sheraton - Ben Franklin Ballroom I
Sponsor: Committee on Physics in High School
Date: Monday, July 30
Time: 3:30–5:30 p.m.

Presider: Barry Feierman

A panel of experienced teachers from the Philadelphia region will present the rationale for their school's move to begin Physics instruction in ninth grade, followed typically by Chemistry in 10th grade and then Biology in 11th grade in a "PCB" sequence. All of the schools represented will have at least a 10-year track record with Ninth Grade Physics. Teachers will discuss both the pros and challenges of teaching physics to ninth graders.

BA01: 3:30-5:30 p.m. Physics First at The Baldwin School

Panel – Jeffrey D. Goldader, The Baldwin School, Bryn Mawr, PA 19010; jgoldader@baldwinschool.org

The Baldwin School in Bryn Mawr began teaching physics in ninth grade in the early 1990s as a response to a revolution— not in physics, but in biology. Teaching a physics-chemistry-biology course sequence allowed our science curriculum to reflect the changing emphasis in biology from morphology and body systems to biochemistry. Our ninth-grade physics class emphasizes concepts in physics, while incorporating Algebra 1-level math (Algebra 2 in the honors section) for calculations. We work to develop good lab practices, including written lab reports. Our girls enter chemistry in 10th grade ready to balance chemical equations, work pH and molarity calculations, and safely perform experiments. Our physics curriculum emphasizes our girls' real-world experiences, to help them see the importance of physics and technology in everyday life. Advanced electives are available to girls in their junior and senior years who wish to continue their study in physics.

BA02: 3:30-5:30 p.m. Physics First – Great for Concrete Thinkers

Panel – Megan J. Williams, Westtown School, West Chester, PA 19382; megan.williams@westtown.edu

Physics First at Westtown is a hands-on engaging experience for students who are just entering algebra. We also offer an advanced section for ninth graders who are more advanced in mathematics. This has been a great way to reach our most concrete thinkers and prepare them for a college preparatory sequence of physics, followed by chemistry and then biology. One of the advantages to this sequence is most of the concepts we cover in physics can be demonstrated in a way that students can see and touch. This gives the kids a solid background to take into chemistry, where far more of the concepts are more abstract.

BA03: 3:30-5:30 p.m. Physics First Works for Us

Panel – Stephen Cooney, Delaware Valley Friends School, Paoli, PA 19301; steve.cooney@dvfs.org

My school, Delaware Valley Friends, implemented Physics First to ninth graders eight years ago. There have been a host of positive effects at many levels. It provides real-world math applications for students in all different sections of algebra or even pre-algebra, therefore improving their understanding. Using a combination of Active Physics curriculum and Vernier experiments using Logger Pro software and their hardware, we have the students generating the data they are investigating. Among many other topics, they prove to themselves that acceleration due to gravity is constant. We follow physics with chemistry and biology, allowing for a variety of options in 12th grade, including a much more mathematically rigorous physics elective.

BA04: 3:30-5:30 p.m. Challenges and Rewards of a "Physics First" Sequence

Panel – Joseph J. Scherrer, Germantown Academy, Ft. Washington, PA 19034; joseph.scherrer@germantownacademy.org

Thirty-seven of my 41 years of secondary physics teaching have been spent in a "Physics First" classroom. Those experiences have provided innumerable intellectual and practical challenges resulting in an ongoing realignment and reassessment of instructional goals and an annual rededication to the aspirations of Physics First. This paper describes the evolution of Germantown Academy's current three tiered Physics First sequence and the author's time-hardened perspectives on what works.

BA06: 3:30-5:30 p.m. Physics Union Mathematics, Making it Work in Grade 9!

Panel – Joseph Spaccavento, North Arlington High School, North Arlington, NJ 07031 Joseph.Spaccavento@narlington.k12.nj.us

North Arlington HS is a suburban 9-12 high school in Northern New Jersey. After several years of preparation, the science sequence for the 2011-12 school year was changed from BCP to PCB. The physics curriculum for grade nine evolved from "Physics Union Mathematics" (PUM), a physics curriculum linking middle/high school physics curricula and builds on the intrinsic mathematical reasoning to develop and strengthen students' mathematical concepts at the pre-algebra and algebra levels. PUM curriculum consists of logically connected modules that allow students to build their conceptual understanding of physics concepts, develop relevant mathematical reasoning, and simultaneously learn how to think like scientists. The PUM curriculum builds on the philosophy of the Investigative Science Learning Environment (ISLE, Etkina & Van Heuvelen, 2007) This talk will focus on steps taken to implement this sequence change, advantages of physics and algebra teacher cross-curricular collaboration, and our evaluation of student progress and performance to date.

Session BB: Leadership Models in Science

Location: Sheraton - Ben Franklin Ballroom II
Sponsor: Committee on Women in Physics
Co-Sponsor: Committee on Professional Concerns
Date: Monday, July 30
Time: 3:30–5 p.m.

Presider: Juan Burciaga

BB01: 3:30-4 p.m. Project Kaleidoscope's Summer Leadership Institutes: Preparing STEM Faculty Leaders

Invited – Beth A. Cunningham, American Association of Physics Teachers, College Park, MD 20740; bcunningham@aapt.org

Information will be presented on the Project Kaleidoscope (PKAL) Summer Leadership Institute (SLI), which PKAL has offered since 1996. The institutes are designed to help emerging STEM faculty leaders set a professional course for their future as agents of change on their campuses. Participants in this session will learn about a set of experiential learning exercises that immerse STEM faculty in cycles of learning and reflection. These activities inform personal leadership development and the leadership plans for specific projects at the home campus. I will also describe the SLI structure, discuss the ways in which the institute has evolved, and highlight the institute's impact on faculty careers.

BB02: 4-4:30 p.m. Increasing Opportunities Through Negotiation and Communication Skills Workshops.

Invited – Sherry Yennello, Texas A&M University, Cyclotron Institute, College Station, TX 77843; yennello@comp.tamu.edu

The Committee of the Status of Women of the APS runs professional development workshops for women physicists at the March and April APS meetings. The program brings in professional facilitators to lead half-day workshops in negotiation and communication. By bolstering their professional skills in these two critical areas, these women are better positioned to advance their career in physics. Some of the women who have gone through the program have advanced into leadership roles within their professional society or their home institution. Originally offered for faculty and research scientists in industry and at National Laboratories, the program has expanded to serve post-doctoral research associates. Through this program the field of physics is able to draw on a broader talent pool as more women are better prepared to assume leadership roles.

BB03: 4:30-5 p.m. The SACNAS Leadership Program: Leadership Development for Underrepresented Minority Scientists

Invited – Yvonne W. Rodriguez. Society for the Advancement of Hispanics/Chicanos and Native Americans in Science, Santa Cruz, CA 95061; yvonne@sacnas.org*

Joseph Garcia, Western Washington University

Donna Blancero, Bentley University

Richard Weibl, American Association for the Advancement of Science

Jack Mills, Independent Evaluation Consultant

The Society for the Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) is a society of scientists dedicated to fostering the success of Hispanic/Chicano and Native American scientists—from college students to professionals—to attain advanced degrees, careers, and positions of leadership. One of its key initiatives is the SACNAS Summer Leadership Institute (SLI). The SLI, developed in collaboration with AAAS, provides premier training designed for URM scientists and is open to all. The institute prepares participants to assume leadership roles in the global scientific community by offering advanced strategic trainings that develop critical leadership skills. It is an intensive five-day course featuring small group exercises, keynote speakers, leadership development planning, networking opportunities and extensive community building among participants. Successes and lessons learned in the planning, implementation and evaluation of this program will be presented. The SLI is partially funded by NIGMS and is now in its fourth year.

*Sponsor: Juan Burciaga

Session BC: The Art and Science of Teaching

Location: Sheraton - Ben Franklin Ballroom III
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Physics in Undergraduate Education
Date: Monday. Juluy 30
Time: 3:30–5:30 p.m.

Presider: Ray Burnstein

BC01: 3:30-4 p.m. The Art and Science of Teaching with Technology

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

Art (noun) \`ärt\ 1: skill acquired by experience, study, or observation* Science (noun) \`s?-?n(t)s\ 4: a system or method reconciling practical ends with scientific laws* Like many aspects of teaching, the use of technology is partly science and partly art. In this talk, I will present an overview of technology in education, including technologies that are primarily used by instructors, those that are primarily used by students, and those that facilitate interactions among faculty and students. Throughout, I try to elucidate the art of selecting technology and using it in an educational setting, and ground this discussion in the science that supports our use of technology.

* http://www.merriam-webster.com/dictionary/

BC02: 4-4:30 p.m. A Shaken Faith: Deconstructing the Art and Science of Teaching*

Invited – Stamatis Vokos, Seattle Pacific University, Seattle, WA 98119-1959; vokos@spu.edu

PER helps improve conceptual understanding. That is only part of our goals in teaching physics. We also want learners to become better learners, to value consistency, to appreciate the beauty in physics, to be empowered to tackle previously inaccessible tasks, to leverage their new perspective for the amelioration of their communities, etc. If the learners in our classroom are science teachers, additional teaching goals emerge. Prospective and practicing teachers should hone their content knowledge for teaching physics, value student ideas as the raw materials that shape instruction, respond to the disciplinary substance of those ideas moment by moment, believe that all students are capable of learning; in short, we want to enlarge teachers' vision of what is possible in science education. The classroom requires us to attend simultaneously to multiple stimuli. Sometimes, conflicting value systems within the instructor create internal conflicts that derail learning. I will discuss a video episode in which I tried unsuccessfully to pursue several of the threads above as a "novice." The analysis will seek to present teaching in a broader framework than that of art or science.

*The work has been supported in part by the National Science Foundation under Grant # 0822342.

BC03: 4:30-5 p.m. Framing, Epistemology, and All That Jazz: Why it Matters

Invited – Edward F. Redish, University of Maryland, College Park, MD 20742-4111; redish@umd.edu

Vashti Sawtelle, University of Maryland

Three decades of Physics Education Research (PER) have convinced many teachers that their students may "bring misconceptions" to class that can be difficult to overcome. But many do not realize that in the past dozen years, PER has documented that sometimes students' difficulties are not about "getting the physical principles wrong," but rather about misinterpreting the nature of the knowledge they are learning and what they are supposed to do to learn it. I refer to these as "epistemological misconceptions." They can affect student responses in subtle ways through dynamic framing of the task at hand — students' judgment about "what's going on here" and what knowledge it is appropriate to bring to bear. Sometimes these framings are labile and easily changed; in other cases they are robust and need serious pedagogical effort. I will give examples occurring across the curriculum and suggest some ways of dealing with these issues.

Session BD: PER: Attitudes

Location: Houston Hall - Class of 49
Sponsor: Committee on Physics Education Research
Date: Monday, July 30
Time: 3:30–5:30 p.m.

Presider: David Brookes

BD01: 3:30-3:40 p.m. Polarization on the CLASS in a General Education Physics Course

Contributed – David Donnelly, Texas State University-San Marcos, San Marcos, TX 78666; donnelly@txstate.edu

Eleanor Close, Hunter Close Texas State University-San Marcos

We used the Colorado Learning Attitudes about Science Survey (CLASS) to assess changes in attitude during a general education course aimed at non-science majors. The course is two semesters in duration, and both semesters were surveyed. The survey was administered to a total of 1037 student in 26 different sections over three semesters. With this study, we observe a variety of different attitudinal shifts in different sections, including large increases in favorable responses in some sections. In general one might expect that increases in favorable responses would be accompanied by decreases in unfavorable responses. However, we observe some situations with increases in both favorable and unfavorable responses, and others with decreases in both. We will present an analysis of the attitudinal shifts, and discuss factors, such as instructor and method of instruction, that might contribute to shifts in attitude.

BD02: 3:40-3:50 p.m. Investigating Students' Affective Experience in Introductory Physics Courses

Contributed – Jayson M. Nissen, University of Maine, Orono, ME 04469 jayson.nissen@maine.edu

Jon T. Shemwell, MacKenzie R. Stetzer, University of Maine

Improving non-cognitive outcomes such as attitudes, efficacy, and persistence in physics courses is an important goal in physics education. This investigation implemented an in-the-moment surveying technique called the Experience Sampling Method (ESM)[1] to measure students' affective experience in physics. Measurements included: self-esteem, cognitive efficiency, activation, intrinsic motivation and affect. Data are presented showing contrasts in students' experiences, (e.g., in physics vs. non-physics courses).

1. R. Larson and M. Csikszentmihalyi, "Validity and Reliability of the Experience-Sampling Method," *J Nerv Ment Dis.* **175**(9), 526-36 (1987).

BD03: 3:50-4 p.m. Community and Collaboration in Upper-Division Physics Courses

Contributed – Michael Loverude, California State University Fullerton, Fullerton, CA 92834; mloverude@fullerton.edu

Sissi L. Li Catalyst Center, California State University Fullerton

As part of an ongoing study of student learning in upper-division courses in thermal physics and mathematical methods, we have examined students' approaches to homework completion and test preparation. For example, students were asked to complete and submit supplemental information sheets with homework assignments. On the sheets, students reported, among other things, with whom they had worked and what resources they had consulted. The responses suggested very different strategies for completing homework, and vast differences in the level of collaboration. In this talk, we report a preliminary examination of these responses and their relationship to performance on homework and course examinations.

BD04: 4-4:10 p.m. Learning Practices of Physics Majors

Contributed – Sissi L. Li ,California State University Fullerton, Fullerton, CA 92831; sili@fullerton.edu

Michael E. Loverude, California State University Fullerton

Multiple researchers have reported that active engagement classrooms are associated with higher gains in student performance. However at the individual level, increased student participation doesn't always lead to high course performance. We propose that the classroom as a single community of practice (CoP) does not stand on its own but is interconnected with myriad other CoPs. Students doing physics in communities beyond the classroom contribute to their physics major identity development. For example a student may develop a strong, persistent sense of being a physicist with parents as role models but only participate peripherally in class. To elicit students' perception about being a physicist and participation in relevant CoPs, we collected a series of prompted reflective journals and individual student interviews in an upper-division course in thermodynamics. In this talk, we present several case studies of these students' physics major identity development and the communities in which they practice physics.

BD05: 4:10-4:20 p.m. Classroom Experiences that Help Females Become Interested in Physical Science Careers: Testing Five Common Hypotheses

Contributed – Zahra Hazari, Department of Engineering & Science Education, Clemson University, Clemson, SC 29634; zahra@clemson.edu

Geoff Potvin, Robynne M. Lock, Florin Lung, Clemson University

Philip M. Sadler, Gerhard Sonnert, Science Education Department, Harvard Smithsonian Center for Astrophysics

There are many hypotheses regarding physics classroom experiences that may encourage female students to pursue careers in the physical sciences. Using Propensity Score Matching (PSM) on national data (n=7505) drawn from the Persistence Research in Science and Engineering (PRiSE) project, we test five commonly held beliefs including having a single-sex physics class, having a female physics teacher, having female scientist guest speakers, discussing the work of women scientists, and discussing the under-representation of women. The effect of these experiences is compared for female students who are matched on several factors, including parental education, prior science/math interests, and academic background, thereby controlling for the effect of many confounding variables. (NSF Career 0952460, GSE 0624444).

BD07: 4:20-4:30 p.m. Assessing Student Self-Confidence with the CLASS Learning Attitudes Survey

Contributed – Andrew E. Pawl, University of Wisconsin-Platteville, 1 University Plaza, Platteville, WI 53818 pawla@uwplatt.edu

David E. Pritchard, MIT

Administering the CLASS to students in the mainstream freshman mechanics course at MIT yields significant negative shifts in all the categories related to problem solving and conceptual understanding. These shifts are consistent with the observations published by the creators of the CLASS. In the MIT sample, these shifts can be ascribed to five statements that unambiguously assess student self-confidence. No substantial shift is observed in statements assessing students' conception of what constitutes problem-solving expertise. By contrast, students enrolled in calculus-based introductory mechanics at the University of Wisconsin-Platteville, a small state engineering school, enter the course with significantly lower rates of expert-like responses in the non-self-confidence statements but similar levels of self-confidence, and leave the course without a significant shift in either category of statements. Substantial remediation of the drop in MIT student self-confidence statements has been achieved by a three-week ReView course employing Modeling Applied to Problem Solving (MAPS) pedagogy.

BD08: 4:30-4:40 p.m. Evolving Positions and Acknowledged Abilities: Expert Identity Development*

Contributed – Idaykis Rodriguez, Florida International University, Miami, FL 33199; irodr020@fiu.edu

Renee Michelle Goertzen, Eric Brewe, Laird H. Kramer, Florida International University

This study examines how graduate students become physics experts in a physics research group using Wenger's apprenticeship framework within a Community of Practice. For an individual, the process of social reconfiguration is a matter of identity development through participation. We analyze data from an ethnographic case study of a biophysics research group with two professors and four graduate students. Data consist of six months of participant observations and video recordings of the group's research meetings, interviews, document analysis, and two months of observations a year later. We present how students' development of community membership is a matter of identification, how an individual is recognized or labeled, and negotiability, how individuals position themselves based on their abilities to negotiate meaning in an interaction. Differences in members' ability to negotiate in an interaction informs us of their evolving position within the research group and the acknowledgement of their abilities and technical expertise.

*Supported by NSF Award # PHY-0802184

BD09: 4:40-4:50 p.m. How Tadao Avoided the "Culture Shock" of Reformed Physics Instruction*

Contributed – Michael M. Hull, University of Maryland 082 Regents Drive, College Park, MD 20742; mhull12@umd.edu

Many educators struggle with student resistance to PER-based "active learning" curricula. We might expect that Tadao, a university student in Tokyo using translated Maryland Open Source Tutorials,[1] would exhibit such resistance. His previous physics experiences in high school (focused on university entrance exam preparation) and in college had been very traditional; Tadao reported that he had developed a view of physics as knowledge to memorize and calculations to perform. However, despite this epistemological mismatch, Tadao (and other classmates) quickly adapted to the new style of learning and developed a more sophisticated view of what it means to understand physics. Why wasn't there more resistance? Tadao and a few other students credited elementary school with having provided "constructivist," tutorial-like experiences that made the adjustment easier. An instructional implication for overcoming resistance to PER-based pedagogy is the possibility of utilizing students' "constructivist" experiences, even ones seemingly distant from university physics.

1. A. Elby, R.E. Scherr, T.L. McCaskey, R. Hodges, E.F. Redish, D.M. Hammer, & T. Bing, (2007). *Open Source Tutorials in Physics Sense-making: Suite I*. DVD retrieved from http://www.spu.edu/depts/physics/tcp/tadevelopment.asp

*This work is partially supported by NSF-IEECI grant # 0835880

BD10: 4:50-5 p.m. Understanding the Learning Assistant Experience with Physics Identity

Contributed – Eleanor W. Close, Texas State University-San Marcos, 601 University Dr., San Marcos, TX 78666; eclose@txstate.edu

Hunter G. Close, David Donnelly, Texas State University-San Marcos

Learning Assistants (LAs) have been shown to have better conceptual understanding and more favorable beliefs about science than non-LAs, and are more likely to choose a career in K-12 science teaching.[1] We propose that connections between elements of identity, persistence, and participation in an LA program can be explained using the concept of the community of practice and its intimate relationship to identity.[2] In separate work, Hazari et al. found that physics identity was highly correlated to expressed career plans in physics.[3] We hypothesize that a thriving LA program has many features of a well-functioning community of practice and contributes to all four elements of physics identity: "personal interest," "student performance," "competence," and "recognition by others." We explore how this analysis of the LA experience might shape decisions and influence outcomes of adoption and adaptations of the LA model.

1. Otero, Pollock, & Finkelstein, *Am. J. Phys.* **78** (11), 1218-1224 (2010).
2. Wenger, *Communities of Practice: Learning, Meaning, and Identity* (Cambridge Univ. Press, 1998).
3. *J. Res. Sci. Teach.* **47** (8), 978-1003 (2010).

BD11: 5-5:10 p.m. Modern Physics Labs Using Responsive Inquiry to Create Research Experiences

Contributed – Benjamin L. Stottrup, Augsburg College, Minneapolis, MN 55454; stottrup@augsburg.edu

Sarah B. McKagan, McKagan Enterprises

Augsburg College offers a sophomore-level modern physics course with associated lab. We will describe our redesign of this lab to create a semester-long responsive inquiry research experience focused on nanotechnology, materials characterization tools, and biology as an inspiration for engineers. Students gain hands-on experience using scanning electron microscopes, atomic force microscopes, as well as other sample preparation tools, and develop their own research projects using the equipment. A goal of the lab is to give students an experience of what research is like and what a scientist does, in order to improve their self-identity as scientists. The focus on contemporary skill building is intended to meet the changing demographics of our student body (increased enrollment, interest in engineering, and first-generation college students). One goal of our project is to determine if the valuable experiences gained through undergraduate research can be re-enforced, supplemented, or extended to a broader student population through more traditional areas of the curriculum. We assess the impact of labs and undergraduate research experiences on students' understanding of the process of science and what a scientist does, and on their self-identities as scientists. We identify general features of labs, research experiences, and other educational environments that may impact student's self-identities as scientists.

BD12: 5:10-5:20 p.m. Identifying Systemic Contradictions in a Post-Graduate Astrophysics Program

Contributed – Victoria Nwosu, University of Cape Town, Physics Department, Rondebosch, 7701 South Africa' victoria.nwosu@gmail.com

Saalih Allie, Andrew Deacon, University of Cape Town

Dedra Demaree, Oregon State University

Sissi Li, California State University Fullerton

While epistemology can go some way toward understanding student performance, it has become clear that a number of other factors including broader socio-cultural and systemic issues play critical roles. Using Cultural Historical Activity Theory (CHAT) as a theoretical framework we investigated various such aspects including systemic contradictions that lead to student under-performance. We present findings from studies involving small groups of postgraduate students who transferred from "Historically Black Universities" to the National Astrophysics and Space Science Programme that is run at the University of Cape Town

Session BE: Video Analysis in Undergraduate Education

Location: Sheraton - William Penn Suite
Sponsor: Committee on Educational Technologies
Date: Monday, July 30
Time: 3:30–5:10 p.m.

Presider: Bob Teese

BE01: 3:30-4 p.m. Understanding Projectile Motion: Comparing Video Analysis Activities to Other Approaches

Invited – Priscilla W. Laws, Dickinson College, Carlisle, PA 17013; lawsp@dickinson.edu

Robert B. Teese, Rochester Institute of Technology

Maxine C. Willis, Dickinson College

Patrick J. Cooney, Millersville University

The LivePhoto Physics Group has been exploring the impact of guided digital video analysis activities and other instructional methods on student understanding of projectile motion with special emphasis on its graphical representations. A pre-/post- test instrument, the Projectile Motion Conceptual Evaluation (PMCE), was developed for this learning research. In this talk the PMCE will be described along with common pre-conceptions held by introductory physics students that the test reveals. In addition, preliminary results of the impact of various instructional techniques on PMCE gains will be presented for over 1000 students enrolled in 50 introductory physics classes. The instructional techniques explored include use of video analysis, style of instruction (e.g. traditional lecture/lab vs. active learning), and whether 2D motion is introduced during the study of kinematics or after Newton's second law. This research is based on work supported by NSF grants 0089380, 0424063 and 0717699.

BE02: 4-4:30 p.m. Advanced Video Analysis for Student Research

Invited – Aaron Titus, High Point University, High Point, NC 27262; atitus@highpoint.edu

Undergraduate research can be defined as students asking interesting questions and finding answers to those questions. Video analysis is one of the most economical and effective experimental techniques to enable students to do undergraduate research, starting with introductory physics and continuing to upper-level physics. Particular features of Tracker—a free cross-platform, open-source video analysis application—allow students to easily change reference frames, compensate for panning and zooming of a camera, auto-track objects, and test a numerical model. Exemplary student projects from various schools will be demonstrated, including research projects from first-year to fourth-year physics students. If you want to hook students on the excitement of independent discovery with a budget of $300 or less (for a camera), then video analysis is for you.

BE03: 4:30-4:40 p.m. Video Analysis as a Tool to Explore Capillary Waves

Contributed – Tetyana Antimirova, Ryerson University, Toronto, ON M5B 2K3 Canada; antimiro@ryerson.ca

Surface tension is one of many topics that over the years quietly disappeared from almost all standard undergraduate physics curricula. Yet, this particular topic is very important at least for the life science programs, because surface tension plays an important role in biophysics and physiology. (Perhaps one of the most dramatic examples is so-called infant respiratory syndrome caused by the lack of lung surfactant in premature babies' lungs, which can be fatal without treatment). Surface tension can manifest itself in capillary waves that propagate on the surface of liquids under certain conditions. We will describe a couple of simple experiments using motion video analysis to study a propagation of such capillary waves and to measure a coefficient of surface tension.

BE04: 4:40-4:50 p.m. Gelatin Jiggles or Determining the Shear Modulus of Gelatin

Contributed – Craig M. Jensen, Northern Virginia Community College, Annandale, VA 22003-3796; cjensen@nvcc.edu

Gelatin has been known to jiggle for some time. Analysis of the oscillations of gelatin as a damped harmonic oscillator will be demonstrated using LoggerPro.[1] These oscillations are then used to determine the shear modulus of gelatin. LoggerPro will also be used to demonstrate resonance of the gelatin system.

1. LoggerPro is a licensed product of Vernier Software & Technology.

BE05: 4:50-5 p.m. OpenTrack: A Browser-based Video Tracking and Analysis Tool

Contributed – Timothy A. Niiler, Penn State Brandywine, Media, PA 19063; tim.niiler@gmail.com

OpenTrack (OT)*, is a Firefox-based video tracking application that supports both manual and automatic digitization of video for physics and biomechanics related research and teaching. Compared to many video tracking applications, OT features a flow-based approach to tracking which we have found helpful for students trying to learn the process. OT includes a number of analytic tools including statistics, fitting, and scripting support which can help advanced users with reduction of complex data sets and which can introduce novices to basic coding. A number of labs and pre-recorded videos are downloadable via OT, and there is extensive screencast-based help for users. OT also has an integrated HTML report editor which can automatically import selected graphics from the tracking portion of the program. Additionally, the editor supports graphics editing, a whiteboard mode that allows students to record drawing and derivations, equation rendering using JSMath, tables, video import, and a presentation mode.

*Please see http://www.niiler.com/opentrack/opentrack.xpi for latest update. Note: this is a Firefox extension.

BE06: 5-5:10 p.m. Passage of Asteroid 2005 YU55

Contributed – Stephen Luzader, Frostburg State University, Frostburg, MD 21532; sluzader@frostburg.edu

On Nov. 8, 2011, asteroid 2005 YU55 passed closer to the Earth than the Moon. It afforded an opportunity to do a different kind of video analysis. Using a digital camera set to take exposures automatically at a fixed rate, we recorded the motion of the asteroid across the sky over a period of 35 minutes. By measuring the position of the asteroid in successive images, its transverse speed could be determined by using its distance from the Earth, which was obtained from an online ephemeris. Movies made from the individual images will be shown, and the speed results will be presented. This stop-motion type of video analysis can be applied to other phenomena that occur over long time intervals.

Session BF: Innovations in Teaching Astronomy

Location: Sheraton - Ben Franklin Ballroom V
Sponsor: Committee on Space Science and Astronomy
Date: Monday, July 30
Time: 3:30–5:30 p.m.

Presider: Trina Cannon

BF01: 3:30-4 p.m. The ASTRO 101 Teacher's New Toolkit for Addressing Diversity*

*Invited – Mark Reiser, University of Wyoming, Center for Astronomy & Physics Education Research,** Laramie, WY 82070; markreiser57@gmail.com*

ASTRO 101 professors start each new year with increasingly diverse groups of non-majoring undergraduate students populating their classrooms. By and large, the current cadre of ASTRO 101 teachers fully understand the value and importance of having a wide diversity of students who understand and contribute to the scientific enterprise; yet, few professors have had the opportunity to learn how to best teach the quickly broadening range of contemporary student audiences in multi-cultural classrooms. This presentation serves as a first-steps departure point for faculty interested in improving teaching to diverse student bodies. Strategies highlighted include negotiated syllabi, structured collaborative learning, mini-debates, and backwards faded scaffolding, among others. The talk surveys the current landscape of interactive teaching methods, as well as the barriers to be overcome, when effectively teaching and providing inquiry experiences specifically designed to engage all students.

* Resources available online at URL: http://www.caperteam.com. Work supported in part by the Wyoming Excellence in Higher Education Endowment, NASA NNH11ZDA001N-EPOESS, NSF OEDG 1108238 & NSF TUES 1044482.
**Sponsor: Tim Slater

BF02: 4-4:30 p.m. Learning Critical Thinking Through Astronomy*

Invited – Joe Heafner, Catawba Valley Community College, Hickory, NC 28602; heafnerj@sticksandshadows.com

Learning Critical Thinking Through Astronomy is a project intended to teach astronomy upon a foundation of critical thinking. Formal reasoning must be explicitly taught, much like skills that must be taught first in instrumental music. Too often, we who teach science fail to teach the fundamental skills we tacitly assume students already have. LCTTA attempts to address through inquiry in critical thinking first, and then application of critical thinking to astronomy. This talk will summarize the project and its approach.

*The LCTTA website is www.sticksandshadows.com/lctta/lctta.html with free materials available.

BF03: 4:30-4:40 p.m. Using Virtual Planetarium Programs for Online Lab Instruction

Contributed – Gregory L. Dolise, Harrisburg Area Community College, Harrisburg, PA 17112; gldolise@hacc.edu

The use of virtual planetarium software to reinforce basic concepts and combat misconceptions will be discussed. Programs such as The Sky or Starry Night are frequently packaged with textbooks, and freeware programs are widely available, enabling all students to experiment firsthand with celestial motions. Students can experience how planets move in relation to stars, why retrograde motion occurs, how stellar altitude varies with latitude, and a wide range of other activities. Misconceptions about astrology and horoscopes are quickly put to rest by examining the Sun's true position along the zodiac. All of these activities are currently being employed by the author in online planetary and stellar astronomy courses.

BF04: 4:40-4:50 p.m. Improving Student Understanding of Astrophysics Concepts

Contributed – Heather A. Rave, Rutgers University, New Brunswick, NJ 08901; heather.rave@gmail.com

Eric Gawiser, Saurabh Jha, Eugenia Etkina, Rutgers University

As part of an effort to improve students' learning of astrophysical phenomena, we are investigating strategies to improve students' conceptual understanding in the undergraduate Astrophysics classroom: Physics 342 Principles of Astrophysics. Although students used to do well on quantitative problems, their performance on conceptual quizzes was lacking. In an attempt to improve student conceptual understanding, we made changes to the course in the spring of 2012. We added conceptual questions to the student's homework problem sets and expanded in-class conceptual questions. We collected student homework assignments and student work on a midterm conceptual quiz. The findings of this preliminary research project will be used as a guide for the development of the Physics 341 and Physics 342 Principles of Astrophysics courses. We will present a brief overview of the project, with special attention to the findings that emerged.

BF05: 4:50-5 p.m. High School Heliophysics Research Using Online Resources

Contributed – Tiffany Coke, Punahou School, Honolulu, HI 96822; tcoke@punahou.edu*

Kathryn Whitman, Institute for Astronomy, University of Hawaii at Manoa

Do sunspots appear in patterns? How can we find out? Using available resources from NOAA, high school students will determine for themselves the 11-year sunspot cycle. What can sunspots tell us about the rotation rate of the Sun? Using the free application JHelioviewer downloaded from the Internet, students will plot sunspots over time both near the center of the Sun and also near the poles to determine the differential rotational period. The focus of this 60-90 minute activity is to allow students the opportunity to see how many valid sources of scientific data are readily available online, and also to use data to confirm unexpected outcomes.

*Sponsored by the Institute for Astronomy Heliophysics group, Mary Kadooka

BF06: 5-5:10 p.m. Astronomy Demos for College Students to Do

Contributed – Mary Lou West, Montclair State University, Montclair, NJ 07043; westm@mail.montclair.edu

Lecture demonstrations are powerful, especially when done by students who rehearse from scripts the week before. Later, on tests, they explain another's demo with enthusiasm. Most of these demos are classics, but the student scripts are new. Solar system demos: Sundial Types, Analemma, Retrograde Motion, Blue Sky, Foucault Pendulum, Radioactive Half-life, Moon Figures, Jack and Jill, Lunar Phases, Eclipse Geometry, Impact Craters, Conic Sections, Mars Rovers, Spin Oblateness, Titius-Bode's Rule, Scale Models, Warped Space Orbits, Make a Comet, Sun's Diameter, Sun's Magnetic Field, Photon Random Walk, Sunspotter Sunspots, and Sunspot Brightness. Stellar Demos: Reading Star Charts, Twinkling, Parallax, Counting Stars, Star Temperatures/Colors, Emission Line Spectra (spiral fluorescents), Binary Systems, Astroblaster Supernova, Pulsar Models, Ultraviolet Supernova Colors, Filters for Supernova Remnants, Milky Way Model, Angle of Solar System, Galactic Velocity Curve, Hubble Atlas, Galaxy Collisions, Age of the Universe, Center of the Universe, Expansion of Space, and Cosmic Timeline.

BF07: 5:10-5:20 p.m. Astronomy Course for Non-Science Majors and Amateur Astronomy Society Partnership

Contributed – Judith Parker, Muhlenberg College, Allentown, PA 18104; jparker@muhlenberg.edu

Muhlenberg College, a liberal arts college in Allentown, PA, is located about 15 minutes drive from the site of the Lehigh Valley Amateur Astronomical Society (LVAAS). This presentation will detail two activities that have resulted from the partnership of these two organizations to benefit all students on campus and provide non-major astronomy students the opportunity to do research at the LVAAS site as an option for meeting their course requirements. The on-campus star party began as a year of astronomy event in 2009 and has been repeated each semester since. Over 90 students participated in spring, 2012 (24 students were taking astronomy that semester). Astronomy students study spectra and do a computer simulation lab as an integral part of the course. Interested students have the opportunity to use the LVAAS telescopes and spectrometer and actually take the spectra of visible stars, planets, and nebula for spectral analysis.

BF08: 5:20-5:30 p.m. Introductory Astronomy Essays on Transits, Eclipses and Occultations

Contributed – Noella D'Cruz, Department of Natural Sciences, Joliet Junior College, Joliet, IL 60431; ndcruz@jjc.edu

Joliet Junior College, Joliet, IL, offers a one-semester introductory astronomy course each semester. We teach over 110 primarily non-science major students each semester. We use proven active learning strategies such as lecture tutorials, think-pair-share questions and small group discussions to help these students develop and retain a good understanding of astrophysical concepts. Occasionally, we offer projects that allow students to explore course topics beyond the classroom. We hope that such projects will increase students' interest in astronomy. We also hope that these assignments will help students to improve their critical thinking and writing skills. In spring '12, we are offering three short individual essay assignments in our face-to-face sections. The essays focus on transits, eclipses and occultations to highlight the 2012 transit of Venus. Details of the essay assignments and students' reactions to them will be presented at the meeting.

Session BG: PER Around the World

Location: CCH - Claudia Cohen Terrace
Sponsor: Committee on International Physics Education
Co-Sponsor: Committee on Research in Physics Education
Date: Monday, July 30
Time: 3:30–5:10 p.m.

Presider: Genaro Zavala

This is an invited and contributed session designed for reports from groups around the world working on Physics Education Research. We include research approaches, perspectives, and results in different countries; successes and challenges of this area of research around the world; and the effect of the structure of different school systems on research on physics education.

BG01: 3:30-4 p.m. Research Communities on Education in an Engineering School in Chile*

Invited – Hugo Alarcon, Universidad Tecnica Federico, Santa Maria Av. Espana 1680, Valparaiso, 2340000 Chile; hugo.alarcon@usm.cl

Arie Aizman, Universidad Tecnica Federico Santa Maria

The Universidad Tecnica Federico Santa Maria is a well-known Chilean institution focused on educating engineers. It has no school in Science Education nor in Engineering Education. In recent years there have been various initiatives by professors to implement methodologies that promote active learning in the classroom and incorporate the use of information and communication technologies to support teaching and learning processes. In general, these innovations have been carried out without performing research in education to assess progress. Thus the university, with government support, has created a research center focused on education in engineering and science, which has taken some ideas from the discipline of Physics Education Research. In this talk we will show the strategy used to motivate professors to initiate educational research projects and the progress of the first seven research communities on education created since 2011.

*This work has been supported by the Government of Chile through the grant MECESUP FSM-0802.

BG02: 4-4:30 p.m. Development of Meaningful Learning Through Active Learning and Video Analysis*

Invited – Omar Olmos, López Instituto Tecnológico y de Estudios Superiores de Monterrey, Eduardo Monroy, cárdenas 2000 Toluca, México; oolmos@itesm.mx

PDSM (progressive development of skills methodology) is a methodology for the development of general skills for learning physics. Using a process of progressive development skills, we show how active learning and video physics analysis generate learning experiences that allow us to develop general and disciplinary skills. Using a gradual process, deep learning is gained through the process of cognitive construction of John Biggs. Interactive activities allow students to understand and associate the fundamental phenomena that subsequently lead to understanding more complex concepts. Results of learning in undergraduate courses are shown.

*Project supported by the ITESM Campus Toluca.

BG03: 4:30-4:40 p.m. Promoting High-Level Cognitive Activity in Student-Generated Content

Contributed – Ross K. Galloway, University of Edinburgh, School of Physics

and Astronomy, James Clerk Maxwell Building, Edinburgh, EH9 3JZ, United Kingdom; ross.galloway@ed.ac.uk

Simon P. Bates,University of Edinburgh

Morag M. Casey, University of Glasgow

Student-generated content — for example, student-authored course questions—is increasingly being used to promote engagement and learning in undergraduate courses. Given the relative rarity of such tasks in the previous educational experience of typical students, a natural question is: what kinds of questions do the students create? It is possible to broadly classify student output according to the cognitive domains of Bloom's taxonomy. Previous work has suggested that the vast majority of student authored questions fall into the lowest levels of Bloom's taxonomy, i.e. simple recall or comprehension. We report on a series of student-question authoring tasks set to our first-year undergraduate physics classes using the PeerWise online system. We find that the majority of our student contributions fall into the higher levels of Bloom's taxonomy, i.e. application, analysis, and some featuring very high-level cognitive tasks such as synthesis. We suggest techniques for promoting such high-level engagement.

BG04: 4:40-4:50 p.m. A Two-Institution Replication Study of Peer Learning and Collaboration

Contributed – Morag Casey, University of Glasgow, University Avenue Glasgow, G12 8QQ United Kingdom; Morag.Casey@glasgow.ac.uk

Simon Bates University of British Columbia

Ross Galloway University of Edinburgh

We present two major results from a comparative study[1] of the implementation of PeerWise[2] as an online tool for student-led (and instructor-free) learning in undergraduate physics. In 2010-11, we piloted PeerWise with the level-1 physics class at the University of Edinburgh[3] and found a high quality of submissions as well as a positive correlation between student activity and end-of-course examination score; we undertook a similar study during the 2011-12 academic session, finding similar results. In 2011-12 we also successfully implemented PeerWise at level-2 physics in the University of Glasgow and found similar levels of engagement, quality of submissions, and positive correlations between student activity and academic gain. We suggest, therefore, a model for high-impact student-learning and conceptual gain with minimal instructor intervention required.

1. https://www.wiki.ed.ac.uk/display/SGC4L/Home
2. http://peerwise.cs.auckland.ac.nz/
3. http://proceedings.aip.org/resource/2/apcpcs/1413/1/123_1

BG05: 4:50-5 p.m. Collaborative Learning, Enquire-based Laboratory, PER, and Paulo Freire's pedagogy

Contributed – Arnaldo M. Vaz, Universidade Federal de Minas Gerais, Colégio Técnico Av., Antonio Carlos, 6627 Belo Horizonte, MG 31.270-901, Brazil; arnaldovaz@ufmg.br

Members of the PER group at Colegio Tecnico UFMG (Belo Horizonte, Brazil) are practicing high school physics teachers who are yet to have professor status. In this university laboratory for pedagogical innovation, we design, adapt, and use research-oriented teaching strategies, materials, and assessment. We also do scholarly research, supervise grad students, conduct governmental education consultancy, and run the science-teacher development center. Our research is based on multiple theoretical-methodological perspectives: Donald Schön, Lee Shulman, Raewyn Connell, Pichon Rivière, Wilfred Bion, Ross Buck, Lev Vygotsky, Mikhail Bahktin. The approaches include individual students' decision making or engagement (behavioral-affective-cognitive), as well as collaborative learning. That results in knowledge about engagement dependence from group, socio-cultural and expectation factors. Present research interests result from above-described milieu. School-work gives us insights about Paulo Freire and John Dewey. Which inspires new deliberations, which has led us to see new problems worth investigating. In sum, we enact Joseph Schwab's type of curriculum research.

BG08: 5-5:10 p.m. Performance Gender Gap in Undergraduate Physics from a UK Context

Contributed – Robyn C. Donnelly, School of Physics and Astronomy, University of Edinburgh, James Clerk Maxwell Building, Edinburgh, EH9 3JZ United Kingdom R.C.A.; Donnelly@sms.ed.ac.uk

Simon P. Bates, Cait MacPhee, University of Edinburgh

This study explores the existence and degree of gender disparity in student performance in physics courses at the University of Edinburgh between 2006-2012. We have used pre- and post-instruction implementation of the Force Concept Inventory to identify the presence of a significant performance gender gap in our introductory physics course, which is taught in an interactive engagement style. Data will be presented indicating that this significant gender discrepancy persists after one semester of teaching although the gap is narrowed. In addition to standardized tests, a gender analysis was carried out of students' performance on both continuous assessment and end-of-course examinations in several years of the undergraduate programme to investigate the possibility of gender dependence on type of assessment. Preliminary results suggest female students consistently outperform males on coursework elements while the pattern is less clear when considering examination results.

Session BH: Continuing Teacher Preparation: Inservice Professional Development

Location: Sheraton - Ben Franklin IV
Sponsor: Committee on Teacher Preparation
Date: Monday, July 30
Time: 3:30–5:30 p.m.

Presider: Steven Maier

Whether or not one's initial physics teacher preparation was completed through an accredited undergraduate program, a graduate degree or by non-traditional means, in-service physics teachers often need continuing professional development. The goal of this session is to let those involved in physics professional development programs tell their "stories" and share the successes, benefits, and perhaps challenges of their efforts.

BH01: 3:30-4 p.m. AAPT/PTRA – Part of the Solution

Invited – Jim Nelson, 6871 SW 89th Way, Gainesville, FL 32608; nelsonjh@ix.netcom.com

With the help of National Science Foundation (NSF) and the American Physical Society (APS), the American Association of Physics Teachers (AAPT) has developed the Physics Teaching Resource Agent (PTRA) model for successful physical science and physics teacher inservice professional development. This model includes development of peer mentors, systemic infrastructure, assessment instruments, and a curriculum based on experienced mentors and physics education research. The AAPT/PTRA curriculum is supported by a series of AAPT/PTRA Teacher Resource Guides. These guides serve not only as a personal resource for the teacher's professional development, but also are appropriate for teachers' continued use in their classrooms. The talk will discuss the unique features of the AAPT/PTRA Program, and outline how your university can form a partnership with AAPT to support teachers in your local area.

BH03: 4-4:30 p.m. Supporting the STEM Initiative in Oklahoma Through Statewide Effective Physics and Physical Science PD

Invited – Saeed Sarani, Oklahoma State Regents for Higher Education, Oklahoma City, OK 73104; ssarani@osrhe.edu*

When viewed from the perspective of an entire state's needs, the challenges of designing effective professional development programs to meet the state and federal requirements are daunting. In Oklahoma, the concerns about delivering effective professional development programs to rural and urban populations which contain a variety of underserved populations are further complicated by the differences in the way sciences are structured as different disciplines. In my presentation, I will describe a science model program specifically designed for physics and physical science teachers in rural

Oklahoma. The program has three common elements that make it highly successful: 1) Program fully engages teachers through inquiry-based and effective teaching and learning in classroom approaches, 2) Program seeks to change learning by impacting teachers' pedagogical content knowledge, and 3) Program strives to establish a productive network among participants. Additionally, the program's long-term goal is to establish a statewide infrastructure to meet the needs for critical shortages of physics and physical science teachers through effective and sustainable professional development in Oklahoma.

*Sponsor: Steven J. Maier

BH04: 4:30-4:40 p.m. Western New York Physics Teachers Alliance (WNYPTA) Professional Development Model

Contributed – Kathleen A. Falconer, SUNY Buffalo State College, Buffalo, NY 14222; falconka@buffalostate.edu

Joseph L. Zawicki, David Henry, Dan MacIsaac David Abbott, SUNY Buffalo State College

The Western New York Physics Teachers Alliance (WNYPTA) is a model of professional development originally developed upon the model used for the New York State Mentor Networks. The initial statewide networks were grant-funded and supported a network of physics teachers throughout New York State. The WNYPTA has developed into a learning community including university faculty from both education and physics, local high school teachers, pre-service physics teachers and in-service graduate students. The program meets once a month on Saturday morning during the school year, with the meeting agendas collaboratively developed by the participants. Presenters include university faculty, in-service teachers and graduate students, and pre-service teacher candidates. The program is largely self-sustaining with minimal support from the university physics department and other sources.

BH05: 4:40-4:50 p.m. Physical Science Pontotoc County: Four Years After

Contributed – Karen A. Williams, East Central University, Ada, OK 74820; kwillims@ecok.edu

This paper will examine how the public school teachers that took the Physical Science Pontotoc County PHYS/EDUC 5982 Seminar in the summer of 2008 are doing now four years later. Have the teachers implemented any of the labs in their classrooms? If the teachers have implemented some of the labs, how many of them? If yes, do they have their students do the labs on regular basis every year? Were the labs a success in the classroom? We will attempt to track down all the teachers involved in the two-week-long summer workshop to check on how they have applied the physics concepts in their classrooms since our seminar. The findings of this study should help future workshops better plan for greater implementation of physics topics in the upper elementary and middle school classrooms.

BH06: 4:50-5 p.m. Boston University's PhysTEC Teacher-in-Residence – A Year in Review

Contributed – Juliet B. Jenkins, Boston University, Boston, MA 02215; julietbj@bu.edu

In 2011, Boston University (BU) was awarded a grant from the Physics Teacher Education Coalition (PhysTEC) that primarily funds a high school Teacher-in-Residence. I am the first Teacher-in-Residence, with a primary focus of getting our large urban campus to learn about our invigorated efforts in secondary school physics teacher preparation. Key to this effort is 1) Active recruiting; 2) Providing early teaching experiences; 3) Pedagogical content knowledge; and 4) Learning Assistants. I will highlight my contributions in these areas in my year at Boston University -- identifying, encouraging and mentoring prospective high school physics teachers as well as working closely with physics department faculty and teaching fellows to incorporate research-based teaching methods. I will comment on the growth of BU's existing collaborations between the physics department, the School of Education, as well as the collaborations between the PhysTEC program and the area in-service high school physics teachers.

Session BI: What Works in the Pre-College Classroom

Location: Irvine Auditorium - Amado Recital Hall
Sponsor: Committee on Physics in Pre-High School Education
Date: Monday, July 30
Time: 3:30–5:30 p.m.

Presider: Dale Freeland

What is working in the pre-college classroom? This session will highlight successes that could include new programs, technology usage, mentoring relationships, or use of traditional physics with emphasis on student centered applications.

BI01: 3:30-4 p.m. An Inquiry into What Works in the Pre-College Classroom*

Invited – Richard Steinberg, City College of New York, New York, NY 10031; steinberg@ccny.cuny.edu

To compliment experiences as a college faculty member conducting research into student and teacher learning at the college level, I spent a year as a full time science teacher in an inner city public high school. I was empowered with knowledge of Physics Education Research, well-designed curricula shown to be effective, formal teacher education training, countless hours in high school classrooms, and cultural roots in New York City. Within one day I knew I was overmatched. In this presentation, I will share some of the challenges I encountered and some of what I learned about what works in this environment.

* This work was supported in part by the National Science Foundation

BI02: 4-4:30 p.m. Engaging Activities for Students in Pre-College Classroom

Invited – Duane B. Merrell, Brigham Young University, Provo, UT 84602; duane_merrell@byu.edu

When I started teaching high school in a small rural school, the physics enrollment was 16 students, with only two of those 16 being female. During the next several years the enrollment grew to seven periods of physics and half of the enrollment was female. One year at graduation as I counted the students that I had taught physics I realized that 70% of the graduating class had taken physics during their high school time. I will outline the things we did to make physics in a rural high school grow and the curriculum programs that were used to support physics students. Things like projects, activities, labs—the whole effort that was made will be shared.

BI03: 4:30-5 p.m. What Works in the Pre-College Classroom

Invited – Christina Magee, 917 C St., Rockford, IL 61107; christina.magee@gmail.com

Discover ways to bring physics concepts come alive for middle school students through underwater remotely operated vehicles, wind turbines, Lego robots and model rockets. Learn more about a newly created program called Pathways for Technical Careers Academy that enriches the learning of middle school students interested in pursuing careers in engineering and manufacturing. These activities have all been successfully completed in an urban middle school setting.

BI04: 5-5:10 p.m. Using PhET Simulations in the Middle School Classroom

Contributed – Ariel J. Paul, PhET, University of Colorado, Boulder, CO 80301; ariel.paul@colorado.edu

Noah Podolefsky, Emily Moore, Katherine Perkins PhET

Initially, the PhET project developed simulations (sims) for high school and college level students, but more recently, we have begun designing and revising sims targeted at middle school students. Our sims provide students with an intuitive and game-like environment which allows for productive scientist-like exploration, rich visualizations, and rapid inquiry cycles. Along with our new design effort, PhET researchers have collaborated with middle school teachers to investigate the effective implementation of sims in a classroom environment. This collaboration currently includes the joint development of 14 activities and video-taped observations of their classroom implementation. Informed by this observation data, we have developed a set of strategies for designing and facilitating student-centered sim activities for the classroom. These strategies span activity scope, structures, pacing, and effective prompts. We will present the broad goals of these activities, our suggested strategies, specific examples, and evidence of their effectiveness.

BI05: 5:10-5:20 p.m. Broadening the Meaning of Progress in Elementary Science

Contributed – Jennifer A. Radoff, Tufts University, Department of Education, Medford, MA 02155; Jennifer.Radoff@tufts.edu*

David Hammer,Tufts University

We argue that progress in learning physics should be understood to encompass more than conceptual gains. In particular, it involves the ways in which students come to understand the disciplinary practices that have emerged within the classroom community. Part of becoming a better science learner involves understanding what it means to be engaged in science within the classroom. This kind of progress cannot be marked by how well students' conceptions come to align with the canon. Rather, we must evaluate this progress by considering the ways students come to participate within the complex and dynamic activity of a classroom. We present analyses of a third grade class's discussions about motion as evidence of this aspect of progress.

*Sponsor: David Hammer

BI06: 5:20-5:30 p.m. Modeling a Magnetic Biosensor*

Contributed – Elena K. Cox, Chamblee High School, Chamblee, GA 30341; elenacox@bellsouth.net

The magnetism unit was presented in a secondary science classroom using a model of a microelectronic magnetic bacterial sensor. The miniaturized bacterial sensor, based upon magnetic properties of nanobeads, was manufactured on a silicon wafer in the Clean Room at the Microelectronics Research Center at Georgia Institute of Technology. The magnetic nanobeads are coated with ligands capable of interacting with specific bacterial cells. When placed in a magnetic field, the nanobeads spin and rotate around the Fe-Ni pins on the wafer trapping the bacteria from a solution. Student hands-on experiments were designed to model the magnetic biosensor.

*Noyce program in physics, chemistry, and mathematics. A collaboration of Kennesaw State University and Georgia Institute of Technology.

Session BJ: Introductory Labs/ Apparatus

Location: Houston Hall - Golkin
Date: Monday, July 30
Time: 3:30–5:30 p.m.

Presider: David Sturm

BJ01: 3:30-3:40 p.m. Cell Dynamics for Freshmen

Contributed – Mark E. Reeves, George Washington University, Washington, DC 20052; reevesme@gwu.edu

Robert Donaldson, Rahul Simha, George Washington University

In our introductory physics class, we have replaced much of the classic content on two-particle, loss-free interactions with curriculum and labs that address viscosity and loss. These culminate in problems and hands-on material where the students study the motion of paramecia and bacteria and analyze the dynamics of propulsion in a viscous medium. Much of the work is with student-made videos in which dynamics data are extracted using frame-by-frame tracking in LoggerPro software, and from these data and a model designed to extract the propulsion force from the terminal velocity, the students infer details about molecular motors and diffusive and driven transport in cells. These labs have been created as part of a course in introductory physics with a biological emphasis, and respond to a growing need to train premedical students to think across disciplinary boundaries, and to learn to apply the laws of physics to understand and model biological phenomena.

BJ02: 3:40-3:50 p.m. Designing for Change: Reform in a Lower-Division E&M Lab

Contributed – May Lee, University of Colorado, Boulder, CO 80504; maydayz@gmail.com

Steven Pollock, University of Colorado at Boulder

At the University of Colorado at Boulder, we transformed a single introductory algebra-based lab on electric potentials from a lab of verification to a lab of discovery and inquiry. In this transformation, we drew our initial ideas from an inquiry-based activity grounded in research-based practices. We also took into consideration constraints in the implementation of this reform, which included: continuity with course and departmental expectations, adequacy in the breadth and depth of content covered, cost and maintenance of equipment, and concerns for teaching assistants and other instructors to enact the reform without too much additional guidance. We discuss our processes in addressing these constraints and present some preliminary results and feedback from our first implementation of the transformed lab with respect to its impact in helping students create a framework to better understand how different concepts in electricity are related to each other.

BJ03: 3:50-4 p.m. An Introductory Circuits Lab in Bioelectrical Impedance Analysis

Contributed – Elliot E. Mylott, Portland State University, Portland, OR 97207-0751; emylott@pdx.edu

Sabrina Hoffman, Ralf Widenhorn, Portland State University

We will present a laboratory exercise that highlights the applicability of physics concepts in medicine, specifically in the use of RC circuits in bioelectrical impedance analysis (BIA). This is a popular method to analyze body composition by measuring body impedance. Students will be introduced to concepts in RC circuits such as phasor diagrams and impedance, as well as electrical characteristics of cells, which can be modeled with resistors and capacitors. Equipment used for this lab can generally be found in most teaching labs. This lab and other activities we have developed show students the connections between the life sciences and physics.

BJ04: 4-4:10 p.m. Determination of Electrical Resistivity of Water: An Introductory Lab Experiment

Contributed – A. James Mallmann, Milwaukee School of Engineering, Milwaukee, WI 53202-3109; mallmann@msoe.edu

An experiment to determine the electrical resistivity of water will be described. The resistivity can be determined by graphical analysis of data that can be obtained using simple apparatus available in a typical undergraduate laboratory.

BJ05: 4:10-4:20 p.m. Flexible Physics: A Multimedia Bridge from Lecture to Lab*

Contributed – Duncan Carlsmith, University of Wisconsin, Madison, WI 53711; duncan@hep.wisc.edu

The Flexible Physics Project at the University of Wisconsin-Madison has created a library of short multimedia educational objects to prepare university undergraduates for introductory physics laboratory experiences. Integrating still photographs, video, and audio using Flash, each object reviews important principles, describes the goals of the lab, and provides a brief tour of the experiment. Best practices related to the production of these materials will be described.

*See website flexible.physics.wisc.edu.

BJ06: 4:20-4:30 p.m. Portable Labs and Online TAs in Introductory Physics

Contributed – William R. Sams, North Carolina State University, Raleigh, NC 27604; wrsams@ncsu.edu*

Michael Paesler, Clifford E. Chafin, North Carolina State University

We are developing teaching laboratories for introductory mechanics courses involving portable equipment kits used extramurally in lieu of traditional laboratory rooms. These kitlabs are scheduled during regular lab times and are monitored by TAs through electronic conferencing software. In this manner, student groups have the same tasks, goals, and supervision as a standard lab, but without the need to be in the laboratory room. Students use their own technology (laptops or smartphones) for data collection rather than unfamiliar probes and data loggers. Initiated to address the strain on existing lab facilities of rapidly growing enrollment in introductory courses, the project has a number of applications. These could include distance and virtual courses, high schools, and institutions that may not have access to traditional laboratory rooms. I will present the motivation, initial development, and implementation of the project, as well as recent revisions and prospects for the future.

*Sponsor: Robert Beichner

BJ07: 4:30-4:40 p.m. Reformation of Physics Lab Manual for Life-Science Students at USM

Contributed – Bharath K. Kandula, The University of Southern Mississippi, Hattiesburg, MS 39406 bharath.phy@gmail.com

Hiro Shimoyama, The University of Southern Mississippi

As one of the project members, I contributed to it and observed the change in students' understanding and attitudes after using the new type of physics lab manual. Our result indicates that students and even teachers learn through the new lab manual. There are several factors that affect effective understanding in physics lab, such as the lab manual, the equipment, teacher's scientific pedagogy, students' inquisitive mind, students' background, etc. Especially for life-science majors, teaching physics requires a better guide or manual and extra supports which include personal attention and interactive questioning with instructors. From our observations of last year, we have concluded that the new lab manual has improved students' understanding in the concepts of Newton's laws, torques, conservation of momentum, moment of inertia, etc. This scheme also gives us the future work toward demonstrations using diagrams and providing software.

BJ08: 4:40-4:50 p.m. Reforming the Introductory Physics Laboratory to Impact Scientific Reasoning Abilities*

*Contributed – Carol Fabby,** University of Cincinnati, Cincinnati, OH 45221-0011; fabbyc@mail.uc.edu*

Kathleen Koenig, University of Cincinnati

Lei Bao, The Ohio State University

Research indicates that students enter college with wide variations in scientific reasoning abilities, and it also suggests that students with formal reasoning patterns are more proficient learners. Unfortunately, these abilities are not impacted in the typical college course. In an effort to better target the development of scientific reasoning abilities of students in our introductory physics lab courses, we have revised the structure of the lab activities while maintaining the same topics and equipment we have been using for years in a more traditional lab setting. The changes enable students to become more involved in the actual design of the experiments and place more emphasis on student use of evidence-based reasoning. The challenges in implementing these curricular adjustments with large enrollments of 700 or more students will be addressed in addition to the impact the changes have had on student development of scientific reasoning abilities.

*This work is partially supported by the National Institutes of Health 1RC1RR028402-01

**Sponsor: Kathleen Koenig

BJ09: 4:50-5 p.m. Remote-Controlled Online Physics Labs

Contributed – Todd G. Ruskell, Colorado School of Mines, Golden, CO 80004; truskell@mines.edu

Daniel Brannan, Rhonda Epper, Colorado Community College System

Patricia Shea, Western Interstate Commission for Higher Education

Introductory physics courses taught online are regularly offered by many institutions. While content delivery is now relatively straightforward, the laboratory component of these courses provides many challenges. Two common ways to deliver the laboratory component are to have students purchase lab kits that enable them to perform experiments at home, or to have students take the laboratory component in residence. The North American Network of Science Labs Online (NANSLO) project has developed a relatively new alternative to these methods. We have developed several introductory physics laboratory experiments that students control remotely via a web-based interface. We report on the results of the first implementation of these laboratories used by students enrolled in introductory physics taken through Colorado Community Colleges Online.

BJ10: 5-5:10 p.m. Incorporation of Hands-on Learning into Online Introductory Instruction

Contributed – Katie Crimmins, University of Illinois at Urbana-Champaign, Urbana, IL 61801; crimmin1@illinois.edu

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

Recent work in our group has yielded a small, inexpensive device—the IOLab system —which can measure various physical quantities including displacement, acceleration, magnetic field, and voltage and display real-time results on a computer screen. The portability of the IOLab system and the prevalence of personal computers make it possible for students to perform hands-on activities outside of the formal laboratory classroom setting. We have investigated the use of this system as an aid to initial learning in the context of online instruction. In our study, undergraduate physics students viewed a multimedia presentation about Faraday's law and subsequently explored the topic further using computer-guided independent hands-on activities involving simultaneous measurements of magnetic field and voltage. Students responded positively to this supplementary instruction, both in attitude and in improved initial understanding.

BJ11: 5:10-5:20 p.m. Experimental Demonstration Using a Blowgun for Introducing Dynamics

Contributed – Koji Tsukamoto, Kashiwa Minami High School, Kashiwa City, Chiba 277-0033 JAPAN; fumanchu@auone.jp

Kiyonobu Itakura

In many Asian countries, the "blowgun" has been commonly used for hunting or has been played with by children since ancient times. We have devised an efficient way to introduce dynamics with a blowgun demonstration experiment.[1] This demonstration is effective for introducing a relationship between force and its effect because the procedure is simple and the results can be seen clearly without measurement. At this presentation, we will conduct the demonstration in front of the audience, and also show the results of the measurement. The results and analyses of the measurement will be shown at our poster presentation, "Analyses of The Blowgun Demonstration Experiment."

1. K. Tsukamoto, M. Kano, and K. Itakura, "Mechanics Demonstrated with the Use of Darts," *International Newsletter on Physics Education* (International Commission on Physics Education) No.**44**, pp. 7-10 (2002)

BJ12: 5:20-5:30 p.m. Rolling Demonstrations

Contributed – Jeffrey M. Wetherhold, 33 N. 17th St., Allentown, PA 18104; wetherholdj@parklandsd.org

Teaching about rolling motion can be a daunting task, especially when it comes to demonstrating the direction of the frictional force. To me, the friction force has always been a somewhat unwelcome and mysterious guest in my classroom. Unwelcome, in that I often minimized it and mysterious, in that I always had trouble understanding and demonstrating its direction in a concrete way. Recently I designed several demonstrations that changed all that for me and my physics students. It is still somewhat unwelcome in my classroom, but its aura of mystery has diminished.

Session CA: Can Computational Modeling be Accessible to Introductory Students?

Location: Sheraton - Ben Franklin Ballroom I
Sponsor: Committee on Educational Technologies
Date: Monday, July 30
Time: 7–8:30 p.m.

Presider: John Burk

Modern programming tools allow even the youngest physics students (grades 6-12) to create and modify computational models to explore real-world scenarios. In this invited/contributed session, we will discuss the use of computational modeling environments at these levels including challenges and limitations, the development of a support community for teachers interested in using these computational tools, and the future work for this community.

CA01: 7-7:30 p.m. Computational Thinking Resources and Implementation Strategies for Classrooms

Invited – Phil Wagner, Google, 1600 Amphitheater Parkway, Mountain View, CA 94043; pwagner@google.com

Computational Thinking is an excellent way for teachers and students to discover how they can apply principles of Computer Science to their own domains. Using free resources and tools, classrooms can start developing models to test physics concepts and deepen their understanding. Students break down problems, look for patterns, abstract ideas, and develop algorithms much like they do in the scientific method but with modern tools students ability to test and experiment is greatly enhanced.

CA02: 7:30-8 p.m. Computational Modeling with High School Seniors

Invited – Mark S. Hammond, St. Andrew's School, Middletown, DE 19709; mhammond@standrews-de.org

At St. Andrew's School, students take a first-year physics course based on Modeling Instruction. Interested students continue taking physics in a second year, calculus-based course. We teach computational physics as a part of this second-year course using the VPython programming language in conjunction with the Matter and Interactions curriculum of Chabay and Sherwood. Students begin learning VPython on their own before school starts using several tutorials and Internet resources. The addition of a computational component to the second year physics course serves several purposes. First, it allows the students to explore more realistic problems in greater detail, thus enlivening the curriculum. Second, it introduces them to an alternate approach to problem-solving. We have found that thinking computationally improves student understanding of calculus and its application to the physical world in a way that traditional problem sets fail to do.

CA03: 8-8:10 p.m. Prediction Tasks in Computational Activities for Introductory Calculus-based Physics

Contributed – Shawn A. Weatherford, Saint Leo University, Saint Leo, FL 33574; shawn.weatherford@saintleo.edu

Ruth Chabay, North Carolina State University

Computational modeling in the Matter & Interactions curriculum for calculus-based introductory physics promotes the tenets of the curriculum: mainly, the deterministic view of classical mechanics using a small set of fundamental physics principles. New activities introduced with the third edition of the text ask students to read for comprehension an example program that strategically omits key physics principles and asks students to make predictions of the visual output based on their understanding of the program code. We'll present how students approached these new activities and the lessons learned from their implementation out in the wild.

CA04: 8:10-8:20 p.m. Why Use Computational Modeling in the Introductory Physics Course?

Contributed – Brandon R. Lunk, NCSU Department of Physics, Raleigh, NC 27695; brlunk@ncsu.edu

Computational modeling is a central enterprise in both theoretical and experimental physics but it can also be an excellent tool to help students in the introductory courses develop a deeper conceptual understanding of fundamental physics principles. Many instructional benefits are associated with computational modeling, including visualizing 3D phenomena, modeling complex, real-world systems, and reasoning algorithmically. In this talk, I will discuss many of the benefits associated with introducing computational modeling to introductory physics students.

CA05: 8:20-8:30 p.m. Reflections on Computational Modeling in the Undergraduate Physics Curriculum

Contributed – Michael F. Vineyard, Union College, Schenectady, NY 12308; vineyarm@union.edu

For many years I have been introducing computational components into many of my undergraduate physics courses. This includes the use of LabVIEW for virtual instrumentation in introductory and upper-level laboratories, Spice for circuit simulation in electronics, Mathematica in mechanics and quantum mechanics, and VPython in introductory courses. It has been my experience that while some students readily embrace these computational tools, many do not and some even fear and loath them. In this talk I will describe how I use these computational tools in my courses and discuss strategies to try to overcome the fear and loathing.

Session CB: Labs at Many Levels

Location: Sheraton - Ben Franklin Ballroom II
Sponsor: Committee on Physics in Pre-High School Education
Co-Sponsor: Committee on Teacher Preparation
Date: Monday, July 30
Time: 7–8:30 p.m.

Presider: Duane Merrell

A discussion of lab exercises that can be readily adapted for use at various curricular levels, including middle school. A few quick examples of things that can be used anywhere from middle school to Advanced lab include the pendulum (in various forms), the ballistic pendulum, granular materials, lenses and image formation, NanoTech, and examples of exponential growth and decay, such as population simulations and radiation/counting.

CB01: 7-7:30 p.m. Spiraling the Curriculum: Labs to Do at Many Levels

Invited – Paul J. Dolan, Jr., Northeastern Illinois University, Chicago, IL 60625; p-dolan@neiu.edu

The physics curriculum spirals across the various levels, in "theory" courses, with each student level addressing an increasingly sophisticated treatment of the physical situations. Physics being a lab science, this spiral curriculum can be used also in the lab; students then improve their understanding of the physical phenomena as they improve their mathematical sophistication and understanding of theory. With only minor modification of the equipment or the experimental approach, exercises that are currently used at the elementary or middle school, high school, introductory, or ?advanced levels can be used at other levels. Lab exercises that are successfully used at various levels will be presented and discussed. Some of the labs are: the pendulum (in various forms, simple-physical-coupled); sound and wave phenomena; the ballistic pendulum; the properties of granular materials; optics; lenses and image formation; NanoTech; and exponential growth and decay, such as populations and radiation/counting.

CB02: 7:30-8 p.m. Elementary Electronics: From Simple to Sophisticated Circuits

Invited – Steve Lindaas, Minnesota State University, Moorhead, MN 56563; lindaas@mnstate.edu

How do you light a bulb without wire? How many ways can you pick up a paperclip with a nail? This talk will present some open and guided-inquiry activities on electronics. These activities have been used successfully with students from second graders to electrical engineering majors. Each of these activities provides numerous extensions and both qualitative as well as quantitative experimental opportunities. As students increase their physics training, these activities can be modified to reinforce more sophisticated physical models. This session is appropriate for all levels -- from elementary to college educators -- and will provide a hands-on experience with parts of these activities. Come to this session to get energized and share your electronics experiences.

CB03: 8-8:30 p.m. Introductory Laboratory-Exploration Activities

Invited – Jim Hicks, 4701 Edgewood Rd., Crystal Lake, IL 60012; ujhicks@juno.com

A number of secondary school laboratory-explorations will be presented that encourages the discovery of basic principles of physics and mathematical formalization before class discussions. In addition, some of these laboratory assignments or explorations can be extended for advanced topics at the university level. The physics topics to be considered: Gauss' law, equipotential lines and surfaces for gravitational and electrostatic fields, Ampere's law, numerous relativity concepts, SHM, and more.

Session CC: Teaching Environmental Physics in the Undergraduate Curriculum

Location: Sheraton - Ben Franklin Ballroom III
Sponsor: Committee on Physics in Undergraduate Education
Date: Monday, July 30
Time: 7–8:30 p.m.

Presider: Juan Burciaga

CC01: 7-7:30 p.m. Integration of the Environment in the Physics Curriculum

Invited – Miron Kaufman, Cleveland State University, Cleveland, OH 44115; m.kaufman@csuohio.edu

I report on my decade-long experience with integrating in the undergraduate curriculum a course on the physics of the environment. This course provides a middle ground, for science and engineering students on one hand and urban studies, law and education students on the other hand, to learn cooperatively about global warming, urban heat island, heat pollution, radiation and health, and conventional versus nuclear energy. Computer modeling is used to enhance the students' understanding of the phenomena. The students are exposed to chaos theory by analyzing the period doubling route to chaos prevalent in population models. The diffusion of pollutants in the atmosphere and radioactive decay are taught through simulations. The course incorporates three modules: Thermodynamics, Electricity and Magnetism, and Nuclear Physics. For example during the Thermodynamics module we analyze heat pollution and the urban heat island effect. Global climate change is studied during the Electricity and Magnetism module.

CC02: 7:30-8 p.m. Science and Protecting the Environment – at Odds?

Invited – Gordon Aubrecht, Ohio State University at Marion, Marion, OH 43302; aubrecht@mps.ohio-state.edu

Physics is often called the queen of the sciences; science spawned technology, which many people see as antithetical to a "healthy" environment and as contributing to heedless exploitation of the natural world. There may be substance to this view, but physics in its emphasis on mechanism and insistence on data-driven decisions can provide a basis for rational environmentalism. Physics teachers naturally focus on reducing the "information deficit," lack of understanding of phenomena, but this, while necessary, is not sufficient. Knowledge of the nature of science and its understanding of knowing something, the tentativeness of that knowledge, the basics of modeling, and the actions taken based on the best experimental and theoretical understanding are proper issues underpinning informed action in complex systems.

CC03: 8-8:30 p.m. Incorporating the Energy Crisis into the Undergraduate Curriculum

Invited – Joshua A. Henry, Bates College, Lewiston, ME 04103; jhenry@bates.edu

On a percentage basis, the United States generates less renewable energy today than it did in 1950. This is an astonishing and somewhat depressing fact. How is it possible, that with all of our advances in technology over the past half century, we still generate most of our energy by combustion? Largely it is attributable to the high cost of renewable energy. The cost in turn is due to two factors that I would argue are heavily influenced by science education—the improper monetary valuation of natural resources and the environment and the lack of game-changing innovation in the area of renewable energy and conservation. This talk will outline efforts to bring energy issues to the forefront of our scientific curriculum at all levels without overburdening faculty or excluding fundamentals.

Session CD: iPad & iPhone Apps and Mobile Devices in the Classroom

Location: Sheraton - Ben Franklin Ballroom IV
Sponsor: Committee on Physics in High Schools
Co-Sponsor: Committee on Science Education for the Public
Date: Monday, July 30
Time: 7–8 p.m.

Presider: Martha Lietz

CD01: 7-7:10 p.m. An iPad App Textbook for Introductory Physics

Contributed – Andrew Duffy, Boston University, Boston, MA 02215; aduffy@bu.edu

In this talk, I will demonstrate an iPad app textbook for introductory physics (actually, two apps, one for the first semester, covering mechanics, and one for the second semester, covering electricity, magnetism, optics, and modern physics). This is a work in progress, but the project is more than half done. Accompanying each chapter is a set of simulations and animations designed to bring the physics to life, and to take advantage of the interactivity of the iPad. I will also demonstrate new interactive features that, by the time of the meeting, will have been recently added to the app. Interested attendees will also be able to get a code so they can download the app for free.

CD02: 7-7:20 p.m. iPAL (In-Class Polling for All Learners): Beyond Clickers

Contributed – Anne J. Cox, Eckerd College, St. Petersburg, FL 33711; coxaj@eckerd.edu

Bill Junkin, Eckerd College

Students carry with them a variety of web-enabled devices (laptops, smart phones, iPads, etc). Instead of asking them to check these at the classroom door, iPAL encourages students to use them in place of clickers for polling during class. iPAL is a free polling module in Moodle or available through a stand-alone module for non-Moodle schools and requires that the instructor only have a computer. While instructors can write their own polling questions, iPAL also includes a database of ready to use questions (Eric Mazur's ConcepTest questions) for Intro Physics. Bring your smart phone or laptop and see for yourself if you would like to use this technology to increase interaction in your classroom.

CD04: 7:20-7:30 p.m. Make Learning Mobile in High School Physics

Contributed – Eric Walters, Marymount School of New York, New York, NY 10028; ewaltes@marymountnyc.org

The iPad (as well as the iPhone and iPod Touch) offers physics educators the opportunity to rethink and reimagine our curriculum from a mobile perspective. This workshop will review the development and implementation of the Marymount School Mobile Learning in Physics Initiative, which has successfully integrated the iPad and iPod Touch into the Physics curriculum. Participants will review a variety of pedagogically sound learning opportunities, including iPad-based "Apptivities" that connect Apps such as Graphicus and Vect Calc to existing content found on the Web and on iTunesU; student-produced "virtual lab reports" using Vernier Video Analysis, iMovie for iOS5 and Numbers for iOS5; use of the iPod Touch in AP Physics as a classroom response system; and the publication of iBooks, using the iBooks Author App by students and teachers to support and extend the learning process. Strategies for assessment will be included; samples of student and teacher products will also be reviewed.

CD05: 7:30-7:40 p.m. Online Video Analysis in HTML5*

Contributed – Robert B. Teese, Rochester Institute of Technology, Rochester, NY 14450; rbtsps@rit.edu

Rohit Garg, Brian Soulliard, Gordon Toth, Brian Wyant, Rochester Institute of Technology

The LivePhoto Physics project is creating a series of short online tutorials, called Interactive Video Vignettes, that combine narrative videos with video analysis and other interactive segments. The vignettes will run on a wide variety of platforms including both mobile devices and desktop computers. After surveying and testing available and emerging technologies for creating vignettes, we chose HTML5 and Javascript. We are using the techniques of software engineering to set up a framework for ongoing software development. The use of a touch-based rather than a mouse-based interface on mobile devices created special problems for designing the video analysis segments. The first vignette will be demonstrated and the development process described.

*Supported by NSF grants DUE-0717699 and DUE-1122828.

CD06: 7:40-7:50 p.m. Using Screencasting and Voice-threading to Alter High School Student Roles

Contributed – Ben Van Dusen, University of Colorado, Boulder, CO 80303; benjamin.vandusen@colorado.edu

Susan Nicholson-Dykstra, Valerie Otero, University of Colorado

This physics education research study investigates how a high school physics class responds to the inclusion of a classroom set of iPads and associated applications, such as screencasting and voicethreading. The participatory roles of students and the norms and practices of the collective class community were examined. Findings suggest that classroom norms of practices were expanded through the use of iPad technology, to include increased roles of argumentation and collaboration. Findings also suggest that students were more likely to take leadership roles and teaching responsibilities within the technologically enriched classroom, ultimately allowing them to learn more physics. Videos, observations, interviews, and survey responses were analyzed to provide insight into the nature of these transformed classroom and student practices. Implications for the use of technology to engage students in physics will be discussed. Conjectures will be made about how the iPad-assisted learning differs from that of desktop or laptop computers.

Session CE: *Panel:* Writing for Academic Journals

Location: Sheraton - Ben Franklin Ballroom V
Sponsor: Committee on Graduate Education in Physics
Co-Sponsor: Committee on Space Science and Astronomy
Date: Monday, July 30
Time: 7–8:30 p.m.

Presider: Renee Michelle

This panel session will provide an overview of four prominent journals that publish research and results in physics education. Representatives from the American Journal of Physics, *the* Journal of Learning Sciences, *the* Journal of Research in Science Teaching, *the* Physical Review Special Topics – Physics Education Research, *and* The Physics Teacher *will discuss their different audiences and missions. The panel discussion will provide opportunities to discuss manuscript review processes, the criteria used to evaluate manuscripts, and the various topics addressed by each journal.*

Panelists:

–David Jackson, *American Journal of Physics*
–Karl Mamola, *The Physics Teacher*
–Valerie Otero, *Journal of Research in Science Teaching*
–Sanjay Rebello, *Physical Review Special Topics – PER*

Session CF: Video Analysis in the High School and Introductory College Classroom

Location: Sheraton - William Penn Suite
Sponsor: Committee on Educational Technologies
Co-Sponsor: Committee on Physics in High Schools
Date: Monday, July 30
Time: 7–8:30 p.m.

Presider: Maxine Willis

CF01: 7-7:10 p.m. Using Direct Measurement Video to Teach Physics*

Contributed – Peter H. Bohacek, Henry Sibley High School, Mendota Heights, MN 55118; peter.bohacek@isd197.org

Direct Measurement videos are short video clips of situations that illustrate physics concepts. Grids, frame counters, and other overlays allow students to make measurements from the videos directly, without needing other video analysis software. When using direct measurement videos, students must identify, and then measure quantities needed to complete their analysis. These videos can be used for open-ended problem solving, as a supplement to lab work, or for quantitative problem solving as an alternative to traditional word problems. When used as a supplement to labs, students learn measurements techniques and uncertainty propagation. These videos can be embedded in online homework systems such as WebAssign or LON CAPA. A collection of these videos has been developed for an introductory mechanics course.

*More information about Direct Measurement Videos can be found here: http://serc.carleton.edu/sp/library/direct_measurement_videos/index.html

CF02: 7:10-7:20 p.m. Using Video Analysis and Model Roller Coasters in Introductory Physics

Contributed – Dave R. Rishell, Vassar College, Poughkeepsie, NY 12603; darishell@vassar.edu

This paper will report on the lab we do in an introductory calculus-based physics course at Vassar using scale model working roller coasters and video analysis. Students record a video of a cart moving through the course, then import the video into Vernier Loggerpro software and analyze its motion by creating a motion diagram where the cart is modeled as a particle. Before the lab, students have gone over the material in lecture and have had time to work on homework related to the topic, so students are only given very basic guidelines for deriving the pertinent equations. Students predict several quantities, for example the g forces at the top and bottom of a "loop." They then observe the results and explain their findings. Of particular interest is the difference in "g"s between a so-called clothoid shaped loop and a circular loop.

CF03: 7:20-7:30 p.m. Video Analysis of Motion: Jumping Off a Swing Rope

Contributed – Arunava Roy, Young Harris College, Young Harris, GA 30582; aroy@yhc.edu

Tyler Benson, Baishali Ray, Young Harris College

Students were asked to make a video of a physical situation of their interest with the aim of analyzing the motion using video analysis. The primary objective was not to examine any particular physics concept. They rather were encouraged to analyze everyday phenomena involving a rich variety of physics, thus providing a means of motivation and increasing their enthusiasm for the subject. The study presented here concerns one such video where a student jumps off a swing rope into a lake. Various ideas of basic physics can be demonstrated using the above video. In our analysis, particular attention is paid to velocity and acceleration of the person and compared to that of the classic situation, an object in free fall. Other pertinent physics concepts, such as rotational motion, is also explored to complete the investigation. The students' feedback on the effectiveness of this method is also presented. The authors acknowledge support by NSF through the LivePhoto project.

CF04: 7:30-7:40 p.m. Following the Bouncing Ball

Contributed – Marco Ciocca, Eastern Kentucky University, Richmond, KY 40475; marco.ciocca@eku.edu

Jing Wang, Eastern Kentucky University

Video analysis is a research-proven effective tool in physics teaching. It enhances students' understanding through visualization. As a result they are able to develop a deeper conceptual understanding of the phenomena studied.[1,2] In introductory physics the transition between rotational and translational energy of a rolling object is a topic discussed often, but rarely tested in introductory labs due to the complexity of the measurements. In this work we present an experiment at the introductory level showing the interplay between rotational and translation energy on the flight of a bouncing ball. Work supported in part by the NSF through the LivePhoto project.

1. R. J. Beichner, "The impact of video motion analysis on kinematics graph interpretation skills," *Am. J. Phys.* **64**(10), 1272-1277 (1996).

2. P. Laws and H. Pfister, "Using digital video analysis in introductory mechanics projects," *Phys. Teach.* **36**(5), 282-287 (1998).

CF05: 7:40-7:50 p.m. Electric Field Due to a Thundercloud Using Video Analysis.

Contributed – Baishali Ray, Young Harris College, Young Harris, GA 30582; bray@yhc.edu

Arunava Roy, Young Harris College

Electric field measurements due to a thundercloud are one of the major concepts in atmospheric physics research. This topic is not well discussed in introductory calculus-based physics texts. To fully help students understand this difficult concept we extend the video analysis due to a line charge from Physics with Video Analysis by Vernier to include a charged disk. We use video analysis to compute the electric field due to a charged disk and employ curve-fitting techniques to fully analyze the solution. This idea is then used to calculate the electric field due to a thundercloud using multilayer charged disks and the principle of superposition. The authors acknowledge support by NSF through the LivePhoto project.

CF06: 7:50-8 p.m. Video Analysis on Rotation of a Wheel

Contributed – Cheng Ting, Houston Community College, Houston, TX 77087; cheng.ting@hccs.edu

Video analysis can show that the rotation of a wheel has an angular velocity at the center of the wheel and the vector of the angular velocity is at 90 degrees to the plane of the wheel following the right hand rule. For the rolling motion of the wheel on the ground, video analysis will show that there is an instantaneous center of rotation at the contact point of the wheel to the ground. The angular velocity at the instantaneous center is same as that at the wheel center.

CF07: 8-8:10 p.m. Punkins, Baseballs and Soccerballs: Roughness, Resistance and Curvature

Contributed – Timothy N. Knudson, Southern Virginia University, Buena Vista, VA 24416; tim.knudson@svu.edu

While there are a number of sources detailing the physics of baseball and soccer, not enough has been written about the physics of pumpkin projectiles. I will present evidence that the drag coefficient on a pumpkin has a typical value of 0.26. I will also argue that the initial speed of a pumpkin can be greater than 600 mph. The video evidence was gathered during the 2011 "Punkin Chunkin Competition." This annual event has been very popular from an entertainment point of view. A number of possible activities show that the "punkin chunkin" field is ripe for measurements and modeling by students with mid range physics abilities.

CF08: 8:10-8:20 p.m. Billiards and Croquet: The Physics of Colliding Spheres

Contributed – Richard Gelderman, Western Kentucky University, Bowling Green, KY 42101-1077; richard.gelderman@wku.edu

Introductory physics students are expected to understand that when two identical sliding balls collide head-on in an elastic (energy conserving) collision the ball will stop dead, transferring all its energy to the struck ball. So let's investigate how English and spin (i.e., torque) can be used to alter the result. All the remarkable ways that a ball can be struck and react during collisions with other balls provide excellent applications of the physics of force, friction, and angular momentum during a collision.

Session CG: Mentoring Minority Students

Location: CCH - Claudia Cohen Terrace
Sponsor: Committee on Minorities in Physics
Date: Monday, July 30
Time: 7–8:30 p.m.

Presider: Geraldine Cochran

Mentoring is an important part of our job as educators. What role does mentoring play in the success of minority students? Is mentoring minority students any different than mentoring their non-minority counterparts?

CG01: 7-7:30 p.m. Effective Mentoring: A Personal View

Invited – James H. Stith, American Institute of Physics, College Park, MD 20740; jhstith@msn.com

Most students, especially first-generation college students, know very little about what physicists do and whether their unique skills and attributes are a good match for a possible physics career. Advice designed to help students fill that void often focuses only on the academic skills and background needed. This talk will explore ways to provide students with a broader view and to help them acquire the skills and perspectives needed to persist in their journey to a full physics related career. It will discuss issues that help mentors become more effective as well as ways to help students become good mentees.

CG02: 7:30-8 p.m. Demystifying the Mentoring of Minority Students*

Invited – Diola Bagayoko, Southern University and A&M College, Baton Rouge, LA 70813; Diola_Bagayoko@subr.edu

The Timbuktu Academy (www.phys.subr.edu/timbuktu.htm), at Southern University and A&M College in Baton Rouge (SUBR), LA, and the Louis Stokes Louisiana Alliance for Minority Participation (www.ls-lamp.org) are comprehensive, systemic mentoring programs implementing a Ten-Strand Systemic Mentoring model that practically ensures success. As per 2011 data from the American Physical Society (APS), under-represented minorities accounted only for 9-10% of BS and 5-6% of PhD degrees in Physics. Results from the Timbuktu Academy and LS-LAMP strongly validate their model. The aim of this presentation is to discuss key factors that explain the success of the Academy and of LS-LAMP. They include the rigorous implementation of the Ten-Strand Systemic Mentoring model (to be thoroughly explained), including extensive research participation on and off campus. They also include standard-based curriculum, teaching, and learning (SBC, SBT, and SBL). For the above model and results, the Timbuktu Academy received several national awards, including two U.S. Presidential Awards for Excellence.

*Acknowledgments: Presentation funded by AAPT. Mentoring activities funded in part by the Department of the Navy, Office of Naval Research (ONR), NASA, through the Louisiana Space Consortium (LaSPACE), and the National Science Foundation (NSF), through the Louis Stokes Louisiana Alliance for Minority Participation (LS-LAMP) and LASiGMA.

CG03: 8-8:10 p.m. Changing the Face of Astronomy Through Authentic Research Experiences

Contributed – Kimberly Coble, Chicago State University, Dept. of Chemistry and Physics, Chicago, IL 60615; kcoble@csu.edu

K'Maja Bell, Mother McAuley High School

Jameela Jafri, Gabrielle Lyon, Project Exploration

Project Exploration is a Chicago-based science outreach organization that works to ensure communities traditionally overlooked by science--particularly minority youth and girls--have access to personalized experiences with science and scientists. We particularly target students who may not be academically successful. The results of a recent 10-year retrospective study demonstrate that Project Exploration students are significantly more likely than their peers to graduate from high school (95%), go to college (50%), and major in science (60%); and they attribute their persistence in science and education to their Project Exploration experience. Furthermore, Project Exploration works with the scientists involved to help them understand what it means to do effective outreach and how to put the interests of the youth at the center of the work. We describe the details of the Project Exploration model, as well as projects in astronomy that our students and scientists have carried out.

CG04: 8:10-8:20 p.m. What I Learned About Mentoring from My Physics Students in Chicago

Contributed – Mel S. Sabella, Chicago State University, Chicago, IL 60628; msabella@csu.edu

For the past 10 years I have worked at an urban, comprehensive, minority-serving university on the south side of Chicago. During this time I have played the role of an instructor, an academic advisor, a research advisor, an assessment coordinator, and an interim chairperson. These diverse roles have taught me a great deal about mentoring—and, I would like to believe that at some point in my career, I will begin to figure out what I'm supposed to be doing. In this talk I will describe some successes, some challenges, and what I have learned from my students about the role of mentoring at my institution.

Session CH: Oral History – Methods and Examples

Location: Houston Hall - Class of 49
Sponsor: Committee on the Interests of Senior Physicists
Date: Monday, July 30
Time: 7–8:30 p.m.

Presider: John Hubisz

CH01: 7-7:30 p.m. Oral History Interviewing: Documenting How Science Has Been Taught

Invited – Gregory A. Good, American Institute of Physics, College Park, MD 20740; ggood@aip.org

A continuing program of conducting oral history interviews is necessary to document both the history of physics and the history of the teaching of physics. Although the Niels Bohr Library & Archives has over 1000 oral history interviews, including some classics with early AAPT officers, the story is not over. Now is the time to interview new people and to recruit and train new interviewers. It's not rocket science, but neither is it something a person can just wing. It's a serious job, with standards and best practices. This talk provides an overview of this process.

CH02: 7:30-8 p.m. Evidence in Oral History

Invited – Babak Ashrafi, Philadelphia Area Center for History of Science, 431 Chestnut St., Philadelphia, PA 19106; ba@pachs.net

I will use several accounts of conducting oral history interviews to raise questions about the kind of data that is produced: For what kinds of conclusions could such data be used as evidence? In what ways is such data reliable or unreliable? How does oral history data compare to archival data? When should we count parts of oral histories as error or data?

CH03: 8-8:30 p.m. History Lost: Preserving Unpublished Scientific Knowledge

Invited – David J. Caruso, The Chemical Heritage Foundation, 315 Chestnut St., Philadelphia, PA 19106; dcaruso@chemheritage.org

Science is as much about scientists as it is about the experiments they perform. Often, however, the practice of science and the knowledge it generates is relegated to publications in journals and in textbooks; the experience of science and the lives of scientists are often lost, missing from the annals of history. Drawing on the Chemical Heritage Foundation's collection of oral histories, I will discuss the relevance of conducting oral histories of scientists to the preservation of modern scientific thought and practice, and the ways in which the knowledge and insights generated from such interviews integrate with other primary sources and provide a more detailed and rich understanding of science.

Session CI: Examining How Different Research-based Curricula Promote Different Agendas in Research

Location: Houston Hall - Golkin
Sponsor: Committee on Research in Physics Education
Date: Monday, July 30
Time: 7–8:30 p.m.

Presider: Andrew Boudreaux

CI01: 7-7:30 p.m. Research-Driven Curricula and Curricula-Driven Research: Physics by Inquiry*

Invited – Paula R. Heron, University of Washington, Seattle, WA 98121; pheron@uw.edu

For many years the Physics Education Group (PEG) at the University of Washington has conducted a program to prepare pre-service and in-service K-12 teachers to teach physics and physical science as a process of inquiry. The goals of the program include helping teachers develop deep conceptual knowledge, pedagogical content knowledge, and experience, as learners, with guided inquiry. Research on student learning helped shape these goals, and they in turn shaped the research agenda that guided the development of Physics by Inquiry (Wiley, 1996). The nature of the courses in which Physics by Inquiry is used (at UW and elsewhere) provides motivation and opportunity that shape a research agenda that emphasizes small-scale, qualitative investigations of teacher learning and its impact on practice.

*Supported by the National Science Foundation.

CI02: 7:30-8 p.m. How Responsive Inquiry Promotes a Transformative Experience Agenda

Invited – Brian W. Frank, Middle Tennessee State University, Murfreesboro, TN 37132; bfrank@mtsu.edu

Leslie J. Atkins, California State University Chico

We discuss how teaching responsive inquiry courses has led the presenters to a scholarly interest in the concept of transformative experience--a construct that aims to describe and assess the extent to which students use science concepts to see and experience the world in new and meaningful ways. While responsive teaching has provided us with rich points of contact for noticing (and perhaps even fostering) students' transformative experiences, our scholarly interest in this notion has influenced our observations of the phenomena and our perceptions of its value as a course outcome. In this talk, we describe the curricular contexts in which our interests in transformative experiences continue to develop and our ongoing attempts as researchers to both immerse and distance ourselves from the phenomena. Along the way, we present data from surveys, classroom artifacts, and interviews to illustrate the nature of transformative experiences and the means by which we are investigating it.

CI03: 8-8:30 p.m. Conceptual Change to Critical Race Theory: Spectrum of PET Research*

Invited – Valerie K. Otero, University of Colorado, Boulder, CO 80309; valerie.otero@colorado.edu

The Physics and Everyday Thinking (PET) Curriculum[1] was initially developed using a derivative of the classical conceptual change perspective on learning.[2] Implementation research, however, has deviated greatly from this perspective. While constrained by the affordances of a curriculum and the population with which it is used, research possibilities are largely dependent on how the researcher sees the world. This is usually greatly influenced by the academic kinship of the researcher. [3] This presentation explores how research topics involving the PET curriculum have changed over time and with diverse schooling contexts (for both the researcher and for PET student populations). I will take you from classical conceptual change theory to critical race theory and explore the conditions for theoretical change within a community of scholars. By investigating the research trajectories of scholars, their students, and their students' students, I will conjecture some parameters that influence or inhibit change.

1. F. Goldberg, S. Robinson, V. Otero, *Physics and Everyday Thinking*, Armonk, NY: It's About Time. (2006).
2. P. Hewson, R. and Thorley, "The conditions of conceptual change in the classroom," *Int. J. of Sci. Ed.* **11** (1990).
3. L. Fleck, *Genesis and Development of a Scientific Fact*, The University of Chicago Press, 1979. (1935).

*Partially funded by NSF grant #ESI-0096856

Session CJ: Undergraduate Research

Location: Irvine Auditorium - Amado Recital Hall
Date: Monday, July 30
Time: 7–7:20 p.m.

Presider: TBA

CJ01: 7-7:10 p.m. Modeling the Motion of a Magnet in the Presence of a Conductor

Contributed – Benjamin Irvine, Loyola University, Chicago, IL; 60660 birvine@luc.edu

Asim Gangopadhyaya, Matthew Kemnetz, Robert Polak, Thomas Ruubel, Loyola University Chicago

As a magnet moves in proximity to a conductor, the changing magnetic field produces an electric field, and hence an eddy current. The eddy current then produces a magnetic field that opposes the motion. Magnetic braking plays an important role in industry and is used to slow down moving parts of a system without losing energy to friction. The kinetic energy of an object is converted directly into electrical energy, which could be stored for later use. We have developed an analytical model of a cylindrical Neodymium magnet moving through a conducting pipe. Owing to its uniform magnetization, we show the magnet can be effectively modeled by two magnetically charged disks. We derive analytical expressions for the current distribution and the resistive force and compare them to experimental measurements. Since Neodymium magnets have become ubiquitous, our analysis will provide a good benchmark for experimental and computational models used in industry.

CJ02: 7:10-7:20 p.m. Hartnell College: A Study in Undergraduate Research at a TYC

Contributed – Leo C. Osornio, Hartnell College, Salinas, CA 93905; leo.osornio@gmail.com

Sewan Fan, Scott Davis, Brooke Haag, Hartnell College

In the summer of 2011, during an eight-week summer internship program at Hartnell Community College, we successfully constructed two complementary cosmic ray experiments. The first employed NIM electronic modules, the second was constructed as per specifications of a circuit board designed by the Berkeley Lab Cosmic Ray Telescope Project (http://cosmic.lbl.gov/). In this talk I'll present data obtained from both setups including the dependence of the cosmic ray flux on the separation between scintillator paddles and polar angle. In addition, ongoing improvements to the LBL lab board will be discussed. Finally I will include prospects for curriculum development using the cosmic ray experiments.

Session CK: Assessing Student Learning in the Introductory Lab

Location: Irvine Auditorium - Amado Recital Hall
Sponsor: Committee on Laboratories
Co-Sponsor: Committee on Research in Physics Education
Date: Monday, July 30
Time: 7:30–8:30 p.m.

Presider: Nancy Beverly

When introductory lab assessment strategies align with lab purpose, the clarity of the learning goals benefits students, instructors, and administrators. What is valued in the introductory lab? Every institution and pedagogical approach will have a unique answer to that question, but there will be common themes.

CK01: 7:30-7:40 p.m. Assessing Student Learning of Error Propagation in the Introductory Lab

Contributed – Fang Liu, The Richard Stockton College of New Jersey, Gallaway TWP, NJ 08240; fang.liu@stockton.edu

Laboratory work is essential in the study of physics. At Stockton the program learning goals for introductory physics laboratory are stated as follows: students should demonstrate abilities to (1) design and conduct experiments (2) analyze and interpret experimental results (3) report experimental information verbally and in written form. These goals align well with the goals proposed by the American Association of Physics Teachers for the introductory laboratory. It is an important but challenging task for students to understand the inherent limitations of measurement processes and deal with uncertainty and error propagation in calculations. In this presentation I will describe a simple and direct method to assess student learning of error propagation in the introductory lab. The change of the teaching strategies based on the assessment results will also be presented.

CK02: 7:40-7:50 p.m. Investigating the Development of Students' Scientific Conceptions of Pulleys

Contributed – Amy Rouinfar, Kansas State University, Manhattan, KS 66506-2601; rouinfar@phys.ksu.edu

Adrian M. Madsen, N. Sanjay Rebello, Kansas State University

Tram Do Ngoc, Hoang Ho Chi Minh City University of Pedagogy

Sadhana Puntambekar, University of Wisconsin-Madison

Several studies have investigated differences in students' learning with physical and virtual manipulatives. However, the process by which these differences in learning occurs has not been studied as extensively. We investigate the development of scientific conceptions as students in a conceptual physics laboratory class interacted with either physical or virtual manipulatives to investigate several pulley systems. The investigation occurred over two consecutive laboratory classes, each lasting about two hours. Each class was divided equally into virtual and physical groups, with the former using a computer simulation and the latter using real pulleys, strings and weights. Both groups had identical scaffolding facilitating them to construct their understanding of pulley systems by making and testing predictions and refining their models. We report on changes in students' conceptions of pulleys as they progressed through the activities. This work supported in part by Department of Education IES grant R305A080507.

CK03: 7:50-8 p.m. Problem Solving Labs at UND: Five Years Later

Contributed – William A. Schwalm, University of North Dakota, Witmer Hall 213, Grand Forks, ND 58202-7129; william.schwalm@und.edu

Mizuho K. Schwalm ,University of North Dakota and University of Minnesota-Crookston

Five years ago, with the help of an NSF CCLI grant, introductory physics laboratories at the University of North Dakota were changed over to a problem-solving format. Originally this was an adaptation of the University of Minnesota system. We present results of assessment based not on learned content but on learning of a problem-solving process within the cognitive apprenticeship paradigm. The assessment instrument focuses on the first three steps of the Minnesota five-step problem solving scheme. We attempt to measure the degree to which the importance a student assigns certain cognitive resources matches the importance attached to the same items by a set of expert problem solvers. We describe the instrument and show an analysis of the data collected over the past four years. As a result of what we learned we have been able to suggest improvements. Assessment materials can be provided on request.

CK05: 8-8:10 p.m. The Power and Usefulness of Lab Tests in Intro Lab

Contributed – Michael Ponnambalam, University of the West Indies, Kingston 7, 00007, Jamaica; michael.ponnambalam@uwimona.edu.jm

We have conducted Lab Tests, with credit, for four years at the freshman level and one year at the sophomore level. It was clearly noticed that during these years the students took the lab work far more seriously than in other years. This resulted in a better learning of the lab work and the theory behind it. Details of this project will be presented.

CK06: 8:10-8:20 p.m. Developing Analysis Skills Through Invention

Contributed – Natasha Holmes, University of British Columbia, Vancouver, BC V6T 1Z1, Canada; nholmes@phas.ubc.ca

Doug Bonn, Ido Roll, James Day, University of British Columbia

Laboratory learning goals are often vast and overwhelming, as students attempt to develop their ability to work with equipment, analyze data, and understand the underlying physics concepts. One particular first-year lab course at UBC has altered the focus of its learning goals to be primarily on data analysis methods. This is largely achieved through the use of invention activities: inquiry-based activities that ask students to invent a solution to a problem before being taught the expert solution. The combination of invention activities and traditional direct instruction has been shown to improve student learning and performance on transfer tasks, as compared to traditional lessons alone. Also, scaffolding the activities to take students through specific analysis or invention strategies leads them to notice more features of the data and reason at a deeper level. This talk will present results from a four-month treatment of computer-delivered, scaffolded invention activities.

PST1: Poster Session I

Location: Houston Hall - Bistro
Date: Monday, July 30
Time: 8:30–10 p.m.

Odd number poster authors should be present 8:30-9:15 p.m.
Even number poster authors should be present 9:15-10 p.m.
(Posters should be set up by 9 a.m. Monday and then taken down by 10 p.m. Monday)

A - Astronomy

PST1A01: 8:30-9:15 p.m. Demonstration Videos for Introductory Astronomy

Poster – Kevin M. Lee, University of Nebraska, Lincoln, NE 68858-0299; klee6@unl.edu

Demonstrations of physical apparatus are an important component of teaching introductory astronomy as they make science principles visible for students, keeping them engaged. However, astronomy instructors may face obstacles in exposing their students to physical demonstrations for a number of reasons: 1) many astronomy classes are taught by instructors who do not have formal training in astronomy and may be unaware of what demonstrations are possible, 2) many smaller institutions have modest or nonexistent collections of demonstration equipment, and 3) astronomy is increasingly taught as a distance education course. This poster will describe a new series of 2-4 minute videos entitled AU. The videos are publicly available at http://astro.unl.edu and may be viewed online or downloaded. Simple interactive curriculum that can be used with some of the videos will be displayed.

PST1A02: 9:15-10 p.m. Introductory Astronomy Essays on Transits, Eclipses and Occultations

Poster – Noella D'Cruz, Department of Natural Sciences, Joliet Junior College, Joliet, Il 60431; ndcruz@jjc.edu

Joliet Junior College, Joliet, IL, offers a one-semester introductory astronomy course each semester. We teach over 110 primarily non-science major students each semester. We use proven active learning strategies such as lecture tutorials, think-pair-share questions and small group discussions to help these students develop and retain a good understanding of astrophysical concepts. Occasionally, we offer projects that allow students to explore course topics beyond the classroom. We hope that such projects will increase students' interest in astronomy. We also hope that these assignments will help students to improve their critical thinking and writing skills. In spring '12, we are offering three short individual essay assignments in our face-to-face sections. The essays focus on transits, eclipses and occultations to highlight the 2012 transit of Venus. Details of the essay assignments and students' reactions to them will be presented at the meeting. Please note that this poster will expand on the contributed talk with the same title.

PST1A03: 8:30-9:15 p.m. Misconceptions in Astronomy

Poster – Gregory L. Dolise, Harrisburg Area Community College, Harrisburg, PA 17112; gldolise@hacc.edu

A survey of astronomy misconceptions among non-science majors. Students were asked a series of questions to gauge their understanding of such basics concepts as solar and celestial motions, space exploration technology, and the difference between astronomy and astrology. Results are shown, follow-up questions and future plans for more detailed surveys discussed, and recommendation for extending the survey to science majors given.

PST1A04: 9:15-10 p.m. Teaching Moon Phases: A Multiple Method Approach

Poster – Carl T. Rutledge, East Central University, Ada, OK 74820; crutledge@mac.com

As clearly illustrated by the movie "A Private Universe" (Harvard-Smithsonian Center for Astrophysics), very few students have an understanding of the cause of the phases of the Moon. Most believe they are caused by the Earth's shadow on the Moon and/or that it somehow has to do with reflected light—perhaps by a mirror or some other object, not by the Moon itself. Depending on the students' level of intellectual development, different approaches may overcome these misconceptions, so I use many methods, hoping one will succeed. I will describe the methods, their advantages, and their effectiveness. The simplest seems to work best.

PST1A05: 8:30-9:15 p.m. Updated Research on the Delta Scuti Variable Star DY Herculis

Poster – Robert Moore, University of West Georgia, Carrollton, GA 30118-rmoore@westga.edu

Bob Powell, University of West Georgia

The authors reported several modest research projects at a small observatory at the AAPT summer meeting in 2009. Since then, they have had an ongoing two-year observation campaign on the variable star DY Herculis (GSC 00968-01567, BD+12 3028, TYC 968-1567-1), which is a variable star of the Delta Scuti type. In this poster we report data on several epochs of photometric data taken through Johnson-Cousin B, V, RC, and IC filters. The data are analyzed for determinations of period of variability and the amplitude of variability. One result of this study is that the published period of 0.148631353 day remains unchanged within the limits of experimental error.

B - Bauder Endowment for the Support of Physics Teaching Activities

PST1B01: 8:30-9:15 p.m. Bauder Endowment Outreach Projects

Poster – Paul W. Zitzewitz, University of Michigan-Dearborn (Retired), 16229 Country Knoll Dr., Northville, MI 48168; pwz@umich.edu

The Frederick and Florence Bauder Endowment provides grants for the development and distribution of innovative apparatus for physics teaching, funds to obtain and or build and support traveling exhibits of apparatus, or funds for local workshops. Up to approximately $500 is available to fund local workshops for teachers who spread the use of demonstration and laboratory equipment. This poster will exhibit the work of prior grant recipients who are unable to attend the meeting to present the results themselves. Come and see what small grants can do and explore ideas you might have for projects.*

*Other members of the Bauder Committee will be present during the poster session.

PST1B02: 9:15-10 p.m. New Jersey Section and the Bauder Fund

Poster – Joseph Spaccavento, North Arlington High School, 222 Ridge Rd. North, Arlington, NJ 07031; Joseph.Spaccavento@narlington.k12.nj.us

Ray Polomski, NJAAPT President

The AAPT Bauder endowment fund for the support of physics teaching was founded in the 1980s as part of the estate of longtime New Jersey residents Fredrick and Florence Bauder. Fred was a professor at the Newark College of Engineering, now know as the New Jersey Institute of Technology. Because New Jersey was their home, the New Jersey Section benefits greatly from this endowment; examples of how the NJ Section utilizes these benefits to better serve their membership and maintain the Bauder legacy will be presented in this poster.

PST1B03: 8:30-9:15 p.m. A Make and Take Workshop at the SLL Observatory: Take 2!

Poster – Steven J. Maier, Northwestern Oklahoma State University, Alva, OK 73717; sjmaier@nwosu.edu

Bobette Deorrie Northwestern Oklahoma State University

In the summer of 2011, a free astronomy professional development opportunity was offered for 15 Oklahoma educators at an observatory in northwest Oklahoma. Unfortunately, due to low enrollment the workshop did not make it in 2011. The circumstances of the 2011 workshop and corresponding follow-up strategies for ensuring success in the summer of 2012 will be discussed. At no cost, each workshop participant will receive a green laser pointer, an LED light, a laminated skychart and a Galileoscope. This project was made possible by funding from an AAPT Bauder grant.

PST1B04: 9:15-10 p.m. Alabama Physics Commercial Competition

Poster – Elizabeth C. Holsenbeck, Science in Motion/Alabama State University, Hardaway, AL 36039; eholsenbeck@alasu.edu

In an effort to increase enrollment in high school physics, a Physics Commercial Competition was held in Alabama. Part of the funding was from the Bauder Endowment for Physics Teaching through AAPT. Students throughout the state were challenged to create a two-minute or less commercial highlighting the advantages of physics. The emphasis was "Recruiting Physics Students—EVERYONE should select physics in HS and here is why." The hope is that peer pressure can be a huge aid in promoting physics. Other funding was from the Alabama Section of AAPT, the Alabama Science Teachers Association, and Huntingdon College in Montgomery, AL. DVDs were hand delivered to every public high school in the state by the physics specialists of Alabama Science in Motion.

C – Technologies

PST1C01: 8:30-9:15 p.m. Electricity and Magnetism Self-Testing and Test Construction Tool

Poster – John C. Stewart, University of Arkansas, Fayetteville, AR 72701; johns@uark.edu

This poster presents an online resource for teaching and evaluating introductory electricity and magnetism classes and introduces a simplified version of the tool that can be used on tablet devices. The resource contains a library of highly characterized, multiple-choice, conceptual and quantitative electricity and magnetism problems and solutions all linked to a free online textbook. The library contains over 1000 classroom tested problems. Each problem is characterized by the complexity of its solution and by the fundamental intellectual steps found in the solution. Exam construction, administration, and analysis tools are provided through the resource's website. Problems may be downloaded for use in exams or as clicker questions. A self-testing tool is provided for students or instructors, an excellent tool for brushing up on conceptual electricity and magnetism. Conceptual inventory scores produced by the site are normed against the Conceptual Survey in Electricity and Magnetism. There is no cost associated with using any of the facilities of the site and you can begin to use the site immediately. Supported by NSF - DUE 0535928. Site address http://physinfo.uark.edu/physicsonline for the full version and http://physinfo.uark.edu/inventory for the version usable on tablet devices.

PST1C02: 9:15-10 p.m. Developing Pre-flight Tutorials for Matter & Interactions

Poster – Andrew S. Hirsch, Purdue University, Lafayette, IN 47907; hirsch@purdue.edu

Rebecca Lindell, Purdue University

Inspired by the success of "pre-flight" tutorials developed by physics faculty at UIUC, we are developing a series that are specifically tailored to students and faculty who use the innovative introductory text, Matter & Interactions: Modern Mechanics, by Ruth Chabay and Bruce Sherwood (Wiley). The M&I approach to mechanics (and electricity and magnetism) is distinctly different from that taken by more traditional texts. Our preflight tutorials will focus on those conceptual difficulties that have revealed themselves over 10 years of experience with M&I. Students will view the tutorials in advance of what would be a traditional lecture period and will be required to answer embedded questions in order to complete the assignment for course credit. The material presented in the tutorials will enable the course instructor to exercise Just In Time teaching, clicker questions that further probe student understanding, and any number of other pedagogically appropriate activities.

PST1C03: 8:30-9:15 p.m. DeepTutor: An Intelligent Tutoring System for Force and Motion

Poster – Brinkley Mathews, University of Memphis, Memphis, TN 38152; brmthews@memphis.edu

Elizabeth Gire, Donald Franceschetti, Vasile Rus, University of Memphis

DeepTutor is an online, intelligent tutoring system designed to support students' conceptual understanding of force and motion. A student begins by responding to a conceptual physics problem. DeepTutor then engages the student in a dialogue that provides feedback and scaffolding to help the student correctly articulate how physics principles apply to the situation. Quality interaction is possible in DeepTutor through the use of a novel, state-of-the-art natural language-based knowledge representation called the latent semantic logic form. Quality instruction is possible through the use of Learning Progressions (LPs), a framework that describes a natural sequence of mental models and mental model shifts students go through while mastering a topic. LPs are used in DeepTutor to model the task domain, track students' knowledge states, and provide appropriate feedback to the student. DeepTutor adapts to maximize the student's learning by customizing an instruction sequence to each individual.

PST1C04: 9:15-10 p.m. Multimedia Learning Modules as Preparation for Lecture-based Tutorials in Electromagnetism

Poster – James C. Moore, Coastal Carolina University, Conway, SC 29528-6054; moorejc@coastal.edu

We have investigated the efficacy of online, multimedia learning modules (MLMs) as preparation for lecture-based tutorials in electromagnetism in a physics course for life science majors. Specifically, we report the results of a multiple-group pre-/post-test research design comparing two groups receiving the following treatments with respect to activities preceding participation in tutorials: (1) assigned reading from a traditional textbook, followed by a traditional lecture; and (2) completion of online multimedia learning modules developed at the University of Illinois at Urbana-Champaign (UIUC), and commercially known as smartPhysics. Students completing the MLMs demonstrated significantly higher mid-term examination scores and larger gains in content knowledge as measured by the Conceptual Survey of Electricity and Magnetism (CSEM). Student attitudes towards "reformed" instruction in the form of active-engagement tutorials were also improved, with post-course surveys showing MLM-group students believed class time was used more effectively than reported by non-MLM students.

PST1C05: 8:30-9:15 p.m. QuVis: The Quantum Mechanics Visualization Project

Poster – Antje Kohnle, School of Physics and Astronomy, University of St. Andrews, North Haugh, St. Andrews, KY16 9SS United Kingdom; ak81@st-andrews.ac.uk

Cory Benfield, Donatella Cassettari, Tom J. Edwards, Aleksejs Fomins, Alastair Gillies, Christopher Hooley, Natalia Korolkova, Joseph Llama, Bruce Sinclair, School of Physics and Astronomy, University of St. Andrews,

Georg Haehner, School of Chemistry, University of St. Andrews

Since 2009, we have been developing and evaluating visualizations and animations for the teaching and learning of quantum mechanics concepts at the university level [Kohnle et al., *Am. J. Phys*. **80**, 2 (2012) 148]. This resource builds on education research and our lecturing experience, and aims to specifically target student misconceptions and areas of difficulty in quantum mechanics. Each animation includes a step-by-step exploration that explains key points in detail, and includes instructor resources consisting of worksheets with full solutions. Animations and instructor resources are freely available at www.st-andrews.ac.uk/~qmanim, and can be played or downloaded from this site. Animations are available on a wide range of topics from introductory to advanced quantum mechanics. Evaluation using questionnaires, diagnostic surveys, and student observation sessions goes hand-in-hand with the development. Current work aims at extending the resource to include animations on introductory quantum chemistry, as well as animations to support a revised quantum mechanics curriculum starting from simple two-state systems.

Monday night

PST1C06: 9:15-10 p.m. Using a Technological Platform in the Implementation of a Physics Course

Poster – Enrique Peña, Universidad de Monterrey, Av. Morones Prieto 4500 Pte., San Pedro, Garza García, N.L. 66238 México; epena@udem.edu.mx

Héctor González, Universidad de Monterrey

Juan Carlos Ruiz, Universidad Autonoma de Nuevo León

In this work we presented the results obtained when implementing the use of the virtual platform of learning called WebCT to the course of Electricity and Magnetism, in the University of Monterrey. Our course is denominated online with support of the WebCT platform, that is to say, that the course takes the traditional component of the transmitting professor as of the content but it has an innovating element, the use of technological resources for the comprehensive formation to support the Teaching -learning process. The used didactic tools for the development of the course, as well as some of the obtained preliminary results after their implementation by four consecutive semesters in an approximated total of 300 students are described.

PST1C07: 8:30-9:15 p.m. Making Kinematics a Dynamic Vehicle for Launching Students into Physics*

Poster – Frederick J. Thomas, Learning with Math Machines, 1014 Merrywood Dr., Englewood, OH 45322; fred.thomas@mathmachines.net

The NSF-funded project, "Math Machines and Algebraic Thinking," has developed hardware and software that empowers students to create, test, compare and modify free-form mathematical functions that CONTROL motion, rather than simply describing it. The software was created in LabVIEW, but distributed in executable form so the only programming skill required is in the language of "algebra." Based on a hobby servo motor with 0.1 degree precision, the system lets students control the motion of a laser dot across the front of a classroom whiteboard or a small laboratory screen, the motion of a block of wood as it creates scale-model earthquakes, the motion of gears as they drive other objects, and more. The system's role in motivation, pedagogy and assessment will be discussed along with opportunities for collaboration.

*Supported in part by NSF's Advanced Technological Education Program through grant DUE-1003381. More information is available at www.mathmachines.net.

PST1C09: 8:30-9:15 p.m. Extending the Laboratory Experience Through Remotely Controlled Experiments

Poster – Johan du Plessis, School of Applied Sciences, RMIT University, Melbourne, VIC 3000 Australia; johan.duplessis@rmit.edu.au

Philip Wilksch, Neil Robinson School of Applied Sciences, RMIT University

Warren Nageswaran, Edu Tech and Learning Design, RMIT University

A suite of five experiments was newly developed to be accessed remotely and performed online: X-ray diffraction, the electronic specific charge e/m, electron diffraction by a graphite polycrystalline sample, photovoltaic cells and the Doppler effect. These experiments were designed in such a way as to preserve the hands-on experience and minimize the feeling of running a simulation. Some of the experiments were used as part of a semester course laboratory cycle and we report on the implementation and responses from non-major and major physics first year classes.

PST1C10: 9:15-10 p.m. Using Tablets in the Laboratory to Improve Feedback to Students

Poster – Johan du Plessis, School of Applied Sciences, RMIT University, Melbourne, VIC 3000 Australia; johan.duplessis@rmit.edu.au

Danilla Grando, Ruby Biezen, School of Applied Sciences, RMIT University

As part of an initiative to achieve an all online submission, electronic marking and feedback system, pen-interactive displays as input devices were installed at first-year laboratory stations. We report here on the changes made to first-year laboratory procedures and resources provided to the students in order to complete the cycle within the laboratory session. Online submission was also a requirement for all physics assignments within the school. In the broader trials, both pen- interactive displays and iPads were used. Student, demonstrator and marker responses were canvassed in surveys and focus group discussions. These responses were overall positive but certain ingrained practices remain. We discuss possible problems and solutions.

PST1C11: 8:30-9:15 p.m. The Physics of Bouncing

Poster – Yi Chen, Penn State Abington, Abington, PA 19001; yoc5181@psu.edu

Mikhail Kagan, Penn State Abington

The physics of a bouncing ball demonstrates some interesting and often unexpected features. For example, a racquetball will not necessarily bounce at the same angle as it hits the floor. This can happen due to force of friction, if the amount of spin is not appropriately balanced with the linear speed of the ball before the bounce. In this work, we investigate the physics of the bounce, using the auxiliary theoretical models (described in the previous poster) and test our assumptions experimentally. For the experimental testing, we designed an original setup that allows us to easily control the relevant parameters, such as horizontal and vertical velocity components of the ball before the bounce, as well as its angular speed. The corresponding quantities after the bounce can be found by analyzing the ball's trajectory and/or using video analysis.

PST1C12: 9:15-10 p.m. Using Video Analysis to Reinforce Problem Solving

Poster – Yi Chen, Penn State Abington, Abington, PA 19001 yoc5181@psu.edu

Mikhail Kagan, Penn State Abington

Science and technology complement each other. Back in history, hypotheses were often developed without essential technologies to support it, and yet science theories were created and evolved. Nowadays science and technology are more than ever fused together. Some methods of examining physics phenomena can be tested in ways that no one would have imagined decades ago. One such possibility is using a video recording to analyze motion, which allows measurements of position, distance, time, velocity, and acceleration without setting up a complicated experiment. Here we present a few mechanical problems that have a clear analytical solution. The answers are tested using video analysis and the appropriate software, which would be highly non-trivial to do otherwise.

PST1C13: 8:30-9:15 p.m. Interactive Visuals to Explore X-ray Spectrum and X-ray Attenuation

Poster – Michael R. Gallis, Penn State Schuylkill, Schuylkill Haven, PA 17972; mrg3@psu.edu

Ryan Chesakis, Penn State Schuylkill

Interactive applets have been developed to help Radiologic Technology students explore some of the key physics concepts behind diagnostic X-ray images. The first applet uses a simplified model for mass attenuation coefficients to allow students to explore the roles of material properties and X-ray energy in differential absorption which in turn to contrast features in diagnostic X-rays. The second applet uses a simplified model to describe bremsstrahlung and characteristic X-rays, allowing students to investigate the effect X-ray tube high voltage and filters on the X-ray spectrum. The validation of the qualitative features of the simplified models is also discussed. These applets were created using the Easy Java Simulations tool from the Open Source Physics project.

PST1C14: 9:15-10 p.m. Accelerator Physics in High School Lab Using Video Modelling.

Poster – Mauricio Mendivelso-Villaquirán, Gimnasio La Montaña, Carrera 51 No. 214-55 Bogotá, CU 09002, Colombia; mauriciomendivelso@glm.edu.co

Fabian A. Martinez, Luis F. Huertas, Ana M. Rodríguez, Gimnasio La Montaña

A not too expensive experiment can be used to clarify main aspects of charged particles' trace analysis in a high school physics lab: Water drops free falling through vertical parallel plates must be deviated from vertical trajectory if there is a difference of potential between plates. Recording fall of water drops in a video can be used to determine forces over drops and its electric charge.

PST1C15: 8:30-9:15 p.m. Modelling the Coefficient of Restitution with Video

Poster – Sandra Leiva, Colegio Nueva York, Calle 227 No 49-64, Bogotá, CU 09002, Colombia; sleiva@colegionuevayork.edu.co*

Daniel F. Santos, Andrés F. Vargas, Colegio Nueva York

Using video modelling software Tracker, we develop (as a high school lab) a model of coefficient of restitution to different materials following Bernstein (*Am. J. Phys.* **45**, 41), Smith et al. (*Am. J. Phys.* **49**, 136) and Stengaard and Lægsgaard (*Am. J. Phys*. **69**, 301) ideas but without sound.

*Sponsor: Mauricio Mendivelso-Villaquiran

PST1C16: 9:15-10 p.m. Enabling Modeling Pedagogy with Google Docs in the Laboratory

Poster – Andrew E. Pawl, University of Wisconsin-Platteville, Platteville, WI 53818; pawla@uwplatt.edu

I teach in an intermediate-size studio classroom with up to 14 groups of four students. At this size, the integrated laboratory component poses two challenges. 1) How can I efficiently lead 14 groups through a laboratory activity in two hours? 2) How can I effectively hold a class-wide discussion about discovery components of the lab? The ideal solution seemed to be data sharing. Give different groups responsibility for different portions of the lab or for performing the experiment with different parameters, then pool data and discuss. Personal experience, however, suggested that sending 14 groups to the instructor station to enter laboratory data is tedious and disruptive. In this presentation I describe an alternate approach: Google Docs. Each student creates a free account, and all groups can simultaneously enter data. Adoption has streamlined data entry, promoted comparison of results across groups, and enabled the detection of incorrect experimental procedure in real-time.

PST1C17: 8:30-9:15 p.m. Position Sensing in the Physics Lab Using Open-Source Programming and Electronics.

Poster – Camila Vargas, Gimnasio La Montaña Carrera, 51 No. 214-55, Bogotá, CU 09002, Colombia; camilavargas@glm.edu.co

María P. Posada, Fabián Martínez Gimnasio La Montaña

We devised a method of determining particle position in a two-dimensional plane, using three no colineal distance sensors. We generate an interface using Processing to collect position data and time and with it, we determine the value of the instantaneous velocities and accelerations.

(NOTE: PST1D posters start on page 80.)

E – Pre-college/Informal and Outreach

PST1E01: 8:30-9:15 p.m. AAPT's PhysicsBowl – A Contest for High Schools

Poster – Michael C. Faleski, Delta College, University Center, MI 48710; michaelfaleski@delta.edu

The PhysicsBowl is an annual contest for high school students. The contest itself is 40 multiple-choice questions in length to be answered in no more than 45 minutes In 2012, there were more than 5000 students participating from approximately 260 schools across the world. In the past few years, schools have competed from the United States, Canada, China, Taiwan, Japan, the Republic of Korea, and Italy. Prizes are awarded to both the students and schools for high performers. This poster is to give high school teachers more information about the contest.

PST1E03: 8:30-9:15 p.m. Early Testing of Head-Mounted Display for Deaf Education

Poster – Holly M. Mumford, Brigham Young University, Provo, UT 84602; ohmymumford@gmail.com

Michael Jones, Eric G. Hintz, Jeannette Lawler, Brigham Young University

Fred R. Mangrubang, Gallaudet University

In an educational environment deaf children must split their attention between a signer and any form of visual learning being presented. This is a particular problem in a planetarium where the need for a dark room conflicts with the need for a signer. We are working to remove this logistical barrier in the science education of deaf children, with the use of a head-mounted display. Plans call for this devise to display a streaming video or a pre-recorded "sound-track" that will allow the student to see the signer regardless of where they are looking. We have begun testing of the prototype and will present some early results from both hearing and deaf children.

PST1E04: 9:15-10 p.m. Middle School Students Exploring Fiber Optics!

Poster – Pamela O. Gilchrist, North Carolina State University, Raleigh, NC 27695 ; pamela_gilchrist@ncsu.edu

Elena Nicolescu, Monica Fanjoy, North Carolina State University

Susann Heckman, Ravenscroft School

Stacey Kaufman, Franklin Academy

Imhotep Academy is a pre-college science and technology program for underrepresented minority students in grades 6-8. The program uses thematic-based instruction and team-teaching approaches to introduce students to physics, chemistry, marine, earth and atmospheric science and mathematics. Come and learn about strategies used to develop students' awareness of fiber optics technology and applications through hands-on investigations of light, project-based activities that enhance students' technical skills, and field trips that connect students to science, technology, engineering, and mathematics professionals using these technologies in innovative ways. Summative data will also be shared to document the impact of the learning intervention on student science attitudes and aspirations.

PST1E05: 8:30-9:15 p.m. Piloting a Fiber Optics and Electronic Theory Curriculum with High School Students

Poster – Pamela O. Gilchrist, The Science House-North Carolina State University, Research Building IV, Raleigh, NC 27695; pamela_gilchrist@ncsu.edu

Eric Carpenter, Tuere Bowles, Asia Gray-Battle, Adrian Coles, North Carolina State University

Previous high school student participants from a multi-year blended learning intervention focusing on science, technology, engineering, and mathematics (STEM) content knowledge, technical, college, and career preparatory skills, were recruited to pilot a new module designed by the project staff. Participant activities included constructing a fiber optics communication system, troubleshooting breadboard circuits and diagrammed circuits as well as hypothesis testing to discover various aspects of fiber optic cables. Participants documented their activities, wrote reflections on the content and learning endeavor, and gave talks about their research experiences to staff, peers, and relatives during the last session. Overall, it was found that a significant gain in content knowledge occurred between the time of pre- (Mean=0.54) and post-testing time points for the fiber optics portion of the curriculum via the use of a paired samples t-test (Mean=0.71), $t=-2.72$, $p<.05$. The program design, findings, and lessons learned will be reported in this poster.

PST1E06: 9:15-10 p.m. Ropes Course Physics

Poster – Elizabeth A. Holden, University of Wisconsin-Platteville, Engineering Hall 219, Platteville, WI 53818; holdene@uwplatt.edu

To counter the still-significant gender gap in physics and engineering fields, the University of Wisconsin-Platteville runs a multi-year outreach program for girls in grades 7-12. Girls stay at the university for one weekend per year and participate in a variety of activities intended to both introduce them to some engineering and physics and to generate excitement and interest about the topics. As part of the weekend's curriculum, I have developed a program to teach a variety of physical concepts through the use of a ropes course. The students take data as they ride the Giant Swing and climb the rope ladders, using the Vernier Wireless Data Sensor System and a digital video camera. Afterwards we meet to discuss energy conservation, periodic motion, and other concepts through the analysis of their experiences on the ropes course and the data they took. My poster will discuss the implementation of the program, its results, and how to modify it for use in a variety of physics outreach and classroom situations.

PST1E07: 8:30-9:15 p.m. The International Young Physicists Tournament for High School Students – 2012

Poster – Donald G. Franklin, Retired- Adjunct Status, Mercer University, Hampton, GA 30228; dgfrank1@aol.com

Alan Allison, President- IYPT

Rudolph Lehn, Host- IYPT/Germany/2012

The International Young Physicists Tournament is a contest for high school students from around the world. A team of five students develops solutions for the 17 questions that are proposed each year. At the contest they take turns in presenting, challenging other teams, and reviewing two teams in what is called a "Physics Fight." After five preliminary rounds, the top three teams as determined by the jurors will enter the final to determine the winner. The United States has sent teams to the 1999, 2001, 2004 to 2007 contests. Are we ready to develop a team for next year?

F – Teacher Preparation and Enhancement

PST1F01: 8:30-9:15 p.m. Assessing the PCK of In- and Out-of-Field Physics Teachers

Poster – Jennifer J. Neakrase, New Mexico State University, Las Cruces, NM 88011; neakrase@nmsu.edu

Pedagogical content knowledge (PCK) refers to how a teacher represents and formulates the subject being taught in order to optimize student understanding. Within physics, PCK is described as "an application of general, subject-independent knowledge of how people learn to the learning of physics." In choosing or designing successful lessons, a physics teacher must weave their knowledge of the discipline with knowledge of how students learn. When there is no certified physics teacher available, other "out-of-field" teachers are asked to fill the role. An out-of-field teacher may have adequate general knowledge of how students learn, but inadequate knowledge of the discipline of physics. This difference in knowledge between an in- and out-of-field physics teacher should be reflected in their PCK. This poster discusses how PCK of in- and out-of-field teachers can be assessed through a mixed-method design, which includes analysis of interviews, observations, and concept maps.

PST1F02: 9:15-10 p.m. ATE Project for TYC and HS Physics Teachers

Poster– Dwain M. Desbien, Estrella Mountain Community College, Avondale, AZ 85392; dwain.desbien@estrellamountain.edu

Tom O'Kuma, Lee College

The ATE Project for Physics Faculty provides intense three-day workshops for High School and Two-Year College faculty. These workshops are led by expert faculty and address all aspects of the introductory physics course (lab, lecture...). Topics range from interactive engagement techniques for lecture classes to using high speed video in the lab. Descriptions of the workshops and future workshops will be shared. Funded in Part by NSF DUE Grant #1003633

PST1F04: 9:15-10 p.m. WNYPTA – Over 20 Years of Grass Roots Professional Development

Poster – Joseph L. Zawicki, SUNY Buffalo State College, Buffalo, NY 14222; zawickjl@buffalostate.edu

Kathleen A. Falconer, David Henry, Dan MacIsaac, David Abbott, SUNY Buffalo State College

The Western New York Physics Teachers Alliance (WNYPTA) was originally developed at the State University of New York at Buffalo, following the model used by the New York State Mentor Networks. The initial statewide networks were grant-funded and supported a network of physics teachers throughout New York state. The New Physics Teacher Institute at the State University of New York at Buffalo met regularly during the summers and occasionally during the school year, and developed a cadre of local physics teacher talent. WNYPTA grew out of a series of Saturday morning presentations initially hosted by Buffalo State College. The program meets once a month on Saturday morning during the school year, with the meeting agendas collaboratively developed by the participants.

PST1F05: 8:30-9:15 p.m. IDIFO3 Teachers Formation on Modern Physics

Poster – Marisa Michelini, Physics Section of DCFA, University of Udine, via delle Scienze 208, Udine, IT 33100 Italy; marisa.michelini@uniud.it

Sri P. Challapalli, CIRD of the University of Udine

Lorenzo G. Santi, Alberto Stefanel, Stefano Vercellati, Physics Section of DCFA University of Udine

The main fall in motivation levels with regard to scientific studies in Italy has been collaboratively answered through the national project (Scientific Degree Project—PLS). Master IDIFO3 is a project in this framework for in-service teacher formation, a project focused on Didactic Innovation in Physics Education and Guidance, carried out by Udine PER Unit in collaboration with 18 Italian universities. It offers educational innovation, science learning laboratories, formative orientation (problem solving) and teacher training on Modern Physics topics for in-service teachers. It implements a model for teacher training, with an aim to develop formal thinking and to relate associated connection between Computer Science-Mathematics and Physics on Modern Physics topics. The activities such as educational and experimental workshops in presence, training teachers at a distance and in presence, conducting exhibitions, designing Inquiry Based Learning materials, activities for the orientation training in physics, informal education through conceptual laboratories (CLOE) and use of ICT to overcome the conceptual nodes in physics, teaching laboratories using problem solving and Prevision-Experiment-Comparison strategies and in-depth analysis of learning processes in educational innovation are achieved.

PST1F06: 9:15-10 p.m. Integrating Astrobiology and Heliophysics into Physics Courses

Poster – Mary Ann Kadooka, University of Hawaii, Institute for Astronomy, Honolulu, HI 96822; kadooka@ifa.hawaii.edu

Physics applications abound in astrobiology, search for life in the universe, and heliophysics, research about the Sun and its impact on Earth. Relating physics to the questions scientists are asking today will motivate students to realize how understanding physics principles is critical for learning any other science. Our University of Hawaii NASA Astrobiology Institute (NAI) team has been sponsoring ALI-I, an astrobiology workshop for secondary science teachers. They learn that main belt comets discovered in the Asteroid Belt remain dirty snow balls despite being so close to the Sun, how mineral samples are studied with an ion microprobe for origin of solar system research, etc. The nuclear physics of the Sun's core, thermodynamics of its convection cells, magnetic fields of sunspots giving off coronal mass ejections, and solar wind speeds are heliophysics applications for physics topics.

PST1F07: 8:30-9:15 p.m. Physics Education Through the Lens of Chemistry Education

Poster – Mark Schober, Trinity School, 101 W 91st St., New York, NY 10024; mark.schober@trinityschoolnyc.org

Physics first is increasingly touted in high school, but the benefits are only realized when the pedagogy and content coverage of the core sciences are coordinated. Teaching both physics and chemistry using Modeling Instruction, I have assembled a list of key concepts, skills, and instructional approaches in physics that I find essential for coherency between physics and chemistry. Treatments of mass, energy, electrostatics, and light; development of experimentation and data analysis skills; and employment of student-centered discussions can be enhanced in the physics classroom when seen as a stepstone to chemistry and beyond.

PST1F08: 9:15-10 p.m. Preparing Future Faculty: Enhancing Science Teaching Among Graduate Students

Poster – Merideth A. Frey, Yale University, New Haven, CT 06511 merideth.frey@yale.edu

Kristi Rudenga, Yale University

Enhancing science teaching is a critical goal for the nation at large and is clearly a complex issue with many possible solutions. At Yale University's Graduate Teaching Center, we aim to enhance teaching by training graduate students to become effective teachers through use of voluntary workshops and programs. This teaching-focused professional development is particularly important for future science teachers whose formal scientific training often lacks significant teaching experiences before becoming full-time faculty members. We have seen a great increase in participation amongst science graduate and post-doctoral participants by simply adding department-specific workshops as well as series that focus particularly on preparing future science faculty to teach their own courses. Here we analyze participation, assessments, and exit interviews to determine "best practices" for science teaching workshops. We offer evidence-based suggestions for enhancing graduate student and postdoctoral enrollment in, engagement with, and benefit from teaching-focused professional development workshops.

PST1F09: 8:30-9:15 p.m. Science Education in Ethnic Minority Areas of China

Poster – Bo Zhao, School of Information Science and Technology, Yunnan Normal University, Kunming, Yunnan 650092, China; ykzb63@126.com*

Lin Ding, School of Teaching and Learning, The Ohio State University

China is a multi-ethnic nation with rich and diverse culture traditions. Statewide standardized textbooks, however, take little into account the local ethnic minority cultures; thus limiting the opportunities of preserving the unique ethnic traditions through education. In this paper, we discuss the relation between ethnic minority cultures and science education in China. In particular, we propose ideas on development of effective curriculum resources for use by teachers, and on reform of classroom teaching in order to incorporate ethnic minority cultures into science education.

*Sponsor: Lin Ding

PST1F10: 9:15-10 p.m. Using RTOP to Mentor Pre-service and Alternative Certification Candidates

Poster – Kathleen A. Falconer, SUNY Buffalo State College, Buffalo, NY 14222; falconka@buffalostate.edu

Joseph L. Zawicki, Luanna Gomez, Dan MacIsaac, Lowell Sylwester, SUNY Buffalo State College

Pre-service and alternative certification physics candidates at the State University of New York, Buffalo State College, have been observed, using the Reformed Teaching Observation Protocol (RTOP) for at least five years. Combined courses in content and pedagogy have utilized the RTOP instrument as a theoretical framework and practical assessment tool. Teacher candidates, and new teachers, often focus on the content, not on the learners; pedagogical content knowledge is not just pedagogy -- it is pedagogy and content within the context of the learner. By focusing on learner actions, the RTOP focuses the attention of the new teachers on the classroom culture. This poster will discuss trends in candidate performance data and in student teacher supervisor observations.

PST1F11: 8:30-9:15 p.m. Web-based Resources for Responsive Teaching in Science*

Poster – Fred Goldberg, San Diego State University, CRMSE, 6475 Alvarado Road, Suite 206, San Diego, CA 92120; fgoldberg@sciences.sdsu.edu

Sharon Bendall, Michael McKean, Center for Research in Math and Science Education/San Diego State University

As part of a project to promote responsive science teaching in elementary classrooms, we have developed two web-based resources. One resource provides an example of a responsive "curriculum," one that could guide teachers as they implement responsive teaching in their own classrooms. The other resource is aimed at science educators and prospective teachers, providing a rich description of what responsive teaching in science looks like in elementary classrooms. In a responsive teaching classroom teachers attend and respond to students' ideas and reasoning; their next move decisions are based on their assessing the merits of the students' own ideas. Thus, a "curriculum" exists only in its enactment, and cannot be prescribed in advance. In this poster we will describe the goals and challenges of developing web-based resources for responsive teaching and provide some examples.

*Supported by NSF Grant 0732233

PST1F12: 9:15-10 p.m. Hands-On-Science: An Integrated Science Curriculum for Pre-Service K-8 Teachers

Poster – Mark Baumann, University of Texas at Austin, 1 University Station, C1600, Austin, TX 78712; markb@ph.utexas.edu

Alex Barr, Antonia Chimonidou, Sacha Kopp, University of Texas at Austin

Hands-On-Science is a new program at the University of Texas at Austin utilizing a guided-inquiry approach to deliver science content to pre-service K-8 teachers. Using "Physics and Everyday Thinking" and "Physical Science and Everyday Thinking"[1] as guide and inspiration, we have developed a four-semester sequence that provides an integrated approach to physics, chemistry, geology, biology, astronomy, and weather. A unified vocabulary and conceptual framework are employed throughout all four semesters. Fundamental ideas—such as conservation principles, interactions, and atomistic models— are applied in all semesters to understand a multitude of physical phenomena that span the various sciences. Hands-on experiments, computer simulations, and mobile apps provide students the opportunity to answer scientific questions using evidence-based reasoning. We present an overview of the structure and methodology of the Hands-On-Science program and its four-semester curriculum, as well as describe current and potential research questions that are enticing and available in an integrated science program such as this one.

1. Fred Goldberg, Stephen J. Robinson, and Valerie K. Otero (San Diego State University)

PST1F13: 8:30-9:15 p.m. From Experiment to Model with the Interactive Whiteboard in the Primary School

Poster – Alberto Stefanel, Research Unit in Physics Education, DCFA of the University of Udine, Via Delle Scienze, 206 UDINE, IT 33100 ITALY; alberto.stefanel@uniud.it

Marisa Michilin, Lorenzo Santi, Alessandro Mossenta, Stefano Vercellati, Research Unit in Physics Education, DCFA of the University of Udine

The interactive whiteboard allows us to construct personal representations starting from photos, drawings, and diagrams. Therefore it can be used in science education to build a bridge between the experimental exploration of phenomena and the construction of formalized models. Some contexts such as optics, electrostatics, and electromagnetism are particularly suitable for developing educational proposals that help students even in basic school to build representations of physical phenomena, favoring the development of formal thinking. The proposals developed were tested with a group of 90 university students (future primary teachers) involved in physics education courses at the University of Udine. Some of these proposals exemplify some of the significant potential of the white board for new educational proposals based on active learning and personal involvements of students in the passage from real phenomenology to the construction of physical models.

G – Labs/Apparatus

PST1G01: 8:30-9:15 p.m. An Advanced Lab on Polarization Optics with Vector Beams

Poster – Enrique J. Galvez, Colgate University, Dept. of Physics and Astronomy, Hamilton, NY 13346; egalvez@colgate.edu

Polarization of light is an important topic of experimental physics. Thus, experiments that go beyond direct verification of creation and detection of polarization states is highly desirable. In this presentation I propose an experiment with "Vector beams" that serves this purpose. Vector beams are combinations of spatial Gaussian modes and polarization. The experiments entail preparing a collinear superposition of two first-order helical (Laguerre-Gauss) modes with orthogonal polarizations. This is done with two forked gratings and a Mach-Zehnder interferometer with polarizing beam splitters. The resulting beams are Vector beams, which contain many different states of polarization in the same beam. Diagnosis consists of a set of waveplates and an imaging camera.

PST1G03: 8:30-9:15 p.m. Creating Sustainable Positive Change in Upper-Division Laboratory Courses at a Large Research University

Poster – Heather Lewandowski, University of Colorado, CB 440 Boulder, CO 80026; lewandoh@colorado.edu

Benjamin Zwickl, Noah Finkelstein, University of Colorado

Courses at a large research university are often taught by a large number of faculty members. This can present a challenge when transforming courses because a large number of faculty have to buy in to the transformed course structure. We highlight the steps we took to create widespread faculty support for significant transformations of the senior-level advanced lab course at the University of Colorado-Boulder. The process began with observations of the original course, followed by the development of consensus learning goals, renovation of the space, purchasing new equipment, redesigning curriculum, and finally assessing student learning. We demonstrate how physics education researchers can form a constructive relationship with the faculty to combine the expertise of traditional faculty with a research-based approach to create sustainable positive change to an upper-division laboratory course.

PST1G04: 9:15-10 p.m. Large-Scale Model of the Force Microscope Cantilever

Poster – Fredy R. Zypman, Yeshiva University, New York, NY 10033; zypman@yu.edu

Scanning Force Microscopy (SFM) has been used and developed for some 20 years and has played a pivotal role in the progress of hard and soft condensed matter. However, its insertion in the physics curriculum has been minimal both regarding theory and experiments. One possible justification of this situation is that an SFM is very expensive and difficult to use. In this presentation, we will show the use of a home-built scaled up model of the cantilever, which is the SFM's sensor. A flexible, 0.5-meter bar is made to vibrate about its horizontal equilibrium position. A laser beam is directed toward the top face of the cantilever and, upon reflection its trace is collected at a screen. The resonant frequencies can then be directly observed and photographed for further analysis. We study the effect of external forces on frequency shifts. We will discuss students' reports.

PST1G05: 8:30-9:15 p.m. Remote Controlled Laboratory Experiments: Some Test with Selected High School Students

Poster – Alberto Stefanel, Research Unit in Physics Education, DCFA of the University of Udine, Via Delle Scienze 206, Udine, IT 33100, Italy; alberto.stefanel@uniud.it

Marisa Michiline, Lorenzo Santi, Stefano Vercellati, Alessandra Mossenta, The University of Udine

The laboratory plays a key role in learning physics in particular when it activates the personal involvement of students in learning. Some experiments, particularly dangerous, expensive or complicated ones, however, may not be easy or even possible to make the equipment usable in educational lab with students. For this reason, remote controlled apparatuses (RCL) may be particularly significant. Several laboratories RCL can also be offered to high school students. As part of modern physics summer school held in Udine in 2011, six RCL laboratory activities on light and electron scattering, Millikan's experiment, the measure of the speed of light, Rutherford experiment, photoelectric effect (http://rcl.physik.uni-kl.de /) have been proposed to a select group of students from all over Italy. The results demonstrate effectiveness of the RCL lab in producing student involvement and enable positive learning paths on conceptual issues central in the processes explored.

PST1G06: 9:15-10 p.m. A Multi-Representational Bernoulli Lab and Assessment

Poster – Katherine Misaiko, University of New England, Biddeford, ME 04005; jvesenka@une.edu

James Vesenka, University of New England

Bernoulli's Principle (BP) is a confounding concept for students partially because of the counterintuitive relationship between speed and pressure. When applied correctly, BP is quite useful in helping to quantify a variety of important and common biological phenomena. Complicating matters are the many phenomena erroneously attributed to BP on the web, some of which are assimilated into instruction. We have developed a lab activity around BP to measure the density of air using a barometric sensor and simple mathematical modeling. Wide variations in results tend to reduce the impact of the lab activity since great care is required in both data collection and corrections. We describe efforts to improve the lab activity along with the development of alternative diagrammatic and graphical representations to establish the best mechanism for helping students to construct understanding about BP. Supported by DUE 1044154

PST1G07: 8:30-9:15 p.m. Using Arduino and Tracker to Model Human Eye's Pupil Response to a Periodic Excitement

Poster – Valentina Mazzanti, Gimnasio La Montaña, Carrera 51 No. 214-55, Bogotá, CU 09002, Colombia; valentinamazzanti@glm.edu.co

Sebastian Escobar, Mauricio Mendivelso-Villaquirán, Gimnasio La Montaña

Modelling is a basic skill to develop physical thinking in our students. We propose a particular situation to model the human eye's pupil behavior using video modelling and a cheap electronic system based on Arduino.

PST1G08: 9:15-10 p.m. Analyses of The Blowgun Demonstration Experiment

Poster – Koji Tsukamoto, Kashiwa Minami High School, 1705 Masuo, Kashiwa City, Chiba 270-2231, Japan; fumanchu@auone.jp

Masanori Uchino, Tokyo Univ. of Science

Etsuo Arakawa, Takane IWASAKI, Tokyo Gakugei Univ.

A demonstration experiment using a blowgun is effective for introducing dynamics. We will conduct this demonstration and show its effectiveness at our oral presentation, "Experimental Demonstration Using a Blowgun for Introducing Dynamics."[1] Quantitative measurement is not necessary for presenting this demonstration in a classroom because its result is explicit and clear. We, however, measured the results of this experiment in order to see that they correspond to the prediction using elementary mechanics equations. We will show the results and analyses of the measurement.

1. K. Tsukamoto and M. Uchino, "The Blowgun Demonstration Experiment," *Phys. Teach.* **46**, 334-336 (2008).

PST1G09: 8:30-9:15 p.m. Bibliography of Experiments for Physics Instructional Labs

Poster – Randall Tagg, University of Colorado-Denver, Denver, CO 80217-3364; randall.tagg@ucdenver.edu

A project was begun more than 20 years ago to create and maintain a bibliography of papers on experiments in physics useful for instructional labs. This includes papers from the *American Journal of Physics*, the *European Journal of Physics*, *The Physics Teacher,* and *Physics Education.* The first compilation appeared in the proceedings of the Labfocus93 conference in Boise, ID. Here is an update on the project, including efforts to merge with other resources for physics instruction and to include a wider range of publications. A significant effort went into a useful classification scheme that now needs to be cross-referenced to other systems used by physics educators.

PST1G10: 9:15-10 p.m. Gelin' in the Physics Lab

Poster – Aaron Titus, High Point University, High Point, NC 27262; atitus@highpoint.edu

Gel electrophoresis is a separation technique used to identify DNA. Yet, it is also an excellent application of introductory physics principles. A uniform electric field is set up across a gel. Negatively charged DNA molecules migrate toward higher electric potential. Due to drag, the DNA molecules travel at a terminal speed, and students can apply Newton's second law to investigate the drag on the DNA. In this experiment, groups of introductory physics students applied different voltages to the gel. They took final photos of the DNA after a measured time interval and used Tracker's line profile to measure the distance traveled by the DNA bands in the gel. Their data was aggregated to see if the terminal speed was proportional to the applied voltage. The results indicated that to some extent, DNA can be simply modeled as a uniformly charged cylinder. The experiment has tremendous value for an introductory physics laboratory. The experiment, its results, and its usefulness in teaching physics will be presented.

PST1G11: 8:30-9:15 p.m. Granular Physics Demonstrations

Poster – Eli T. Owens, North Carolina State University, Raleigh, NC 27695; etowens@ncsu.edu

Karen E. Daniels, North Carolina State University

Granular materials, for example sand, provide several opportunities for physics demonstrations. Composed of macroscopic particles interacting in a purely classical way through the particle contacts, granular materials have many industrial applications and are one of the most commonly transported materials. Granular physics is also relevant in many geophysics and astrophysics studies, yet physics students are rarely introduced to this important class of materials. Granular materials also display some interesting phenomena. For example, two different types of particles tend to segregate in seeming violation of increasing entropy. I will show and explain granular physics demonstrations that illustrate this and many other interesting granular physics principles. These demonstrations are very eye catching and many can be constructed using simple household materials.

PST1G12: 9:15-10 p.m. Helmholtz Coil Magnetic Fields Revisited

Poster – Stephen Luzader, Frostburg State University, Frostburg, MD 21532; sluzader@frostburg.edu

Jason Michael Pattonair

At the 2006 and 2007 AAPT Summer Meetings, we reported on the magnetic field produced by the Helmholtz coils in three e/m setups. One apparatus in particular produced rather poor results, and we suspected that the error might arise from the electrons moving through regions where the magnetic field is less than the value predicted by the standard formula. We have revisited the problem and have done field calculations taking into account the finite axial and radial thicknesses of the coils. We find that all three setups can produce acceptable results as long as the mean radius of the coil is used to calculate the field, and if the electrons always pass through the central region between the coils where the field is relatively uniform.

PST1G14: 9:15-10 p.m. Implementation of a Web-Enabled Interactive Renewable Energy Laboratory

Poster – Steven Vuong, 12 Wimbledon Circle, Salinas, CA 93906; steven.vuongs@gmail.com

Brooke Haag, Tito Polo, Hartnell

Dan O'Leary, UCSC/ NASA AIMS

Since the summer of 2011, I have collaborated on the Course Curriculum and Laboratory Improvement (CCLI) grant project at Hartnell College in partnership with the University of California, Santa Cruz. We have worked to implement a web-enabled renewable energy laboratory to include a remotely operated solar panel. I have assisted in the development of the lab modules, instruction of the labs, and assessment of learning outcomes. In this poster, I present assessment results as of spring 2012 and prospects for future project improvement.

PST1G15: 8:30-9:15 p.m. Interfacing PASCO Sensors with the LabJack U3-HV

Poster – Timothy A. Niiler, Penn State Brandywine, Media, PA 19382; tim.niiler@gmail.com

Malick Fofana, Penn State Brandywine

With recent budget cuts due to the economic situation, it has become increasingly difficult to maintain or replace failing electronics equipment in the physics lab. Other than computers, the most expensive equipment many labs maintain are their DAQ devices such as the PASCO Science Workshop 750. We demonstrate our successful integration of a lower cost alternative, the LabJack U3-HV, with our existent PASCO sensors. Our results include both easy to use open-source data acquisition software for many out-of-the box labs as well as schematics for creating the requisite wiring harnesses needed for the PASCO-LabJack interface. Data collection is shown to be easier than with the DataStudio interface and extensible with modest scripting experience.

PST1G16: 9:15-10 p.m. Measuring Centripetal Force in Vertical Circular Motion with Force Probe

Poster – Oather B. Strawderman, Lawrence Free State HS, Lawrence, KS 66049; ostrawde@usd497.org

A common introductory laboratory utilizes a rubber stopper that is spinning in a horizontal circle. The rubber stopper is attached to a string that is threaded through a plastic tube. At the end of the string hangs a mass that supplies the tension that supplies the centripetal force. My variation of this lab is appropriate for an advanced physics course such as AP Physics. The rubber stopper is this time spun in a vertical circle. The string is still threaded through a plastic tube but this time it is attached to a force probe. The tension in the string varies as it travels around the vertical circle. The graph of the string tension is sinusoidal in nature. Using the data from the graph and other measurements, the students can apply the equation for centripetal force in a more advanced and complex situation. The poster presents the details of the lab.

PST1G17: 8:30-9:15 p.m. New Laboratory for Non-scientists Includes Simple(st?) Equipment

Poster – Leonard Finegold, Drexel University, Philadelphia, PA 19104; L@Drexel.edu

The setting is a science elective with no prerequisites, [1] to seduce students into an appreciation of physics. We have now instituted a laboratory component, with the aim of a range of equipment from the simplest (with the most information/$) to experiments using good oscilloscopes. The experiments start with g (dropping tennis balls, students have good reflexes), v = at (ball rolling down slope), test of general relativity with pendulum, modeling the faster cooling of Mars as compared to Earth by measuring relative cooling rates of metal spheres, and simulating radioactive decay by flipping 100 coins. Commercial experiments measure the speed of light in fiber optics glass, and show similar polarization of light and microwaves. We emphasize straight-line graphs, plotting manually and (later graduating to) Excel.

1. L.A. Bloomfield, *How Things Work*, (Wiley NJ 2010).

PST1G18: 9:15-10 p.m. Pressure Beneath the Surface of a Fluid: Measuring the Correct Depth

Poster – Richard P. McCall, St. Louis College of Pharmacy, 4588 Parview Pl., St. Louis, MO 63110; richard.mccall@stlcop.edu

An experiment where the pressure beneath the surface of a fluid is measured as a function of depth can lead to substantial error if the depth is not measured correctly. In a laboratory exercise, a tube attached to a pressure sensor is lowered into a column of water, trapping air in the tube. As the pressure increases with depth, the volume of the air in the tube decreases resulting in water entering the tube. The water in the tube must be able to be observed in order to properly measure the depth. An example is presented where a 10% error is reduced to only 1% by taking this systematic error into account.

PST1G19: 8:30-9:15 p.m. Real-Time Thermodynamic Experiments with High Resolution

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

Daniel Lund, Lawrence Lechuga, California State University, Chico

The heat equation is often taught in upper-level physics and engineering courses, but laboratory equipment that allows students to test this important concept are lacking. Existing educational apparatus for this experiment is either expensive or extremely limited. Recent advances in microcontroller systems and sensor technology allow the use of large numbers of high-precision sensors to obtain temperature information with high spatial/temporal resolution in real time, at relatively low cost. We demonstrate one such apparatus here.

PST1G20: 9:15-10 p.m. Sound Velocity and End Correction of Open Ended Circular Pipe

Poster – Dongryul Jeon, Seoul National University, Department of Physics Education, 1 Gwanakro, Gwanakgu Seoul, South Korea; jeon@snu.ac.kr

Changsoo Lee, Seoul National University, Department of Physics Education

The antinode of an open-ended pipe is located outside the actual end of the pipe, known as the end correction. The amount of the end correction depends on the pipe size. We performed an experiment to measure the speed of sound and to find simultaneously the amount of end correction as a function of pipe diameter for a circular pipe. For this, we measured the sound intensity as a function of position by scanning a microphone along the pipe and corrected the data by taking into account the theoretical sound intensity. The results showed that the resonance frequency decreased and the length of air column increased proportionally when the pipe diameter increased. The speed of sound and the amount of end correction were calculated from the slope and the intercept of the graph of resonance frequency vs pipe diameter.

PST1G21: 8:30-9:15 p.m. The North American Network of Science Labs Online (NANSLO)

Poster – Todd G. Ruskell, Colorado School of Mines, Golden, CO 80401; truskell@mines.edu

Daniel Brannan, Rhonda Epper, Colorado Community College System

Patricia Shea, Western Interstate Commission for Higher Education

The Western Interstate Commission for Higher Education (WICHE) is collaborating with the Colorado Community College System and BCcampus to create a network of web-based remote-controlled laboratory experiences for introductory physics, chemistry, and biology. We report on the status of NANSLO, discuss results from the initial implementation of these labs in introductory physics courses taught through Colorado Community Colleges Online, and describe plans for expanding the network.

PST1G22: 9:15-10 p.m. The Reformation of Introductory Physics at University of Southern Mississippi

Poster – Hiro Shimoyama, The University of Southern Mississippi, Hattiesburg, MS 39406; hironori.shimoyama@usm.edu

The graduate teaching assistants (TAs) and I have reformed the introductory physics lab education at the University of Southern Mississippi over the last five years. The main goals were to provide proper equipment, to create quality of curriculum, and to establish good network among TAs and lecture instructors. Mississippi State is the worst state in terms of preparing STEM subjects for college study. Under such conditions, we have been seeking the best way to improve these students' ability. In the first phase, we organized the facility so TAs can teach well. In the second phase, we grasped actual students' learning processes and their background. In the third phase, we collected all aspects of feedback from TAs and students. Then, we eventually integrated the solution as our innovative lab manual with other external arrangement.

PST1G23: 8:30-9:15 p.m. Transforming Traditional Labs into Discovery Tasks for Non-STEM Majors

Poster – Mark I. Liff, Philadelphia University, 4201 Henry Ave., Philadelphia, PA 19144; liffm@philau.edu

The search for alternatives to traditional labs intensified lately since traditional labs are often perceived as insufficiently effective teaching vehicles. One of the directions of this search is based on developing discovery labs where the students are expected to solve a problem novel to them or sometimes make a re-discovery by a combination of the theoretical and experimental methods. Instead of step-by-step instructions, the students are given a brief review of the relevant theory, and speedy introduction into operating of the corresponding set-up. A certain knowledge base is indispensable for every creative task. We transformed a number of traditional labs into discovery labs and let our students complete them. In this paper we discuss merits and flaws of the newly developed labs based on the student reaction to them.

PST1G24: 9:15-10 p.m. Addressing Multiple Goals in an Introductory Physics Laboratory

Poster – Scott W. Bonham, Western Kentucky University, Bowling Green, KY 42101; scott.bonham@wku.edu

Doug Harper, Lance Pauley, Western Kentucky University

Physics laboratories can address a variety of goals, such as learning measurement techniques, developing conceptual understanding, designing experiments, analyzing data, reporting results, and others. As our department began revision of our university physics laboratory, we formed a task force representing a cross-section of the department to define learning outcomes for the new curriculum. This resulted in a list of eight general learning outcomes: measurement (using both low- and high-tech tools), developing experimental procedures, analyzing data, technical writing, conceptual understanding, uncertainty and error, team work, and a positive experience. A team led by faculty members with expertise in physics education research (Bonham) and LabView data acquisition (Harper) have developed the new curriculum to address all these goals, which will be described along with a preliminary assessment of the curriculum.

*Supported by the National Science Foundation through DUE-0942293.

D – Physics for All

PST1D01: 8:30-9:15 p.m. Optics for Artists, Photographers, Film Makers and Others

Poster – Scott W. Bonham, Western Kentucky University, Bowling Green, KY 42101; scott.bonham@wku.edu

The Light, Color and Vision course at Western Kentucky University attracts many non-scientists seeking to fulfill their science requirement, many of whom have strong interest in visual phenomena with art, photojournalism, and broadcasting majors strongly represented. To connect, challenge, and make the course relevant to this audience, I have developed a hands-on, studio curriculum that reduces use of mathematical calculation in favor of ray and spectral diagrams. Each unit incorporates a relevant artistic focus, such as works by George Seurat to illustrate principles of color and perception, and an important scientist, including Ahazan, Newton and Einstein, to build a historical storyline of the development of scientific ideas about light, color and vision. Assessments include photographing phenomena and ray diagrams of real-life situations, as well as quizzes and exams. This curriculum helps keep students engaged throughout the semester and connect physics to things they are interested in.

PST1D02: 9:15-10 p.m. Poetry Writing in General Physics Courses

Poster – William L. Schmidt, Meredith College, Raleigh, NC 27607-5298; schmidtw@meredith.edu

Physics and poetry are two of the great human intellectual endeavors—

each producing deep insights on self-created models of the universe. Poetry writing can be incorporated into general physics courses to provide a creative challenge to students who often perceive physics as being unrelated to the real world. Students write poems in a specific context of physics to help them develop a personalized window on the world. The poetry provides lively classroom discussion and a light-hearted approach to what is often seen as a purely logical subject. Teachers get insight into the minds of students from a broader and more personal perspective than problem solving. The assignments and the merits of poetry will be discussed. Some examples of student poetry will be shared.

PST1D03: 8:30-9:15 p.m. Princeton Science and Engineering Education Initiative

Poster – Carolyn D. Sealfon, Princeton University, Princeton, NJ 08544; csealfon@princeton.edu

Els N. Paine, Princeton University

The Science and Engineering Education Initiative at Princeton University aims to inspire and prepare all undergraduates, irrespective of their majors, to become scientifically and technologically literate citizens and decision-makers. Launched by the faculty on the Council on Science and Technology in September 2011, the initiative involves revising and creating science and engineering courses that emphasize the role of science in society. We have begun by defining student-centered learning goals and surveying students' attitudes toward science and engineering. Course by course, we are also gradually applying research-based teaching methods to better align course activities with learning goals, assessing learning gains, and creating a repository of successful methods and courses.

PST1D04: 9:15-10 p.m. Teaching Quantum Physics: There Are No Particles, Only Fields

Poster – Art Hobson, University of Arkansas, Fayetteville, AR 72701; ahobson@uark.edu

A strong case for a pure fields view of reality has developed since 1970, especially since the standard model's confirmation. Electrons, photons, etc. are field quanta, yet we teach students that they are particles, leading to confusion and inconsistency. A textbook survey confirms this conclusion. The history of classical and quantum fields confirms that "the basic ingredients of nature are fields; particles are derivative phenomena" (Steven Weinberg). Thus the Schroedinger equation is the non-relativistic field equation for a real physical matter field (the electron-positron field). Individual electrons and photons really do come through both slits. An electron is its "wave function" (field). Testifying to the reality of fields are the Lamb shift, Casimir effect, Unruh effect, the recently discovered non-locality of single quanta, the inconsistency of relativity with quantum point particles, and more. These ideas can be taught at any level, from conceptual through post-graduate. A preprint will be available.

PST1D05: 8:30-9:15 p.m. Teaching The Physics of Music with an Activities-based Curriculum

Poster – Deva O'Neil, 401 NW View St., Bridgewater, VA 22812; doneil@bridgewater.edu

By centering a course around the theme of sound and music, physics becomes fun and relevant for non-science majors. Students are introduced to the physics of sound waves, including the decibel scale, interference, and the mathematical representation of waves. The bulk of the course is devoted to the physics of music: resonance, intervals, properties of musical notes (pitch, volume, timbre), scales and temperaments, and the design of musical instruments. The Physics of Music lends itself well to experiential learning. In this presentation, various activities that have been implemented successfully at Bridgewater College will be described, including: using an oscilloscope hooked up to a piano keyboard to analyze waveforms of chords and intervals, playing and singing different notes into a microphone to study timbre, using resonance tubes to study the physics of wind instruments, measuring the beat frequency produced by tuning forks, making a "straw oboe," and much more.

http://people.bridgewater.edu/~doneil/music.html

PST1D06: 9:15-10 p.m. Global Energy Resources: A General Education Course

Poster – Ernest R. Behringer, Eastern Michigan University, Ypsilanti, MI 48197; ebehringe@emich.edu

Global Energy Resources is a course that fulfills a general education requirement in the area of global awareness. Initially co-taught by three instructors during fall 2010, it was taught by a single instructor during Fall 2011. Students were introduced to the distribution and use of global energy resources, and to energy concepts and technologies. Students were asked to complete homework assignments, in-class activities, a group project, and to generate a video presentation. The group project included an oral presentation and written report describing a plan to manage the energy resources of a foreign nation from the present time through 2030. A detailed description of the course will be given, along with a summary of successes and challenges, and plans for the future.

PST1D07: 8:30-9:15 p.m. Getting Students to Think Like a Geek

Poster – Hillary D. Stephens, Pierce College-Fort Steilacoom, 9401 Farwest Dr. SW, Lakewood, WA 98498; stephens.hillary@gmail.com

As educators a common goal is to have students apply what they have learned beyond the walls of the classroom. However, the connection between class work and real life can evade many students. This poster presents ways to take students beyond the classroom using media from their everyday lives. Students are asked to critically think about physics concepts as they might encounter them outside of contrived classroom problems by analyzing television shows, cereal boxes, children's books, t-shirts and other media that portray physical phenomena in both accurate and inaccurate ways. Similar to "What if Anything is Wrong?" tasks inspired by physics education research, students discuss the good, the bad and ways to improve.

PST1D08: 9:15-10 p.m. "The Core" Illustration of Poor Physics for Non-Science Majors

Poster – Steven J. Sweeney, King's College, Wilkes-Barre, PA 18711; stevensweeney@kings.edu

The major concepts of physics, such as forces, gravity, and conservation of energy, are some of the most fundamental ideas we hold about the universe. For non-science majors, much of their exposure to these concepts comes through popular movies and television shows. One in particular, "The Core", does such a poor job of following basic physics that I have used it as a capstone-type event in a conceptual physics course for non-science majors at King's College, a liberal arts institution. The semester-long course introduces the major concepts of introductory physics with non-examples from many popular movies, and it finishes with a multi-page analysis by students of "The Core." This provides them both a chance to draw together the concepts learned over the semester and to use those concepts to analyze events and statements in the movie as practice for things they encounter in the media after college.

H – Upper Division Courses and Topics

PST1H01: 8:30-9:15 p.m. A Framework for Adopting Modeling in Upper-Division Lectures and Labs

Poster – Benjamin M. Zwickl, University of Colorado, Boulder CO 80309-0390; benjamin.zwickl@colorado.edu

Noah Finkelstein, H.J. Lewandowski, University of Colorado Boulder

Modeling, the practice of developing, testing, and refining models of physical systems, is gaining support as a key scientific practice, and is included in the new Framework for K-12 Science Education released by the National Research Council. Modeling Instruction, RealTime Physics, Matter & Interactions, and other model-based curricula have introduced a modeling emphasis to many classrooms at the high school and introductory college level, but there has been little move to include modeling in the upper-division lecture or lab courses. In this poster we present a framework for adopting modeling into existing lab courses as part of general strategy for scientific inquiry. We also present a model of laboratory modeling that includes modeling the physical and measurement systems and their relationship. We elucidate the framework through the specific example of a pendulum lab.

PST1H03: 8:30-9:15 p.m. Active Engagement Materials for Nuclear & Particle Physics Courses

Poster – Jeff Loats, Metropolitan State College of Denver, Denver, CO 80217; jloats1@mscd.edu

Ken Krane, Oregon State University

Cindy Schwarz, Vassar College

The past three decades of physics education research have seen the development of a rich variety of research-based instructional strategies that now permeate many introductory courses. Implementing these active-engagement techniques in upper-division courses requires effort and is bolstered by experience. This can impede instructors who might otherwise be eager to use these methods. This particular effort, funded by an NSF-TUES grant[1], aims to develop, test, and disseminate active-engagement materials for nuclear and particle physics topics. We will present examples of the materials being developed, including: a) Conceptual discussion questions for use with Peer Instruction; b) warm-up questions for use with Just in Time Teaching, c) "Back of the Envelope" estimation questions and small-group case studies that will incorporate use of nuclear and particle databases, as well as d) conceptual exam questions. A contributed talk on the same topic will also be presented at the meeting.

1. NSF award DUE-1044037

PST1H05: 8:30-9:15 p.m. Computing Across the Physics Curriculum

Poster – Ethan M. Dolle, Northern Arizona University, Flagstaff, AZ 86011-6010; Ethan.Dolle@nau.edu

Mark James, Kathy Eastwood, NAU

We have received a grant from the NSF CCLI Phase I program to integrate computing into our upper-division physics and astronomy curriculum. Our end product will be a set of learning materials in the form of Matlab computational modules that will be freely available. Computation applications are both qualitative and quantitative in nature and involve simulations and demonstrations during class as well as student explorations and homework assignments outside of class. Pedagogical goals, Matlab code, samples of student work, and instructor comments are included in each module. Information gathered from instructors and students provide insight into benefits and challenges of infusing computation into upper-division courses. We present an overview of the project as well as modules written for upper-division physics and astronomy courses, including mechanics, electromagnetism, quantum mechanics, thermal physics, and stellar and planetary astrophysics. We acknowledge the support of the NSF through DUE-0837368.

PST1H06: 9:15-10 p.m. Developing Research-based Materials for Upper-Division Electrodynamics

Poster – Charles Baily, University of Colorado, Boulder, CO 80309-0390; baily@colorado.edu

Steven J. Pollock, University of Colorado at Boulder

The PER group at the University of Colorado has spent several years researching student learning in the context of upper-division physics courses, and developing instructional materials designed to promote understanding of advanced topics in physics. We have recently expanded our previous efforts in the area of electrostatics, to include topics from junior-level electrodynamics, such as: Maxwell's time-dependent equations, boundary conditions, reflection and transmission of electromagnetic waves, and more. This poster provides an overview of the kinds of transformations we have incorporated into our second-semester E&M course, and offers examples of homework problems, concept tests, and other in-class activities we have developed.

PST1H07: 8:30-9:15 p.m. Enhancing the Experimental Experience: An Advanced Undergraduate Research Laboratory in Medical Physics

Poster – Daniela Buna, Ramapo College of NJ, Mahwah, NJ 07430; dbuna@ramapo.edu

Daniela Buna, Victoria Malczanek, Ramapo College of NJ

Laboratory experience in undergraduate physics is an essential component of the physics curriculum that in many instances seals the student's interest in physics and places the student on the path of graduate studies. Most undergraduate physics majors take two semesters of physics with calculus laboratory, one semester of Modern Physics and possibly another semester of laboratory usually associated with courses such as Electronics, Optics or Condensed Matter, atomic and nuclear physics. Small colleges such as Ramapo College of New Jersey do not offer the laboratory settings and equipment needed for advanced research in physics. However, based on the experience gained in Physics with Calculus and Modern Physics laboratory, a Medical Physics laboratory is a very rewarding experience for the students in the sense that is level appropriate for the junior year, it is based on solid foundation of Modern Physics and it introduces the student to an area that offers great job opportunities as well as an exciting lifelong career in interdisciplinary physics. We developed a Medical Physics laboratory which offers Gamma spectroscopy with a scintillation detector and a multichannel analyzer set-up, NMR measurements of resonance, relaxation rates, introductory spin sequences and signal processing via FFT, X-ray interaction with matter experiments, measuring absorption coefficients, radiation dose and interatomic spacing measurements via Bragg diffraction and an introduction to superconductors and measurements of resistivity of superconductors using SQUIDS. The physical phenomena studied are essential to the Medical Diagnostic Imaging equipment used in hospitals. The laboratory was offered very successfully to a group of 18 students in their junior/senior year, in 2011. The experience gained became very valuable when applying for summer REU internships and admission into graduate school.

PST1H08: 9:15-10 p.m. Instructor Expectations of Undergraduate Students Entering Quantum Mechanics

Poster – Christopher A. Oakley, Georgia State University, Atlanta, GA 30303; chris.oakley@gmail.com

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

Characterizing faculty expectations is important to produce a comprehensive understanding of what knowledge and skills students should acquire before and during a quantum mechanics course (QMC). We describe interviews conducted with faculty members in the Physics & Astronomy Department of Georgia State University. These interviews probe faculty members' expectations of senior undergraduate students' background in mathematics, physics, and quantum mechanics concepts before entering a QMC. The interviews we conducted may provide students with a "map" for areas that will help strengthen the knowledge and skills obtained in their QMC. We will report on faculty members views on optimal preparation for an undergraduate student entering a QMC and appropriate learning goals for a student completing a QMC.

PST1H09: 8:30-9:15 p.m. Affordances of Group Problem Solving Activities

Poster – Adam Kaczynski, University of Maine, Orono, ME 04473-5709; adam.kaczynski@maine.edu

Michael C Wittmann, University of Maine

Tutorial instruction is often an effective method of content instruction but does not address all of the goals we have as instructors. A new group problem-solving activity was implemented in a sophomore-level mechanics course at a four-year university in place of the series of tutorials on damped harmonic motion from Intermediate Mechanics Tutorials.[1] The activity was designed to support students in finding coherence between graphical, symbolic, and qualitative representations of an underdamped harmonic system through discussion of their known models and observations of the system. We will discuss how this new activity affords students the opportunity to authentically solve problems in comparison to the tutorials it replaced.

1. M. C. Wittmann, and B. S. Ambrose, *Intermediate Mechanics Tutorials,* available under a Creative Commons License at http://perlnet.umaine.edu/imt/.

PST1H10: 9:15-10 p.m. Benefits of Pre-Tutorial Homework Assignments in Advanced Thermal Physics Courses*

Poster – Trevor I. Smith, Dickinson College, Carlisle, PA 17013; smithtre@dickinson.edu

John R. Thompson, Donald B. Mountcastle, University of Maine

Over the past decade, guided-inquiry worksheet activities (a.k.a. tutorials) have become popular and effective supplements to lecture-based physics instruction at both the introductory and advanced levels. In our research and curriculum development efforts, we noticed that students were not completing some tutorials in the allotted time because they could not recall or re-derive prerequisite ideas, concepts, or formulas. We designed "pre-tutorial homework" (assigned after the pre-test to complete and bring to tutorial) to address this issue. We find the pre-tutorial homework to be effective for orienting students to the necessary prerequisite information and ideas, thus making the tutorial more time-efficient. We present the benefits of pre-tutorial homework in two cases: one in which a tutorial was modified after the first implementation to include a pre-tutorial homework, and one in which a tutorial was initially designed with a pre-tutorial homework.

*Partially supported by NSF grant DUE-0817282.

PST1H11: 8:30-9:15 p.m. Teaching New Tools to Majors: Computational Instruction in Upper Division Physics

Poster – Marcos D. Caballero, University of Colorado, Boulder, CO 80309; marcos.caballero@colorado.edu

Benjamin Zwickl, Steven J. Pollock, University of Colorado Boulder

Scientific programming is a key skill for our majors to develop in a research environment that relies increasingly on computational models and complex data analysis. Broad consensus of physics faculty at CU-Boulder is that instruction in scientific programming should not be limited to a single course (i.e., a computational physics course), but rather be embedded in the major sequence. This sentiment is echoed by a survey of physics majors. At CU-Boulder, we have begun systematic instruction in scientific programming in our middle-division classical mechanics and upper-division senior laboratory courses. We will outline our approach to computational instruction in both courses, present materials developed to achieve our learning goals, present our preliminary observations of student challenges and students' impressions of computation in these courses, and outline research directions for systematic instruction in scientific programming.

PST1H12: 9:15-10 p.m. Teaching Fourier Data Analysis and Wavelet Data Analysis of Data Records Containing Small Scale and Large Scale Features

Poster – Joseph J. Trout, Richard Stockton College of New Jersey, Galloway, NJ 08205-9441; joseph.trout@stockton.edu

Long-term temperature records contain small scale (short period) and long scale (long period) features that are of interest in the study of weather and climate. On the small scale, an atmospheric front can be defined as sloping zones of pronounce transition of thermal and/or wind fields in the atmosphere. These fronts occur during changing weather. On the large scale, yearly oscillations and longer term trends are of interest in the study of the climate. This study uses Fourier analysis to help students look at the long-term trends in atmospheric data and uses Wavelet Analysis to teach students to analyze the short-term transition zones.

PST1H13: 8:30-9:15 p.m. Students' Use of Eigenvalue Equations in Quantum Mechanics

Poster – Elizabeth Gire, University of Memphis, Memphis, TN 38152; egire@memphis.edu

Corinne A. Manogue, Oregon State University

Eigenvalue equations are used extensively and in a variety of ways when solving problems in quantum mechanics. We conducted semi-structured interviews of upper-level physics students in which students solved a problem related to quantum measurements. In a phenomenographic analysis of the students' solutions, we identified five roles that eigenvalue equations play in student reasoning about quantum measurements: a key for matching eigenvalues, eigenstates and operators; a substitution of an eigenvalue for an operator; a generator of eigenvalues and eigenstates; an instruction for generating a transformed state; and a template for interpreting a measurement. We discuss how these roles may be leveraged to improve student understanding and performance in quantum mechanics.

PST1H14: 9:15-10 p.m. Discussion of Relativistic Kinetic Energy Equation

Poster – Bharat L. Chaudhary, All India Radio, 11198 Gates Terrace, Johns Creek, GA 30097; bl_chaudhary@rediffmail.com

In physics, there are two formulas of kinetic energy, the first one is the classical formula, the other is the relativistic. The classical formula obeys the work-energy conservation principle as it shows the kinetic energy exactly equal to the work done; but the relativistic formula doesn't as it shows more kinetic energy than the work done. But, in both cases, the same force acts on the same body for the same distance and imparts the same speed--work done is the same. Hence, the same kinetic energy is delivered to the body. According to the conservation principle, we should get the same kinetic energy by both formulas. But, we don't get it. Therefore, the relativistic kinetic energy formula is something more than the conservation of work energy principle. We get something for nothing! Therefore, it is necessary to reexamine the derivation of the relativistic equation of kinetic energy.

PST1H15: 8:30-9:15 p.m. Newton's Second Law for an Electrically Charged Particle

Poster – Bharat L. Chaudhary, All India Radio, 11198 Gates Terrace ,Johns Creek, GA 30097; bl_chaudhary@rediffmail.com

Newton published his laws of motion in 1687. At that time the concept of charged particles was not known. Electromagnetic laws were discovered later but no attempt was made to combine that law with the Newton's second law to obtain a general equation of motion applicable to both charged and uncharged particles. My attempt in this paper is to combine the two laws to get a modified Newton's second law. According to Faraday's law of electromagnetic induction, an opposing force is created when a charged particle moves with an acceleration under the action of an applied force. The opposing force increases with speed and the resultant force decreases. This results in decreasing acceleration with speed. The whole thing is explained by combining both forces into one equation, "FORCE minus back-emf-force equals mass times acceleration," in place of, "Force equals mass times acceleration." It applies to both charged and uncharged particles at all speeds.

PST1H16: 8:30-9:15 p.m. Increased Half-life of Pions in Motion

Poster – Bharat L. Chaudhary, All India Radio, Johns Creek, GA 30097; India bl_chaudhary@rediffmail.com

Pions are radioactive charged particles. The half-life of pions in motion is longer than for pions at rest. This activity is explained on the basis of time dilation of special relativity. But, I have different ideas. They constitute a beam of parallel currents when in motion. This current has two effects.

One, as is well known, parallel currents attract each other. This attraction between the charged pions binds them together. This reduces the force causing their radioactive decay. Thus, increasing their half-life. The other reason is Faraday's law of electromagnetic induction which opposes any change. As the pions in motion tend to decay, the current tends to reduce. Faraday's law tends to maintain the original value of current by preventing their decay, thus increasing their half-life. Both reasons collectively increase the half-life of pions in motion. Source: "Introduction to Special Relativity," by Robert Resnick, p. 75.

PST1H17: 8:30-9:15 p.m. Inconsistencies in the Equations of the Special Theory of Relativity

Poster – Bharat L. Chaudhary, All India Radio, 11198 Gates Terrace, Johns Creek, GA 30097; bl_chaudhary@rediffmail.com

In this paper, I discuss the inconsistencies in the four equations of the special theory of relativity, starting with the equation of variation of mass with velocity and working up to the equation of the applied force, the equation of acceleration and finally, the equation of relativistic kinetic energy. By examining these equations, we find that the mass of a moving body increases as gamma times of its rest mass, the relativistic magnitude of the applied force increases as the cube of gamma times the initial applied force, the magnitude of the acceleration decreases as the inverse of gamma cube even though the magnitude of the applied force increases. And at last, we examine the relativistic equation of kinetic energy, which shows more kinetic energy than the actual work done. It is to be noted that the relativistic kinetic energy equation leads to the mass energy relation making it doubtful.

Session DA: International Perspectives on Laboratory Instruction

Location: Sheraton - Ben Franklin Ballroom I
Sponsor: Committee on Laboratories
Co-Sponsor: Committee on International Physics Education
Date: Tuesday, July 31
Time: 8:30–10:30 a.m.

Presider: Steven Wonnell

This invited and contributed session is on the role of laboratory experiments in the overall physics curriculum at the high school, college, and university levels. Insofar as it is possible, the emphasis is on learning different national values, practices, and goals for the laboratory experience in the overall implicit and explicit national curricular scheme.

DA01: 8:30-9 a.m. Novel Developments for Laboratory Instruction in the EU*

Invited – Wolfgang Grill, Institute of Experimental Physics II, University of Leipzig, Linnestr. 5 Leipzig, 04103 Germany; grill@physik.uni-leipzig.de

Albert Kamanyi, Institute of Experimental Physics II, University of Leipzig

Due to efforts and regulations under way to unify higher education in the European Union, the curricula for physics studies have lately been altered substantially. This has led to a reduction of the rather extensive instruction in dedicated laboratories and respective courses, traditionally featured at the continental European universities. Some of the major changes are presented with examples from respective education programs in Germany and neighboring countries. Also exemplified and demonstrated with experiments are our efforts to find new ways to introduce teaching by suitable technological developments with the use of hands-on experiment supported lectures in courses. This is a supplement to otherwise special laboratories with permanently set up individual experiments as in the traditional introductory and advanced physics laboratory for students. These efforts concentrate on compact, laptop-operated universal electronic based signal generation and detection hard- and software, representing a down to earth and low budget spin-off from equipment and software developed by us and installed in the Materials Science Laboratory of the International Space Station. The portable system is used with the appropriate software to perform experiments ranging from basic measurements (voltmeter, oscilloscope) to state-of-the-art studies (correlation based ultrasonic structural health and load monitoring of aircrafts and civil structures).

*Support by ASI Analog Speed Instruments GmbH and within the project AISHAII of the European Commission under the European Union 7th Framework Programme (Aircraft Integrated Structural Health Assessment II, EU-FP7-CP212912) is gratefully acknowledged.

DA02: 9-9:30 a.m. What Kelvin Started, We Continue – A UK Perspective on Laboratory Teaching

Invited – Peter H. Sneddon, University of Glasgow, Kelvin Building, Glasgow, G12 8QQ, United Kingdom; Peter.Sneddon@glasgow.ac.uk

Teaching laboratories form a cornerstone of physics courses at all levels in the United Kingdom. The first was introduced by Lord Kelvin, in 1855, at the University of Glasgow. The AAPT has a published list of goals for laboratory teaching, and in the United Kingdom the professional body for the subject, the Institute of Physics, has similar clear aims. But whilst the professionals agree that laboratories are vital, what about the students who receive them? In this presentation, I will detail work that has been carried out over the last five years looking at the attitudes towards, and experiences of, laboratory learning of students at institutions throughout the United Kingdom. This study concluded that students found laboratories enjoyable and useful, playing a key role in improving their understanding of course material. It improved their confidence, and broadened their skills base.

Tuesday, July 31 Highlights

REGISTRATION	7 a.m–4:30 p.m.	HH - Reading
Fun Run/Walk	7–8 a.m.	31st and Walnut
Exhibit Hall Opens	10 a.m.–4 p.m.	HH - Hall of Flags/Bodek Lounge
B&N NOOK Raffle	10:45 a.m.	HH - Hall of Flags

PLENARY 11 a.m.–12 p.m. Inn at Penn - Woodlands Ballroom

J. Richard Gott —"Sizing Up the Universe"

PLENARY 3:30–4:30 p.m. Inn at Penn - Woodlands

Nima Arkani-Hamed —"Space-Time, Quantum Mechanics and the Large Hadron Collider"

COMMERCIAL WORKSHOPS

CW01: Expert TA	12-1 p.m.	Sheraton - Univ. Suite
CW02: Pearson	12:30-1:30 p.m.	Inn at Penn - Regents/St. Marks
CW03: Vernier	4:30–6:30 p.m.	Inn at Penn - Regents/St. Marks

COMMITTEE MEETINGS, 12–1:30 p.m.

–History and Philosophy	IA - G7
–Minorities in Physics	IA - G16
–International Physics Education	HH - Golkin
–Science Education for the Public	HH - Branchfeld

Afternoon Break	3–3:30 p.m.	HH - Hall of Flags/Bodek
B&N NOOK Raffle	3:15 p.m.	HH - Bodek Lounge

COMMITTEE MEETINGS, 4:30–6 p.m.

–Physics in Undergraduate Educ.	IA - G01
–Interests of Senior Physicists	IA - G16
–Apparatus	HH - Class of 47
–Physics in Pre-High School Educ.	IA - G7

PHILADELPHIA TROLLEY TOUR 7:30–8:30 p.m.

Starts at Houston Hall

AAPT DEMO SHOW 9–10 p.m.

Inn at Penn - Woodlands Ballroom

Poster Session II 6–7:30 p.m. HH - Bistro

KEY: IA = Irvine Auditorium
HH = Houston Hall
CCH = Claudia Cohen Hall

DA03: 9:30-10 a.m. First Year Experiments: Back to Thinking!

Invited – Saalih Allie, University of Cape Town, Rondebosch 7780, South Africa; saalih.allie@gmail.com

Experimentation and deductive reasoning based on experimental data lies at the heart of physics. Yet this aspect of physics is generally neglected in favor of covering theoretical topics in introductory physics courses. First-year physics students at the University of Cape Town come from a wide range of socio-economic backgrounds with the most disadvantaged being least likely to have had either hands-on experience with apparatus or exposure to teaching methods that included critical thinking. Traditional cookbook laboratory experiments, while perhaps addressing the former, inhibit rather than encourage the latter, e.g. tasks are framed in a manner that encourages a world view based on authority rather than one that rewards exploration and original thinking. I will discuss attempts to address this issue by reformulation of the traditional laboratory tasks in a way that removes the "authority" aspect and focuses on interpreting the data at hand.

DA04: 10-10:10 a.m. What Should Students Know Before Using Physics Lab Equipment?

Contributed – Ann Schmiedekamp, Penn State University, Abington, 1600 Woodland Rd., Abington, PA 19001; ams@psu.edu

Carl Schmiedekamp Penn State University, Abington

Tim Harrison University of Bristol, Bristol, U.K.

Pre-lab instruction to ensure good laboratory technique and proper usage of equipment is a common practice. Software to support pre-lab work was developed within Bristol ChemLabS, University of Bristol, UK, has been in use for five years. Its impact has been recognized through a national award, distribution of a resource to all UK secondary schools by the Royal Society of Chemistry (in association with Pfizer) and the commercialization of elements through Foundation Chemistry LabSkills in use worldwide. The UK's Higher Education Academy is now funding a project to produce a software resource to support the transition between high school and first-year undergraduate in the understanding of key lab skills in both physics and biology. An international committee has identified key areas of pre-lab instruction in physics and seeks additional feedback.

DA05: 10:10-10:20 a.m. Experimental Physics in an International High School in Spain

Contributed – Aurora Vicens, Agora Portals International School, Carretera Vella Andratx s/n Calvià, (Mallorca), 07181 Spain; aurora.vicens@agoraportals.edu.es

Traditionally, the laboratory experience for a science student in Spain is relatively small. This presentation is about the design and implementation of an experimental curriculum in a new international school established in Mallorca. Students come from different countries and academic, cultural, and language backgrounds and will continue their college educations in or outside Spain. The project involves looking at the Spanish science curriculum and designing labs that fit in the curriculum and teach skills that eventually make good, independent experimentalists. The challenges and joys of starting a science program with an experimental component are discussed and evaluated.

DA06: 10:20-10:30 a.m. Understanding Effects of Newtonian Physics Through a Lab-Traditional-based Instruction Comparison

Contributed – Sergio Flores, University of Juarez, 1424 Desierto Rico, El Paso, TX 79912; seflores@uacj.mx

Maria Dolores Gonzalez, Juan Ernesto Chavez, Sergio Miguel Terrazas, Juan Luna, University of Juarez

The Physics II course is based on fundamental dynamics contents and is mandatory for all majors in the University of Juarez. Several investigations related to Newtonian physics conceptual learning have found important understanding problems. The students in this course have to develop a functional understanding about concepts such as velocity, acceleration and Newton's second law. In the best case, students learn these concepts as isolated elements with a lack of relationship of the vector properties not only of the physical variables, but also of the equations that relate these variables and model motion. To explore understanding effects and the conceptual versatility students develop through a lab environment, we present an investigation to compare two Physics II groups, one of them under a traditional-base learning process in the classroom, and the other in the physics lab instruction throughout a complete semester. The evaluation elements during the cognitive journey are similar for both groups. One of the micro-curriculum differences is the use of material and equipment by the lab group in all of the sessions. The observations show that despite the better results of the lab group (experiment group) in most of the tests, the control group ended the semester with a better effective learning gaining.

Session DB: Physics and Society

Location: Sheraton - Ben Franklin Ballroom II
Sponsor: Committee on Science Education for the Public
Date: Tuesday, July 31
Time: 8:30–10:30 a.m.

Presider: Art Hobson

Hear ideas about educating public school and college students, and adults, about such physics-related social topics as energy resources, environment, nuclear weapons, pseudoscience, the scientific process, and creating a healthier and more peaceful world.

DB01: 8:30-9 a.m. Teaching the Physics of Climate Change

Invited – Peter J. Collings, Swarthmore College, Swarthmore, PA 19081; pcollin1@swarthmore.edu

A general education course on the Earth's climate and global warming must utilize concepts from atmospheric science, oceanography, and geology, just to name a few disciplines. But basic physics principles are scattered throughout the discussion, and thus represent an interesting opportunity to teach physics to students who might never take an undergraduate physics course but are motivated to learn about climate change. The range of physics that must be understood by the students is quite broad, but black-body radiation and molecular absorption are the most important. Such a course has been taught at Swarthmore College for the past three years.

DB02: 9-9:30 a.m. A Non-Scientists' Course on Energy Use and Production

Invited – Gary Bernstein, University of Pennsylvania, Philadelphia, PA 19104; garyb@physics.upenn.edu

A general-education course on "Energy, Oil, and Global Warming" has been part of Penn's physics curriculum for the past five years. The course offers an opportunity to teach quantitative reasoning skills and many fundamental physical concepts to non-scientists through applications that are highly motivating to the students, while at the same time increasing the competence of future leaders in issues of great import to society. I will describe the structure and physics content of the course, which emphasizes the production and consumption of energy, and relay lessons learned by a teacher who had no previous experience in the energy field.

DB03: 9:30-9:40 a.m. Vermiculture in the Classroom

Contributed – Frank Bellomo, St. Elizabeth High School, 1500 Cedar St., Wilmington, DE 19805; fbellomo@viking.pvt.k12.de.us

With diminishing natural resources, there is a global challenge to feed an increasing population despite the depletion of our planet's healthy soil. We decided to embrace sustainable practices by using nature's own principles. In our classroom, students recycled their family's garbage by composting fruit and vegetable food scraps. They used vermiculture, raising earthworms, to create living soil without chemical fertilizers. Along the way students explored the biology of earthworms, the chemistry of rotting food, and the physics of energy transfer. From sunlight to vegetation to decomposition to digestion, students saw the regeneration of rich earth to once again grow vegetables to nourish humans. The economics of the project included free raw materials from kitchens and free labor from earthworms to make high value compost. Students then found a market for their composted soil and worms with local organic gardeners.

DB06: 9:40-9:50 a.m. Nuclear Questions, Nuanced Answers

Contributed – Kathryn K. Schaffer, School of the Art Institute of Chicago, 112 S. Michigan Ave., Chicago, IL 60603; kschaf2@saic.edu

Real-world questions that students and citizens have about radiation and nuclear technology (such as "is it safe for people to live near the damaged Fukushima reactors"?) often require surprisingly subtle scientific responses. I will describe an approach to teaching about nuclear technology that emphasizes messy and subtle questions, to encourage critical reflection on science in context. Students are challenged to construct nuanced and scientifically correct responses to common real-world questions. To do this, they must address: is the question answerable by science as phrased? Do differences in lay and technical use of vocabulary need to be resolved? Are there ways in which the answer might be "yes" and "no" at the same time? Are there limitations to our knowledge, or aspects of the scientific process that are important here? This approach engages students with the complexities of science in context, while also addressing common misconceptions about radiation and nuclear physics.

DB07: 9:50-10 a.m. Integrating Sustainability Across the Science Curriculum of Gustavus Adolphus College

Contributed – Charles F. Niederriter, Gustavus Adolphus College, Saint Peter, MN 56082; chuck@gustavus.edu

Amy Audette, Kevin Clark, Jeff Jeremiason, Colleen Jacks, Gustavus Adolphus College

We live in an era when student interest in energy, sustainability, and the environment is increasing, as it becomes clear that our current production and consumption of energy negatively impacts the environment and raises a number of potentially significant challenges for the future. The primary goal of the CCLI project we undertook was to improve science education at Gustavus and other colleges across the country by taking advantage of this trend. Integrating sustainability across the science curriculum is an excellent way to educate students about this important area while teaching quantitative skills and increasing interest and enthusiasm for science. We will report on two year's work developing laboratory and classroom experiences and discuss plans for future work.

DB08: 10-10:10 a.m. Your Personal Contribution to Global Warming: Calculating Your Carbon Footprint

Contributed – Barbara M. Hoeling, California State Polytechnic University, Pomona, Physics Dept., 3801 W. Temple Ave., Pomona, CA 91768; bmhoeling@csupomona.edu

Discussions of CO_2 emissions and their effect on global warming are an important part of every course that covers topics related to energy and the environment. However, the personal relevance of these issues and the impact of their own life style do not always become clear to students. In our upper division general education course "Energy & Society," we assign students the project of calculating their personal carbon footprint by evaluating their household's electricity and natural gas bills as well as their gasoline consumption. We will present the results of these studies, together with students' comments and reactions.

Session DC: Teaching Scientific Programming from Intro to Upper Level Physics

Location: Sheraton - Ben Franklin Ballroom III
Sponsor: Committee on Physics in Undergraduate Education
Date: Tuesday, July 31
Time: 8:30–10:30 a.m.

Presider: Craig Wiegert

Scientific programming is an increasingly valuable skill for physicists, whether they're writing simulations, exploring theoretical models, or analyzing complex data. How and when should this training be incorporated into the curriculum? Can it help students understand physics better?

DC01: 8:30-9 a.m. Implementing and Assessing Computational Modeling in Large Introductory Physics Courses*

Invited – Michael F. Schatz, Georgia Tech, Atlanta, GA 30308; mike.schatz@physics.gatech.edu

Scott S. Douglas, Edwin F. Greco, Georgia Tech

Marcos D. Caballero, University of Colorado, Boulder

Computation is a cornerstone of modern science and engineering; however, introductory STEM courses rarely embed computation into the curriculum. Since Summer 2006, computational modeling has been increasingly integrated into introductory engineering physics courses at Georgia Tech; currently, more than 1000 Georgia Tech students annually enroll in a large lecture introductory course that includes computation. Initially, student experiences with computational modeling were limited chiefly to the laboratory; more recently, students have begun to solve numerically homework problems (delivered online via a standard course administration system) and to model real-world problems computationally in extra credit assignments presented and peer-reviewed in video format. We will discuss some key issues associated with integrating computation into large-enrollment introductory courses and describe our efforts to measure the impact of computational curricular materials on student learning.

*Supported by NSF DUE-0942076 and DUE-0618519

DC02: 9-9:30 a.m. Lowering the Barriers for Scientific Computing

Invited – Larry Engelhardt, Francis Marion University, Florence, SC 29502; lengelhardt@fmarion.edu

Most physicists recognize the importance of scientific computing; and Fortran, C, Excel, Maple, and MATLAB have all been available for more than 25 years. So why has the growth of computation in the undergraduate physics curriculum been so slow in coming? We need--and I believe we finally HAVE--computational tools that offer more: tools that are open source (unlike Excel, Maple, and MATLAB); make programming as easy as possible (unlike Fortran and C); and provide "sexy" interfaces. I will address these issues in three ways: (1) open source tools that can be used as a "black box," without any programming whatsoever, for standard computational tasks; (2) using the Python programming language to make simple tasks truly simple; and (3) using Easy Java Simulations (EJS) to make interactive computer simulations with minimal computer programming. For more information, see my contributions to the Open Source Physics library at www.tinyurl.com/engelhardt-comp.

DC03: 9:30-10 a.m. Motivating Computational Physics Education: Angry Birds and the Ising Model*

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

Computational physics has broad appeal since it is an effective way to develop problem solving skills and to become computer literate. Students themselves perceive that they are not well educated without a good understanding of a computer's power and its limitations. However, a computational physics course must be flexible because students have different skills and varying levels of preparation. Some students write well; other students have good graphical design skills; and other students have mathematical ability. In addition, students typically have professional goals other than physics graduate school. This paper describes a project-based course that meets these needs. Learning to develop a program that communicates an idea, as well as learning syntax and numerical methods, is a goal of this course. The course material and numerous student projects are published in the OSP Collection on ComPADRE at: http://www.compadre.org/osp/.

*Partial funding for this work was obtained through NSF grants DUE-0442581 and DUE-0937731.

DC04: 10-10:10 a.m. Computational Modeling as a Promoter of Cognitive Transfer: Pilot Study

Contributed – Scott S. Douglas, Georgia Institute of Technology, Atlanta, GA 30309; scott.s.douglas@gatech.edu

Marcos D. Caballero, University of Colorado at Boulder

Michael F. Schatz, Georgia Institute of Technology

We describe a study of the role of computational modeling in recognizing underlying similarities in different problems, a process called cognitive transfer. Previous studies have shown that this crucial process is highly sensitive to context, suggestion, and familiarity with the subject matter. We propose that courses emphasizing computational modeling, in which students repeatedly employ similar lines of code to model different physical systems, foster a more generalized cognitive transfer ability. We performed a think-aloud study on several students (some from a course involving computational modeling, others from a traditional physics course), exposing them to ordered pairs of problems of varying degrees of separation in specific details (molecular mechanics vs. projectile motion) and solution methods (numerical vs. analytical). With these data, we attempt to separate the influence of long-term instruction in computational modeling from the immediate priming effect of solving computational problems, and relate both to the promotion of cognitive transfer.

DC05: 10:10-10:20 a.m. Teaching New Tools to Majors: Computational Instruction in Upper Division Physics

Contributed – Marcos D. Caballero, University of Colorado, Boulder, CO 80309; marcos.caballero@colorado.edu

Benjamin Zwickl, Steven J. Pollock, University of Colorado Boulder

Scientific programming is a key skill for our majors to develop in a research environment that relies increasingly on computational models and complex data analysis. Broad consensus of physics faculty at CU-Boulder is that instruction in scientific programming should not be limited to a single course (i.e., a computational physics course), but rather be embedded in the major sequence. This sentiment is echoed by a survey of physics majors. At CU-Boulder, we have begun systematic instruction in scientific programming in our middle-division classical mechanics and upper-division senior laboratory courses. In this talk, we will briefly outline our approach to computational instruction in both courses, present our preliminary observations of student challenges, and discuss our students' impressions of computation in these courses.

DC06: 10:20-10:30 a.m. Advanced Lab Fourier Analysis and Wavelet Analysis Using Mathematica

Contributed – Joseph J. Trout, Richard Stockton College of New Jersey, 101 Vera King Farris Dr., Galloway, NJ 08205-9441; joseph.trout@stockton.edu

This is an advanced lab to introduce data analysis using Fourier and wavelet analysis and to study the effects of "noise" in the signal. Sound recordings are made of tuning forks and voice recordings. Fourier and wavelet analysis of the recordings are made using Mathematica. Random noise is introduced and the analysis completed a second time. The noise is then filtered and the Fourier and wavelet analysis is completed a third time.

Session DD: Preparing Teachers to Serve Diverse Communities

Location: Sheraton - Ben Franklin Ballroom IV
Sponsor: Committee on Minorities in Physics
Co-Sponsor: Committee on Teacher Preparation
Date: Tuesday, July 31
Time: 8:30–10:10 a.m.

Presider: Peter Muhoro

Students in high minority schools are less likely to have access to high-quality physics instruction. This session will explore issues, needs, challenges, and successes in preparing physics teachers to serve diverse communities.

DD01: 8:30-9 a.m. Teachers' Roles in Expanding Physics Participation Among Urban Students

Invited – Angela M. Kelly, Stony Brook University, Life Sciences, Stony Brook, NY 11794-5233; angela.kelly@stonybrook.edu

The accessibility of secondary physics in U.S. urban school districts is a complex issue. Many schools do not offer a physics option, and for those that do, access is often restricted by various school policies and priorities that do not promote physics participation for all. Strategies to encourage physics participation for underrepresented students will be discussed, based on current research and discussions with urban physics teachers. Other solutions will be explored regarding the preparation of pre-service physics teachers for diverse settings, strengthening administrative commitment to physics, and improving physics quality with limited resources.

DD02: 9-9:30 a.m. Building a Supportive, Differentiated Environment with High Expectations

Invited – Karen King, University of Missouri, Columbia, MO 65211; kingkar@missouri.edu

As a founding physics teacher at a diverse urban high school with a great range in student proficiency, I worked to help students achieve success by building a community with high expectations that employed a variety of differentiation techniques, accountability measures, and mentoring strategies. Formative assessments played a critical role in identifying student understanding, followed by differentiated options for students to re-learn material or to engage in more challenging content. Inquiry activities in which students were expected to design parts or all of their investigation were also critical to addressing individual needs. Accountability for learning was encouraged through daily homework checks including a requirement that incomplete work was finished after school; tutoring was mandatory for underperforming students; and student progress was monitored in weekly teacher meetings. Most importantly, the supportive learning community celebrated student successes, offered leadership opportunities, and convinced students that we cared deeply about them.

DD03: 9:30-10 a.m. The Role of Community and Professionalism in the Preparation of Physics Teachers for the Urban Learning Environment*

Invited– Mel S. Sabella, Chicago State University, Chicago, IL 60628; msabella@csu.edu

Jennie Passehl, Perspectives High School of Technology

Kara Weisenburger, Harper High School

Andrea G. Van Duzor, Chicago State University

The preparation of physics teachers is extremely complex and relies on the shared experiences of a variety of physics practitioners who understand and embrace their roles in recruiting, preparing, and supporting future teachers. University faculty, high school teachers, and pre-service teachers themselves all contribute to the development of teacher candidates and teacher education programs. It is only through an understanding of shared responsibility that these practitioners can build structures in secondary education programs for effective preparation of teachers. Joint ownership of teacher education responsibilities and the emphasis on professionalism are especially important for those who will serve students in the urban community. In this talk we discuss specific components of the CSU Physics Teacher Preparation Program that we have implemented as a result of the National Science Foundation Noyce Program and the American Physical Society PhysTEC Program that we believe establish a community of individuals that co-contribute to preparing teachers for the urban learning environment.

*Supported by the NSF (Grant 0833251) and the American Physical Society (PhysTEC).

DD04: 10-10:10 a.m. Why (And How) I Do What I Do

Contributed – Jonathan P. Smythe, 7035 Blair Rd., NW, Apt. 405, Washington, DC 20012; jonathan.smythe@gmail.com

Coming from the diverse educational background of Peekskill High School and Cornell University, education has always been at the forefront of my priorities. So it seems fitting that I would choose to become a teacher and help improve the lives of many generations to come. Teaching in inner-city D.C. with some of the toughest students in the country was something I did not see myself getting into. I will be discussing the paths that led me to this career choice as well as this location. I'll also discuss the pros and cons of working in D.C. in an alternative high school as well as things I want to improve on and things I will take away from this year.

Session DE: Upper Division Undergraduate Education

Location: Sheraton - Ben Franklin Ballroom V
Date: Tuesday, July 31
Time: 8:30–10:20 a.m.

Presider: TBA

DE01: 8:30-8:40 a.m. The Experiences of Women in Physics Education Research Graduate Programs

Contributed – Ramon S. Barthelemy, Western Michigan University, Kalamazoo, MI 49009 ;ramon.s.barthelemy@wmich.edu

Charles R. Henderson, Megan L. Grunert, Western Michigan University

Though no direct research has documented the number of women in Physics Education Research (PER), studies have suggested the percentage of women in PER is almost double that of physics overall.* This relative over-representation shows that PER may be a leader in recruiting and retaining female graduate students. The study presented here seeks to understand the experiences of women graduate students in PER through in-depth open-ended interviews. By understanding the positive aspects that draw a larger percentage of women to PER it may be possible to construct best practices to make other areas of physics more amenable to students from all under-represented groups.

* Henderson C., Barthelemy R., Mestre J., Finkelstein N. (2011). Physics Education Research Funding Census. Physics Education Research Conference Proceedings.

DE02: 8:40-8:50 a.m. Adding Distance Learning to an Advanced Undergraduate Physics Course

Contributed – S. Clark Rowland, Andrews University, Berrien Springs, MI 49104; rowland@andrews.edu

Requests for advanced undergraduate physics courses from students who cannot attend classes on campus have motivated us to experiment with various modes of distance learning. In the fall of 2010 our Theoretical Mechanics I course was taught using Adobe Connect. Use of a Hewlett Packard TouchSmart 600 computer allowed me to write on the screen. Each student used a laptop with camera and microphone. Lecture notes were prepared in advance and appeared on the screen with a live picture of each participant. Class participation was similar to usual classes without computers. In the fall of 2011 an agreeable time could not be found for this kind "online" class. To include a remote student asynchronously, a video of each class was made and uploaded to a server for subsequent viewing and discussion by phone. Our experience using these technologies will be discussed.

DE03: 8:50-9 a.m. Active Engagement and Interactive Classroom Techniques in Reformed Upper-Division Quantum Mechanics Courses

Contributed – Homeyra R. Sadaghiani, Cal Poly Pomona, 3801 West Temple Ave., Pomona, CA 91768; hrsadaghiani@csupomona.edu

We have reformed an upper-division quantum mechanics course using principles of active engagement and interactive classroom techniques such as peer discussion strategies. The teaching practices, learning goals, and curricular materials were developed and adopted from research in physics education. Conceptual clicker questions, white-board problem solving activities, research-based tutorials, and computer lab sessions were integrated into a two-quarter sequence of a senior level quantum mechanics course at Cal Poly Pomona. Using Quantum Mechanics Assessment Tool (QMAT) we investigated several key student skills at the end of the first and second quarter. As the course focus varied from mathematical process-driven approaches in the context of the quantum wave-function to more concept-driven approaches in the context of quantum spin measurement, we observed some changes in student performance and attitude. We will discuss the implications of this study for the order and selection of topics in teaching undergraduate quantum courses.

DE04: 9-9:10 a.m. Active Engagement Materials for Nuclear & Particle Physics Courses

Contributed – Jeff Loats, Metropolitan State College of Denver, Denver, CO 80217; jloats1@mscd.edu

Ken Krane, Oregon State University

Cindy Schwarz, Vassar College

The past three decades of physics education research have seen the development of a rich variety of research-based instructional strategies that now permeate many introductory courses. Implementing these active-engagement techniques in upper-division courses requires effort and is bolstered by experience. This can impede instructors who might otherwise be eager to use these methods. This particular effort, funded by an NSF-TUES grant[1], aims to develop, test, and disseminate active-engagement materials for nuclear and particle physics topics. We will present examples of the materials being developed, including: a) Conceptual discussion questions for use with Peer Instruction; b) warm-up questions for use with Just in Time Teaching, c) "Back of the Envelope" estimation questions and small-group case studies that will incorporate use of nuclear and particle databases, as well as d) conceptual exam questions. An associated poster will also be presented at the meeting.

1. NSF award DUE-1044037

DE05: 9:10-9:20 a.m. Eliciting Physics Faculty Expectations for Physics Majors

Contributed – Renee Michelle Goertzen, Florida International University, Miami, FL 33199; rgoertze@fiu.edu

Eric Brewe Florida, David Brookes, Laird Kramer, Florida International University

As part of a project to investigate the goals physics faculty hold for physics majors, we have interviewed 17 physics faculty about what attitudes and abilities they expect students to have developed by the time they graduate with a bachelor's degree from our institution. Our preliminary analysis of the interviews suggests that some of these goals are both implicit and constructed in-the-moment in response to interview prompts. Understanding the nature of physics faculty expectations will allow us to better assess whether students meet these expectations, as well as whether physics programs standards adequately capture faculty goals. In the longer term, our goal is to investigate whether physics programs are providing sufficient opportunities for students to develop these desired attitudes and abilities.

DE06: 9:20-9:30 a.m. Majoring in Physics or Astronomy? Answer is in Students' Past*

Contributed – Florin D. Lung, Department of Engineering and Science Education, Clemson University, Clemson, SC 29634; florinlung@gmail.com

Geoff Potvin, Department of Engineering and Science Education, Department of Mathematical Sciences, Clemson University

Philip M. Sadler, Gerhard Sonnert, Science Education Department, Harvard-Smithsonian Center for Astrophysics

While investigating the career options expressed by college students, among the ones who opted for physical sciences we discovered an interesting effect. Students born in the U.S. tended to be more associated with astronomy, as opposed to foreign-born students, who are more associated to choosing physics instead of astronomy majors. This result is in line with some previous survey data on physics and astronomy PhD recipients reported by AIP in 2011. Starting from this finding, we further investigated other variables related to students' cultural and scientific experiences that are likely to differentiate between astronomy and physics majors.

*This work was supported by NSF Award GSE 0624444.

DE07: 9:30-9:40 a.m. Resources for Research-based Instruction in Upper-Division Physics

Contributed – Bethany R. Wilcox, University of Colorado, Boulder, CO 80302; Bethany.Wilcox@colorado.edu

Stephanie V. Chasteen, Marcos D. Caballero, Charles R. Baily, Benjamin Zwickl, University of Colorado at Boulder

The University of Colorado at Boulder is in the process of reforming five of its upper-division physics courses (Electricity & Magnetism 1&2, Quantum Mechanics 1, Classical Mechanics 1, and Optics & Modern Physics Lab) to incorporate active engagement and student centered pedagogies. Our research-based approach to course transformation is founded on (1) investigations of student difficulties, (2) collaboration with faculty to establish consensus learning goals, (3) development of validated, subject specific conceptual assessments, (4) and iterative design of curricular materials. We have compiled online archives of these materials, representing a rich suite of resources for instructional innovation across upper-division physics. In this talk, we will overview these resources with particular emphasis on how the reforms are tailored to each course. Our work also hints at the need for more unified reforms spanning multiple courses to provide a coherent experience for physics majors as they progress through the physics sequence.

DE08: 9:40-9:50 a.m. Teaching Modern Physics to Mathematically Underprepared Students

Contributed – Deepthi Amarasuriya, Northwest College, Powell, WY 82435-1887; deepthi.amarasuriya@northwestcollege.edu

Many students take Modern Physics together with Differential Equations I, and Linear Algebra. As Modern Physics relies heavily on concepts and techniques covered in these math courses, it is challenging to teach the physics while students are struggling with the rudiments of the requisite mathematical background. I present some strategies I continue to implement in my Modern Physics course that help me teach the material effectively while helping students build a strong mathematical foundation.

DE09: 9:50-10 a.m. What it Means to Work as a Physicist

Contributed – Magdalen Normandeau, University of New Brunswick, Fredericton, NB E3B 5A3 Canada; mnormand@unb.ca

There is a big difference between undergraduate course work and the work done after graduation. To help our students choose the right post-baccalaureate path, it is important that we help them understand this difference and become aware of what it means to work as a physicist. To this end, I included an interview-based project in two upper-level courses. As part of this project, each student investigated the work of a living physicist then interviewed that person to find out more about his/her work and how the interviewee came to be in his/her current position. Students shared their insights with each other at the end of term during a round-table debriefing session, and each student received copies of all reports. I present the logistics involved in this project, share the results of its first implementations, and offer advice and suggestions for anyone wanting to incorporate something similar in their courses.

DE10: 10-10:10 a.m. Data Processing of the Frank-Hertz Experiment

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

Jianmin Yuan, Fudan University

Frank-Hertz experiment is a widely employed teaching lab in modern physics. The first excitation energy is evaluated from the peak intervals in the I-V curve. Puzzling results come forth frequently: the peak interval increases monotonously with the acceleration voltage (VA) and the slope is temperature dependent, as the electrons contributing to the current have a specific energy distribution. Peaks in I-V curve occur when the current decrease caused by electrons undergoing inelastic collision balances the increase of background current (IB) with increasing VA. The increase of IB increasing rate results in larger peak intervals at higher VA. Differentiation of the I-V curve will dramatically reduce the influence of IB variation on the evaluated results. This paper reports the realization of this approach and results obtained. Thus new insights into the classical FH experiment will be further discussed.

DE11: 10:10-10:20 a.m. New Way of Deriving Einstein's Mass Energy Relation

Contributed – Bharat L. Chaudhary, All India Radio, 11198 Gates Terrace, Johns Creek, GA 30097; bl_chaudhary@rediffmail.com

Mass energy relation is the most important and most famous equation of the special theory of relativity. Every student of physics should know its derivation and be able to derive it any time. The basic principle of its derivation is to find the work done by a force in displacing a body to some distance. In textbooks, it is derived in one step by multiplying the force with the distance and integrating the expression from zero to the distance travelled. The process becomes involved and complicated and difficult to follow and more difficult to remember. I have derived the equation in a new and simple way in two steps. First, I find the expression of force by the relativistic way and then multiply the expression of force with the distance and integrate it from zero to the distance travelled. This two- step process is easy to follow and remember.

Session DF: PER: Topical Understanding Intro to Advanced

Location: Houston Hall - Class of 49
Date: Tuesday, July 31
Time: 8:30–10:30 a.m.

Presider: MacKenzie Stetzer

DF01: 8:30-8:40 a.m. Do Students Read the Text? Analyzing Interactions with Online E-texts

Contributed – Daniel T. Seaton, Massachusetts Institute of Technology, Cambridge, MA 02139; dseaton@mit.edu

Yoav Bergner, Gerd Kortemeyer, Saif Rayyan, David E. Pritchard, Massachusetts Institute of Technology

We analyze logged data of student interactions with supplemental e-texts in introductory physics courses at Michigan State University via LON-CAPA. The e-text contains standard text and some interactive content such as videos and simulations. Metrics include what fraction of students access the e-text, at what time with respect to academic deadlines, and for how long. Preliminary results show moderate usage peaks for each weekly assignment that decline to near-zero over the early part of the semester, with large constant peaks of activity in the approximately two days prior to all examinations. We find that only a small minority of the students access the majority of the e-text; however we cannot measure reading of an assigned written textbook. We plan to investigate the e-text study habits of successful students at MSU, MIT, and in our free online physics course (http://relate.mit.edu/physicscourse/).

DF02: 8:40-8:50 a.m. Item Response Theory and Collaborative Filtering: Is Your Course Unidimensional?

Contributed – Yoav Bergner, Massachusetts Institute of Technology, Cambridge, MA 02139; bergner@mit.edu

Stefan Droschler, Ostfalia & MIT

Daniel Seaton, David E. Pritchard, Massachusetts Institute Technology

Gerd Kortemeyer, Michigan State University

Online homework is a natural way to assess what students know, but the questions themselves may not always fit the bill. Items may be flawed, too hard or too easy, or they may measure abilities that are different from the intended ones. Item response models not only measure student abilities independently of which subset of questions they answer, but these models also detect flaws in the questions. We demonstrate how collaborative filtering (used by Netflix to predict which movies you might like) can be used to analyze student response data, motivating and extending a class of item response models. Analysis shows that chemistry homework assigned using LON-CAPA at MSU has two-dimensional skill and discrimination, whereas the Mechanics Baseline Test at MIT is unidimensional.

DF03: 8:50-9 a.m. Research on Students' Interdisciplinary Reasoning About ATP*

Contributed – Benjamin W. Dreyfus, University of Maryland, College Park, MD 20742-4111; dreyfus@umd.edu

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

Students' sometimes contradictory ideas about ATP (adenosine triphosphate) and the nature of chemical bonds have been studied in the biology and chemistry education literature, but these topics are rarely part of the introductory physics curriculum. We present qualitative data from an introductory physics course for undergraduate biology majors that seeks to build greater interdisciplinary coherence and therefore includes these topics. In these data, students grapple with the apparent contradiction between the energy released when the phosphate bond in ATP is broken and the idea that an energy input is required to break a bond. We see that students' perceptions of how each scientific discipline bounds the system of interest can influence how they justify their reasoning about a topic that crosses disciplines. Building interdisciplinary coherence requires attending to these interdisciplinary issues, as part of both curriculum design and education research.

*Supported by the NSF Graduate Research Fellowship (DGE 0750616), NSF-TUES DUE 11-22818, and the HHMI NEXUS grant.

DF04: 9-9:10 a.m. Research on Students' Reasoning About Interdisciplinarity*

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

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

We present qualitative data of undergraduates describing the relationship between scientific disciplines. Rather than viewing biology, chemistry, and physics as existing in disconnected silos, these students often describe the relationships in a hierarchical or horizontal fashion. The hierarchical arrangements order the disciplines by degree of system complexity, or by the scale used to examine a particular system. For example, a student might view the full description of folded proteins at the top (biology), chemical reactions involving proteins' functions as chemistry, and motion of the protein's individual atoms as foundational (physics). Other students describe a horizontal view of disciplinary boundaries, without a foundational bottom but maintaining overlapping realms of interest. Others want physics embedded in a context that positions its relationship to biology via analogy. We examine evidence that students' conceptions are unstable and context-dependent, and suspect that these conceptions are related to course messaging in a bidirectional manner.

*Supported by the NSF Graduate Research Fellowship (DGE 0750616), NSF-TUES DUE 11-22818, and the HHMI NEXUS grant.

DF05: 9:10-9:20 a.m. Students' Ideas in Upper-Level Thermal Physics

Contributed – David E. Meltzer, Arizona State University, Mary Lou Fulton Teachers College, Mesa, AZ 85212; david.meltzer@asu.edu

Repeated investigations have confirmed some consistent difficulties among students in upper-level thermal physics courses. These difficulties include confusion regarding the state-function property of entropy, misinterpretations of the meaning of equilibrium in the context of available microstates, misunderstandings of free-expansion processes, and lack of clarity regarding ideal ("Carnot") efficiency of heat engines. I will discuss these difficulties and related student ideas in the context of development of research-based instructional materials.

DF06: 9:20-9:30 a.m. Student Difficulties Coping with Conflicting Ideas in Statistical Mechanics*

Contributed – Trevor I. Smith, Dickinson College, Carlisle, PA 17013; smithtre@dickinson.edu

John R. Thompson, Donald B. Mountcastle, University of Maine

In statistical mechanics there are two quantities that directly relate to the probability that a system at a temperature fixed by a thermal reservoir has a particular energy. The density of states function is related to the multiplicity of the system and indicates that occupation probability increases with energy. The Boltzmann factor is related to the multiplicity of the reservoir and indicates that occupation probability decreases with energy. This seems contradictory until one remembers that a complete probability distribution is determined by the total multiplicity of the system and its surroundings, requiring the product of these two functions. We present evidence from individual and group interviews that students knew how each of these functions relates to multiplicity but did not recognize the need to combine the two to characterize the physical scenario.

*Partially supported by NSF grant DUE-0817282.

DF07: 9:30-9:40 a.m. Comparing Student Conceptual Understanding of Thermodynamics in Physics and Engineering*

Contributed – Jessica W. Clark, University of Maine, Orono, ME 04469; jessica.w.clark@maine.edu

Donald B. Mountcastle, John R. Thompson, University of Maine

Thermodynamics is a core part of curricula in physics and many engineering fields. Despite the apparent similarity in coverage, individual courses in each discipline have distinct emphases and applications. Physics education researchers have identified student difficulties with concepts such as heat, temperature, and entropy as well as with larger grain-sized ideas such as state variables, path-dependent processes, etc. Engineering education research has corroborated these findings and has identified additional difficulties unique to engineering contexts. We are beginning a project that provides an excellent opportunity for expanding the interdisciplinary research on conceptual understanding in thermodynamics. This project has two goals: first, determine the overlapping content and concepts across the disciplines; second, compare conceptual understanding between these groups using existing conceptual questions from PER and EER. We will present a review of PER and EER literature in thermodynamics and highlight some concepts that we will investigate.

*This project is partially supported by NSF grant DUE-0817282.

DF08: 9:40-9:50 a.m. Instructor Expectations of Undergraduate Students Entering Quantum Mechanics

Contributed – Christopher A. Oakley, Georgia State University, Atlanta, GA 30303; chris.oakley@gmail.com

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

Characterizing faculty expectations is important to produce a comprehensive understanding of what knowledge and skills students should acquire before and during a quantum mechanics course (QMC). We describe interviews conducted with faculty members in the Physics & Astronomy Department of Georgia State University. These interviews probe faculty members' expectations of senior undergraduate students' background in mathematics, physics, and quantum mechanics concepts before entering a QMC. The interviews we conducted may provide students with a "map" for areas that will help strengthen the knowledge and skills obtained in their QMC. We will report on faculty members views on optimal preparation for an undergraduate student entering a QMC and appropriate learning goals for a student completing a QMC.

DF09: 9:50-10 a.m. Students' Use of Resources in Understanding Solar Cells

Contributed – Alan J. Richards, Rutgers University Bedminster, NJ 07921; richard6@physics.rutgers.edu

Eugenia Etkina, Rutgers University

We use the framework of conceptual and epistemological resources to investigate how students construct understanding of a complex modern physics topic that requires mastery of multiple concepts. We interviewed experts and novices about their understanding of the physics of solar cells, and examined their responses for evidence of resources being activated. We used this information to create a unit discussing the physics of solar cells at the advanced undergraduate level, which we then implemented. Based on the patterns in the interviews and student responses in the classroom during the unit we can hypothesize what ideas students draw on when they are trying to understand the complex physics involved in the functioning of solar cells.

DF10: 10-10:10 a.m. The Undifferentiated View of Ionizing Radiation*

Contributed – Andy Johnson, South Dakota Center for the Advancement of Math and Science Education, Spearfish, SD 57799-9005; andy.johnson@bhsu.edu

Natalie Dekay, Rebecca Maidl, CAMSE

The Radioactivity By Inquiry project (NSF DUE grant 0942699) is developing inquiry-based materials for teaching radiation literacy at the high school and college levels. Research by others—Eijkelhof, Millar & Gill, and Prather & Harrington—found that students initially do not distinguish between radiation and the radioactive source. The undifferentiated view is that radiation is "bad stuff," that there is no difference between radiation and radioactivity, and that radiation causes contamination. To understand radiation, students must distinguish between radiation and radioactive materials and view radiation as more of a process than a material. This talk will describe our efforts to identify and characterize students' initial ideas about radiation in terms of the undifferentiated radiation view and quantify student progress towards differentiation. We find that differentiating fully and abandoning the view of "radiation as stuff" involves a long and challenging process that some students find difficult to complete.

*Supported by NSF DUE grant 0942699

DF11: 10:10-10:20 a.m. Examining Student Use of Kirchhoff's Rules in Basic Diode Circuits*

Contributed – David P. Smith, University of Washington, Seattle, WA 98195; dsmith4@uw.edu

Christos P. Papanikolaou, University of Athens

MacKenzie R. Stetzer, University of Maine

The teaching and learning of electric circuits has been the topic of many investigations over a period of many years. The primary focus has been on simple dc circuits. As part of an ongoing, multi-institutional effort, we are extending the scope of this research by conducting an in-depth investigation of student understanding of analog electronics. Some of this work has been carried out in the context of basic diode circuits, which are covered at both the introductory and upper-division levels. This overlap provides a unique opportunity to examine the difficulties students experience when encountering the same content at different instructional levels. This presentation will highlight selected findings from the introductory course, together with insights into how these results can inform the treatment of related content in upper-division courses.

*This work has been supported in part by the National Science Foundation under Grant No. DUE-0618185.

DF12: 10:20-10:30 a.m. Student Evaluations of their Physics Teachers: Bias, Pedagogy, and Culture

Contributed – Geoff Potvin, Clemson University, M-13 Holtzendorff Hall, Clemson, SC 29634; gpotvin@clemson.edu

Using data collected from a nationally representative sample of college freshmen (NSF Grant # 1036617), the evaluation of high school physics teachers by their students is examined. Prior research in this area has found gender bias amongst (both male and female) students with respect to the gender of their teacher, so special attention is paid to gender and gender-interaction effects. Pedagogical practices that may moderate students' evaluations are also considered. The implications of this research for our understanding of physics culture regarding students' gendered expectations of teacher behavior and students' choices toward their continued physics participation is discussed.

Session DG: Physics of Entertainment

Location: Sheraton - William Penn Suite
Sponsor: Committee on Physics in High Schools
Co-Sponsor: Committee on Science Education for the Public
Date: Tuesday, July 31
Time: 8:30–10:30 a.m.

Presider: William Reitz

From Hollywood's big screen to TV's small screen to the panorama of street performance, physics has been a part of daily entertainment throughout history. How can we identify the physics behind the performance and use it in our classrooms? This invited and contributed session will investigate a wide spectrum of physics and entertainment.

DG01: 8:30-9 a.m. Physics Myth Busting

Invited – Martin J. Madsen, Wabash College, Crawfordsville, IN 47933; madsenm@wabash.edu

The popular Discovery Channel TV show "MythBusters" is a model for what is essentially the scientific enterprise. I will describe my analysis of their methodology and how it compares to what we typically think of as the scientific method. I modeled a physics course for non-science students, a so-called "physics for poets" course, at Wabash College on the "Mythbusters" method and engaged the students in doing real-world experiments to bust their own myths. I will describe how I taught the course and what I found through the experience.

DG02: 9-9:30 a.m. "The "Reality" of Science Reality Programs – Physics on TV!

Invited – David P. Maiullo, Rutgers University, Piscataway, NJ 08854-8019; maiullo@physics.rutgers.edu

Programs on or about science fill networks such as Discovery Channel, Science Channel, and National Geographic Channel. These programs are more popular than ever, and the networks produce an ever more increasing variety of them. Exactly what is it like to be part of these productions and also the talking head on screen? How much influence does one have when part of these productions, especially in deciding how much of the "science" will be explained or revealed to the viewing audience? I'll explain the "scientific" process behind the production of these programs and how real science is sometimes subverted through both the entertainment decisions and the editing. Examples of these decisions will be illustrated using clips of some of the shows in which I've participated.

DG04: 9:30-9:40 a.m. Modeling Instruction Through Video Games

Contributed – Igor V. Proleiko, McKinley Classical Leadership Academy, 2156 Russell, St. Louis, MO 63104; proleiko@hotmail.com

Julian K. Proleiko, School of Independent Thought

The Modeling approach to teaching is based on guided inquiry through a series of paradigm labs. In this project the labs are done inside a video game. The regular Modeling activities result in Constant Velocity Model, Constant Acceleration Model, Constant Force Model, and other models commonly used in Modeling instruction. The method provides the students with a motivation to explore the universe relevant to the activity they are engaging with while playing a game.

DG05: 9:40-9:50 a.m. Video Analysis of a Video Game

Contributed – Todd R. Leif, Cloud County Community College, Concordia, KS 66901; tleif@cloud.edu

My use of Video Analysis in the Two Year College Physics Classroom and Laboratory has covered many topics and methods. In my talk I will demonstrate an analysis of the introductory round of Pac-man. Although my students never really played the game like I did, I will show how I used this retro video game to assist students understanding of kinematics in the algebra based classroom/laboratory. If time permits I will show my latest project as well.

DG06: 9:50-10 a.m. Human Cannon Ball Physics

Contributed – Frank D. Lock, retired high school physics teacher, 4424 Sardis Rd., Gainesville, GA 30506; fasterlock@att.net

One of my former students, Shawn Marrin, is currently working in the Great Moscow Circus, touring Australia during 2012. One of his jobs involves presenting a show as a Human Cannon Ball. This is obviously applied physics and entertaining physics at its best. Shawn sent me a video about his act, which will be shown as part of the presentation.

Session DH: PER: Problem Solving I

Location: CCH - Claudia Cohen Terrace
Date: Tuesday, July 31
Time: 8:30–10:20 a.m.

Presider: Eleanor Sayre

DH01: 8:30-8:40 a.m. Instructor's Goals for Using Example Solutions in Introductory Physics

Contributed – William Mamudi, Western Michigan University, Kalamazoo, MI 49008; william.o.mamudi@wmich.edu

Charles Henderson, Western Michigan University

Shih-Yin Lin, Chandralekha Singh, University of Pittsburgh

Edit Yerushalmi, Weizmann Institute of Science

In light of recommendations from the literature for modeling expert-like problem solving approaches, we investigated instructors' goals for providing example solutions in introductory physics courses. Twenty-four graduate teaching assistants and 30 faculty were asked: 1) in a general context, to describe their main purposes for providing example solutions, and 2) specifically, to identify their considerations when comparing three example solutions that reflect different pedagogical views. Differences between the faculty and TAs will be discussed in order to describe possible progression of ideas throughout an instructor's professional career. For example, faculty explicitly emphasize the importance of developing expert-like problem solving when discussing their goals in the general context. In contrast TAs refer to the goal of developing expert-like problem solving mainly in an implicit manner, when examining specific solutions, and emphasize other values, such as helping students develop conceptual understanding, when asked explicitly on their purposes in the general context.

DH03: 8:40-8:50 a.m. Internet Coaches for Problem-Solving in Introductory Physics: Experimental Design

Contributed – Leon Hsu, University of Minnesota, Minneapolis, MN 55455; lhsu@umn.edu

Ken Heller, Qing Xu, University of Minnesota

The Physics Education Group at the University of Minnesota has been constructing web-based programs that can provide introductory physics students with coaching in the use of an expert-like framework in solving problems. During the fall 2011 semester, the coaches were introduced into a large (200+ students) section of the introductory mechanics course at the University of Minnesota to assess their educational impact. In this talk, we discuss the design of this experiment, including the construction of comparison groups, student reactions to the computer programs, and lessons learned. A companion presentation will discuss the status of the data analysis, including results obtained to date. This work was supported by NSF DUE-0715615.

DH04: 8:50-9 a.m. Internet Coaches for Problem-Solving in Introductory Physics: Data Analysis*

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

Leon Hsu, Ken Heller, University of Minnesota-Twin Cities

Bijaya Aryal, University of Minnesota-Rochester

The Physics Education Group at the University of Minnesota has been constructing web-based programs that can provide introductory physics students with coaching in the use of an expert-like framework in solving problems. During the fall 2011 semester, the coaches were introduced into a large (200+ students) section of the introductory mechanics course at the University of Minnesota to assess their educational impact. In this talk, we present the results of using a problem-solving rubric to analyze students' solutions from problems on mid-semester quizzes and the final exam. The rubric evaluates a student's problem-solving performance along five axes based on expert-novice problem solving research.

*This work was supported by NSF DUE-0715615.

DH05: 9-9:10 a.m. Problem Solving Strategies: Effect of Topic and Nature of Solutions*

Contributed – Bashirah Ibrahim, Kansas State University, Manhattan, KS 66506-2601; bibrahim@phys.ksu.edu

N. Sanjay Rebello, Kansas State University

We compare students' problem-solving strategies when completing tasks with the same representational format across two topical areas, kinematics and work. We individually interviewed 19 engineering students completing 10 tasks over three sessions. The tasks were structured in linguistic, graphical and symbolic forms requesting either qualitative or quantitative solutions. The analysis focused on the characteristics (description versus explanation) of the qualitative solution. We also compared the strategies used when attempting tasks asking for qualitative or quantitative solutions, with respect to the representational format. We found that the students were inconsistent in their approach for interpreting the same representation across the two topical areas. The nature of the task's solution does not seem to influence students' strategy for tasks in the symbolic form, but it seems to influence their strategy for kinematics tasks in a graphical form.

*Supported in part by NSF grant 0816207.

DH06: 9:10-9:20 a.m. Rigging Your Card Games – Differentiating Expert From Novice

Contributed – Steven F. Wolf, Michigan State University, Lyman Briggs College, East Lansing, MI 48824; wolfste4@msu.edu

Daniel P. Dougherty, Gerd Kortemeyer, Lyman Briggs College

We are re-examining the seminal paper by Chi et al., which firmly established the notion that novices categorize physics problems by "surface features" (e.g. "incline," "pendulum," "projectile motion," ...), while experts use "deep structure" (e.g., "energy conservation," "Newton 2," ...). The paper has been cited over 3000 times in scholarly articles over a wide range of disciplines. We replicated the experiment with an expert group and a novice group, using a set of 50 problems. The expert-novice distinction between sorters is highly sensitive to the choice of problems in the categorization set and we will discuss the features of the problems that do a good job of distinguishing expert from novice.

DH07: 9:20-9:30 a.m. To Use or Not to Use Diagrams: The Effect of Drawing a Diagram in Solving Introductory Physics Problems

Contributed – Alexandru Maries, University of Pittsburgh, Pittsburgh, PA 15217; alm195@pitt.edu

Chandralekha Singh, University of Pittsburgh

Drawing appropriate diagrams is a useful problem-solving heuristic that can transform a given problem into a representation that is easier to exploit for solving it. A major focus while helping introductory physics students learn problem solving is to help them appreciate that drawing diagrams facilitates problem solution. We conducted an investigation in which 111 students in an algebra-based introductory physics course were subjected to two different interventions during recitation quizzes throughout the semester. They were either (1) asked to solve problems in which the diagrams were drawn for them or (2) explicitly told to draw a diagram. A comparison group was not given any instruction regarding diagrams. We developed a rubric to score the problem-solving performance of students in different intervention Groups. We present results for two problems involving electric field and electric force. We also compare the performance of students in finding electric field to finding electric force in similar situations both immediately after instruction in a quiz and a while after instruction in a midterm exam.

DH08: 9:30-9:40 a.m. Student Expectations in a Group Problem Solving Activity

Contributed – Adam Kaczynski, University of Maine, Orono, ME 04469-5709; adam.kaczynski@maine.edu

Michael C. Wittmann, University of Maine

Students come to any physics course with expectations about the world and about science. Those expectations have an influence on the way that students make observations, reason about phenomena, and draw conclusions. In certain situations, those expectations may be inconsistent with those of the physics community and lead to results that are inconsistent with the body of knowledge in physics. We designed a new group problem-solving activity on damped harmonic motion that supports students in finding coherence between multiple representations through discussion of their known models and observations of an underdamped oscillating system. During the activity, students typically showed appropriate expectations when finding coherence between symbolic, graphical, and qualitative representations, but showed inappropriate expectations about problem solving. We will discuss how students' expectations about the starting point of physics problem solving affect their attempts to achieve coherence and draw conclusions.

DH09: 9:40-9:50 a.m. Students' Use of Real-World Knowledge During Collaborative Physics Problem Solving

Contributed – Mathew A. Martinuk, University of British Columbia, Vancouver, BC, V5T1Z1 Canada; martinuk@physics.ubc.ca

In this talk I will describe students' use of their real-world knowledge and their epistemological framing during collaborative group recitation problems in an introductory algebra-based physics course for non-physics majors. Analysis of 14 different student groups working on three different recitation problems reveals that: 1) Despite significant prompting within the problems and support in lecture, over half of the groups do not make significant use of their real-world knowledge as a part of their solution to the recitation problems. 2) Students that do make use of their real-world knowledge do so during conceptual discussion, but not during procedural discussion. Implications for instruction and future research will be discussed.

DH10: 9:50-10 a.m. Studying Students' Problem Solving Skills in Algebra-based Introductory Physics Course

Contributed – Archana Dubey, University of Central Florida, Orlando, FL 32816-2385; Archana.Dubey@ucf.edu

Jacquelyn J. Chini, University of Central Florida

Students in introductory physics courses have been often found to struggle with problem-solving skills. This difficulty seems to stem not only from their mathematical skills but also from the ability to comprehend and utilize physics concepts to solve problems. A main source of difficulty seems to be analytical reasoning! We can make our teaching more effective by studying students' strengths and weaknesses to develop a comprehensive teaching strategy that promotes better learning. Our study looked at students taking a second-semester studio mode algebra-based physics course. This presentation will share data highlighting several important aspects of students' understanding of physics concepts, mathematical skills and problem solving strategies, and will compare students' abilities to solve "condensed" problems versus more directed problems consisting of subparts. This information has implications about the possibility that students know the subject matter, but have difficulty synthesizing the information to get to the final answer.

DH11: 10-10:10 a.m. Identifying Similarities in Math and Physics Problem Solving

Contributed – Dyan L. Jones, Mercyhurst University, Erie, PA 16546; djones3@mercyhurst.edu

As part of a larger study of mathematics in physics problem solving, this project was designed to examine how students are able to identify similarities between purely mathematics and physics problems. Students were given a set of math problems and then physics problems, in succession. For each set, they were asked to group the problems based on similarities. The results of this study indicate that students are able to detect nuances in the purely mathematical problems that they may miss in an analogous physics problem, despite extensive prompting. This talk will present the larger set of results from this study.

DH12: 10:10-10:20 a.m. Concrete vs. Abstract Problems: How Prior Knowledge Helps and Hinders

Contributed – Andrew F. Heckler, Ohio State University, Columbus, OH 43210; heckler.6@osu.edu

Studies outside of physics education research have found that students tend to solve problems in concrete, familiar representations more accurately than in an abstract representation for relatively simple problems. First, we replicate this finding for some simple physics problems. However, we also find that when a specific problem commonly elicits prior knowledge that is contrary to scientific knowledge, e.g. a scientific "misconception," the concrete representation invokes incorrect answers more frequently than abstract representations. Second, we find that students with higher final course grades perform disproportionally better on abstract problems compared to concrete problems. Thus, from a psychometric perspective, abstract problems would be preferable over concrete because the former is more efficient at discriminating between students. However, from a pedagogical perspective, this study suggests that concrete problem representations are important for determining whether both high and low grade students have overcome the relevant scientific misconceptions.

Session DI: PER: Student Reasoning I

Location: Irvine Auditorium - Amado Recital Hall
Date: Tuesday, July 31
Time: 8:30–10:30 a.m.

Presider: Sissi Li

DI01: 8:30-8:40 a.m. Knowledge Integration While Interacting with an Online Troubleshooting Activity: Methodology

Contributed – Menashe Puterkovski, Weizmann Institute of Science, Rehovot, 76100 Israel; puterkov@gmail.com

Esther Bagno, Edit Yerushalmi, Weizmann institute of Science

A troubleshooting activity was carried out by an e-tutor in two steps. First the student diagnoses a mistaken statement attributed to the virtual student "Danny," then the student compares his/her own diagnosis to an exemplary diagnosis provided by the e-tutor. These steps are based on three design principles: 1) Eliciting common misinterpretations. 2) Incorporating knowledge integration processes. 3) Inspiring a non-judgmental argumentative environment. These activities aim to provide students with ample opportunities to recognize, acknowledge, and attempt to resolve conflicts between possible interpretations of scientific concepts and principles. This talk will focus on the design of the artifacts implemented in these activities (mistaken statements and exemplary diagnoses) and the methodology used to explore the following questions: To what extent do knowledge integration processes take place? How do students make use of the opportunities provided by the activity to negotiate and possibly elaborate alternative interpretations of physics concepts and principles?

DI02: 8:40-8:50 a.m. Knowledge Integration While Interacting with an Online Troubleshooting Activity: Findings

Contributed – Edit Yerushalmi, Weizmann Institute of Science, Rehovot, 76100 Israel; edit.yerushalmi@weizmann.ac.il

Menashe Puterkovski, Esther Bagno, Weizmann Institute of Science

A troubleshooting activity was carried out by an e-tutor in two steps. First the student diagnoses a mistaken statement, then the student compares his diagnosis to an exemplary diagnosis provided by the e-tutor. To examine whether and how the activity attains its objective—to engage students in a process of clarifying and repairing the mistaken ideas underlying the mistaken statement, we studied the discourse between students working with the e-tutor on a statement implying that because there is no current on an open switch in a DC circuit, according to Ohm's law the potential difference is necessarily zero. We present an analysis showing how the activity triggered students to explicate multiple alternative interpretations of the principles and concepts involved and attempt to align conflicting interpretations. We discuss how successive amendations gradually culminated in the elaboration of students' understanding of these concepts.

DI03: 8:50-9 a.m. Interpreting Multi-Variable Expressions: Patterns in Student Reasoning

Contributed – Mila Kryjevskaia, North Dakota State University, Fargo, ND 58108-6050; mila.kryjevskaia@ndsu.edu

It has been shown that students encounter significant reasoning difficulties when interpreting and applying multi-variable expressions in many contexts. For example, students often argue that, since the frequency of a periodic wave is expressed in terms of wavelength and propagation speed, the frequency must change when the speed changes. Similarly, many students think that the capacitance will always change if the potential difference between the capacitor's plates is changed. In this investigation we probed the extent to which students' incorrect reasoning approaches could be altered by making explicit connections during instruction between the treatments of multi-variable expressions in several contexts, such as waves and electrostatics. We also examined students' ability to transfer their understanding between these contexts.

DI04: 9-9:10 a.m. Impact of Argumentation Scaffolds on Performance on Conceptual Physics Problems

Contributed – Carina M. Rebello, University of Missouri, MU Science Education Center, Columbia, MO 65211; cp5xc@mail.mizzou.edu

Research has shown that the inclusion of argumentation tasks can improve students' problem solving and reasoning skills. We investigate two forms of scaffolds—one designed to facilitate construction of an argument and another designed to facilitate evaluation of an argument. We integrated these scaffolds within physics problems, and assessed their impact on the argumentation quality and conceptual quality of students' solutions to these problems. Results suggest that the use of argumentation scaffolds, rather than the mere use of an argumentation task, seemed to improve students' argumentation skills on these problems. We also found that for problems in both verbal and graphical representations, the use of argumentation scaffolds with tasks that required students to evaluate an argument seemed to improve the conceptual quality of students' solutions to these problems.

DI05: 9:10-9:20 a.m. Effect of Paper Color on Physics Exam Performance

Contributed – David R. Schmidt, Colorado School of Mines, Golden, CO 80401; dschmidt@mines.edu*

Todd G. Ruskell, Patrick B. Kohl, Colorado School of Mines

A substantial number of studies in the cognitive sciences have established that color, acting as an environmental cue, can significantly affect subject performance on a variety of tasks. However, there is a dearth of research into how this phenomenon manifests itself in 1) the combined conceptual and computational field of physics and 2) the context of preparation (i.e. where subjects prepare for relevant material prior to assessment as opposed to remaining ignorant of the tasks' nature until immediately before assessment). Our experiment involves approximately 450 students in an introductory E&M course in which the paper color used for examinations was varied. Analysis includes raw exam scores and differentiates between students' multiple choice, written response, conceptual, and computational performance. Additionally, we report on the time students require to complete exams and their confidence levels prior to and immediately following assessment.

*Sponsor: Patrick B. Kohl

DI06: 9:20-9:30 a.m. Language, Skills, and Mutual Understanding in Undergraduates Defining Threshold

Contributed – Angela Little, UC Berkeley, Berkeley, CA 94703; little@berkeley.edu

An important part of physics disciplinary practice is the use of terminology. Scientists need to be able to identify vague or unscientific terms and meanings and refine them into clearly articulated ideas. This work is not done in isolation, but rather, members of the community must come together to decide on mutually agreed upon definitions. But how are words defined and mutual understanding achieved? What skills do physics students already have along these lines and what new skills must be supported? And how does language itself support and constrain this work?

This talk will focus on a study of undergraduate physics majors where small groups of three to four students are asked to categorize and define the physical phenomenon of threshold in an open-ended design task. We will present skills we have identified as important to making definitions and discuss ways that language plays an important role in this process.

DI07: 9:30-9:40 a.m. Nesting as a Solution to the Multiple-Occupancy Problem in Representations

Contributed - Hunter G. Close, Texas State University-San Marcos, San Marcos, TX 78666; hgclose@txstate.edu

Eleanor W. Close, David Donnelly, Texas State University-San Marcos

When drawing and gesturing in physics, spatial dimensions on the writing surface or of the body are used temporarily to stand for physical quantities. Sometimes these quantities are literally spatial (the position of a particle), and sometimes they are more abstract (e.g., velocity, time, electric field, complex amplitude of an energy eigenstate). Sometimes we need more dimensions than are available to communicate a message or think through a problem. When one spatial dimension is used to represent more than one physical quantity, the "multiple-occupancy problem" is created: How do thinkers stay organized, keeping two (or more) separate meanings for one spatial dimension in ways that these meanings can be used productively? We introduce the idea of "nested coordinates" in the spatial communication and cognition of physics as a common way that thinkers deal with the multiple-occupancy problem.

DI08: 9:40-9:50 a.m. The Effect of Problem Format on Students' Answers*

Contributed – Beth Thacker, Texas Tech University, Lubbock, TX 79409; beth.thacker@ttu.edu

We report the results of two studies of the effect of problem format on students' answers. In particular, we studied the ability of students to explain their reasoning and demonstrate the use of a logical problem-solving process based on the physics principles they have learned. We analyzed the structure of both the correct and incorrect answers. The same problem written was written in multiple formats and administered as a quiz in the large introductory physics sections in both the algebra-based and calculus-based classes. The formats included multiple choice only, multiple choice and explain your reasoning, explain your reasoning only, ranking and explaining your reasoning and multiple choice ranking with explain your reasoning, and a few others. We present the results.

*This project is supported by the NIH grant 5RC1GM090897-02.

DI09: 9:50-10 a.m. Using Student Analogies to Investigate Conceptual Understanding

Contributed – Alex M. Barr, University of Texas at Austin, Austin, TX 78759; ambarr@physics.utexas.edu

Student-generated analogies can provide useful insight into students' conceptual understanding. I will describe an activity from a physical science class in which students generated their own analogies to illustrate Newton's laws of motion. Student analogies for Newton's third law indicate that students tend to focus their attention either on the presence of two objects, neglecting their interaction, or on the resulting dynamics of a single object. This result will be illustrated through several student examples. I will also discuss the role of context for students who generated multiple analogies to illustrate multiple concepts.

DI10: 10-10:10 a.m. When Do Students Use Symbolic Forms?

Contributed – Eric Kuo, University of Maryland, College Park, MD 20742 erickuo@umd.edu

Ayush Gupta, Andrew Elby, University of Maryland

Previous work has shown that students can combine physics equations with conceptual understandings. For example, the "Base + Change symbolic form" (1) can be used to interpret the equation v=v0+at conceptually as "the final value is the base value plus a change." Although the use of symbolic forms has been well documented, these studies have not investigated why a student may use a symbolic form in one problem but may not in different problems.[1] Through clinical interviews with undergraduates in an introductory physics class, we investigate the dynamics of whether and how students engage in symbolic forms-based reasoning. The interviews, focused on quantitative physics problems and epistemological prompts, are coded for (1) symbolic forms use and (2) independent and explicit evidence of certain epistemological stances. We argue that epistemological stances that value coherence between intuitive and formal ideas support the use of symbolic forms-based reasoning.

1. B. Sherin, *Cognition and Instruction,* **19**(4), pp. 479-541 (2001).

DI11: 10:10-10:20 a.m. Using Clause Topics to Assess Students' Reasoning While Comparing Problems

Contributed – Frances A. Mateycik, Penn State Altoona, Altoona, PA 16602; fam13@psu.edu

Kendra E. Sheaffer, Penn State Altoona

One of the major goals of teaching physics is to facilitate student learning of the deep principles and concepts, which can later be applied to novel problems. In this study we look at how students assess the importance of principles and concepts for problem solving. Students in an algebra-based physics course were asked to choose two problems from each of their homework assignments which they found to be most similar. The two problems selected were then explicitly compare and contracted in writing. The written statements were then divided by clause topics and further categorized into levels of epistemic reasoning. This presentation is oriented to introduce the audience to the qualitative analysis used and provide some general trends that appear in our homework responses.

DI12: 10:20-10:30 a.m. Student Gestures About Directionality in Projectile Motion Problems

Contributed – Evan Chase, University of Maine, Orono, ME 04469; chaseea0@gmail.com

Michael C. Wittmann, University of Maine

We are studying how students talk and gesture about physics problems involving directionality. Students discussing physics use more than words and equations; gestures are also a meaningful element of their communication. We are investigating the extent to which modifications to a student's gestures lead to changes in that student's thinking. Data come from one-on-one interviews about the sign and direction of velocity and acceleration within a given coordinate system. Specific contexts are the ball toss without air resistance and the interpretation of a differential equation describing the air resistance of falling objects.

Session DJ: Using Research-based High School PER Curriculum in Teacher Preparation

Location: Houston Hall - Golkin
Sponsor Committee on Teacher Preparation
Co-Sponsor: Committee on Physics in High Schools
Date: Tuesday, July 31
Time: 8:30–10:30 a.m.

Presider: Laird Kramer

DJ01: 8:30-9 a.m. PER + Experienced Physics Teacher = New Ideas!

Invited – Jon Anderson, Centennial High School, Circle Pines, MN 55014; anderson.jon.p@gmail.com

More and more, PER drives professional development and teacher preparation and informs those who participate in these endeavors. I will discuss what I have learned while implementing PER-based modeling curriculum into my introductory physics courses after attending three-week modeling instruction workshops at Florida International University in the summers of 2009 and 2010. I will also discuss how PER-based ideas have influenced me in my role as a mentor to pre-service and new physics teachers. This discussion will include what has worked, what hasn't worked, what mistakes I have made, and what temptations I have faced as an experienced physics teacher with an accumulation of curricular materials. Additionally, this talk will explore the role that mentors play in attracting new physics teachers, in helping them through those critical first years, and in retaining them in the profession. PER influences all of these roles.

DJ02: 9-9:30 a.m. Impacting the Attitudes of Prospective Teachers with Physics by Inquiry

Invited – Beth A. Lindsey, Penn State Greater Allegheny, McKeesport, PA 15132; bal23@psu.edu

Leonardo Hsu, University of Minnesota

Homeyra Sadaghiani, California State Polytechnic University

Jack W. Taylor, Baltimore City Community College

Karen Cummings, Southern Connecticut State University

Physics by Inquiry[1] (PbI) is a research-validated curriculum designed to help current and prospective teachers (re)learn physics content as a process of inquiry. Its success at improving the conceptual understanding of physics students at all levels has been well-documented over the past 30 years. Recent results demonstrate that the Physics by Inquiry curriculum fulfills another important role in the preparation of future K-12 teachers by improving their attitudes about science, as measured by the Colorado Learning Attitudes about Science Survey (CLASS).[2] I will discuss results indicating that PbI is particularly successful at shifting prospective teachers toward more expert-like attitudes on areas of the CLASS dealing with problem solving, despite the fact that the curriculum does not focus on numerical problem solving in the traditional sense that students expect.

1. L.C. McDermott and the Physics Education Group, *Physics by Inquiry*, Volumes I and II. (Wiley, Inc., New York, NY, 1996).
2. http://www.colorado.edu/sei/class/

DJ03: 9:30-10 a.m. Investigative Science Learning Environment as a Framework for Physics Teacher Preparation

Invited – Robert C. Zisk, Rutgers University, New Brunswick, NJ 08901; robert.zisk@gmail.com

Eugenia Etkina, Rutgers University

This talk will describe how Investigative Science Learning Environment (ISLE) serves as a framework for a physics teacher preparation program whose main goal is to help future teachers develop pedagogical content knowledge (PCK) in physics. Investigative Science Learning Environment is a guided-inquiry comprehensive learning system that engages students in processes that mirror the practice of scientists constructing knowledge. It is based on the theory of cognitive apprenticeship and formative assessment and relies heavily on multiple representations. These theoretical pillars can not only guide the development of physics curriculum but also help develop cognitive skills. Pre-service teachers who learn PCK through ISLE learn how to engage their students in the construction of knowledge while simultaneously acquiring science process abilities. They learn to scaffold and coach their students through continuous feedback and then slowly remove the scaffolding. They also become acquainted with the wealth of knowledge developed in PER.

DJ04: 10-10:30 a.m. Designing Modeling Instruction into Pre-service Teacher Preparation

Invited – Eric Brewe, Florida International University, Miami, FL 33199; ebrewe@fiu.edu

Laird H Kramer, Leanne Wells, Florida International University

As universities redesign and reorganize teacher preparation programs, they have the opportunity to build in reformed science courses. At Florida International University the secondary teacher preparation programs were reformulated in 2009. The redesigned program allows students to earn degrees in physics and become certified teachers upon graduation. The experiences teachers have within their program of study greatly influence initial teacher performance, thus we included a reformed physics pedagogy, Modeling Instruction, not only as a recommended introductory physics course but also as a summer methods and professional development experience. We report on both the coherence of the design of the curriculum and look to evidence of graduating teacher performance.

PLENARY: Sizing Up the Universe – *J. Richard Gott*

Location: **Inn at Penn – Woodlands Ballroom**
Date: **Tuesday, July 31**
Time: **11 a.m.–12 p.m.**

Presider: Gay Stewart

J. Richard Gott

The Sun is so large that a million Earths could fit inside it, yet there are stars much larger than the Sun, and the distances between stars and galaxies are truly awesome. The large sizes encountered in astronomy are part of its fascination, but depicting them is perhaps astronomy's greatest challenge. Professor Gott will tell about his Map of the Universe, which preserves shapes (as the Mercator map of the Earth does), but which allows him to plot everything from satellites in Earth orbit to the Moon and planets to distant stars and galaxies, out to the cosmic microwave background, the most distant thing we can see—all on a single map. The *L.A. Times* compared it to famous maps over the centuries, calling it "arguably the most mind-bending map to date." Professor Gott will tell how he got in the *2012 Guinness Book of Records* for measuring the "largest structure in the universe," the Sloan Great Wall—1.37 billion light years long. He will show size comparisons and maps from his new National Geographic book *Sizing Up the Universe,* in collaboration with Professor Robert J. Vanderbei, answering such questions as, how big was Hurricane Katrina compared to the Great Red Spot (a centuries-old storm on Jupiter)? A series of size comparisons, each covering a scale a thousand times larger than the one before, will show everything from Buzz Aldrin's footprint on the Moon, to asteroids, moons, planets, stars, black holes, and galaxies, ending with the first real picture of the entire visible universe.

Sizing Up the Universe:
"A feast for the eyes, and a banquet for the mind." *–Neil deGrasse Tyson*

–Professor Gott will be available for a book signing from 12:15–1:15 p.m.

CRKBRL 3: Crackerbarrel for Solo PERs

Location: Sheraton - Ben Franklin Ballroom I
Sponsor: Committee on Professional Concerns
Co-Sponsor: Committee on Research in Physics Education
Date: Tuesday, July 31
Time: 12–1:30 p.m.

Presider: Steve Maier

Are you the only professional active in PER within your department? Are there only one or two colleagues in close proximity you can talk "PER shop" with? The membership of Solo PER is larger than you may think, and more diverse than most suspect. Join us for this crackerbarrel to connect with other Solo PER professionals and learn what is being done to help our/your endeavors. As in the past, bring questions, ideas, and professional concerns to share.

CRKBRL 4: Common Core Framework and Physics Standards for College Success

Location: Sheraton - Ben Franklin Ballroom II
Sponsor: Committee on Teacher Preparation
Date: Tuesday, July 31
Time: 12–1:30 p.m.

Presider: Cathy Ezrailson

Join this Crackerbarrel to discuss the Common Core and Physics Standards for College Success. Discussion centers on the two-step process to develop the Next Generation Science Standards for K-12. The NRC Framework presents a view of science as both a body of knowledge and an evidence-based, model and theory-building enterprise that continually extends, refines, and revises knowledge. The Physics Standards for College Success (see http://groups.physics.umn.edu/physed/Millikan.html) are based on learning research and what is truly essential for student success in higher education and in the workplace.

CRKBRL 5: YouTube Sharathon

Location: Sheraton - Ben Franklin Ballroom V
Sponsor: Committee on Physics in High Schools
Date: Tuesday, July 31
Time: 12–1:30 p.m.

Presider: Dean Baird

Share your favorite web video clip (10 minutes or less; shorter is better) and see clips others brought to share. Bring your clip on a projector-connectable device or thumbdrive. Show, tell, and share curriculum materials that correspond to the clip. Clips must be accessible to anyone via the Internet, such as clips posted to YouTube. We'll have a projector with a standard VGA connection and a computer with USB ports, but you'll need to bring any dongles your device might need.

Session EA: The Coolest Experiment You Teach (beyond the first year)

Location: Sheraton – Ben Franklin Ballroom I
Sponsor Committee on Laboratories
Co-Sponsor: Committee on Apparatus
Date: Tuesday, July 31
Time: 1:30–1:50 p.m.

Presider: Mark Masters

EA01: 1:30-1:40 p.m. Undergraduate Electronics Laboratory with an Arduino Microcontroller

Contributed – Herbert Jaeger, Miami University, Oxford, OH 45056; jaegerh@muohio.edu

Microcontrollers are found in cars, coffee makers, and alarm clocks, just to name a few. Recently several families of low-cost but powerful microcontrollers entered the stage, e.g. the PIC, Basic Stamp, and the Arduino. The Arduino drew our attention because of its open-source architecture and its ability to be used with Windows, MacOS, and Linux platforms. Programming the Arduino is quickly learned, even by students with no formal programming experience and instructors with an antiquated Fortran background. We have begun integrating the Arduino microcontroller into our sophomore electronic instrumentation laboratory course and use it alongside LabVIEW which has become a de-facto standard laboratory software. In this talk we introduce the Arduino prototyping platform and showcase its capabilities with example of exercises we perform in our electronics lab.

EA02: 1:40-1:50 p.m. Determination of Carrier Temperature from Junction Current Voltage Measurements

Contributed – Mohamed Hedi, Boukhatem Collège, de l'Outaouais 333 boul., de la Cité-des-Jeunes Gatineau, QC J8Y 6M4, Canada; a_boukhatem@yahoo.fr

Mario El Tahchi, Lebanese University-Faculty of Sciences, Lebanon

Pierre Mialhe, University of Perpignan, France

The carrier temperature differs from the lattice temperature in operating silicon junctions. This paper describes a practical experiment that can be performed by undergraduate students to introduce and understand the concept of the carrier temperature or the kinetic temperature. An application is proposed, for the determination of the semiconductor energy gap at zero K temperature, Eg(0), from the analysis of the pn junction current-voltage characteristic.

Session EB: Continuing Teacher Preparation: Inservice Professional Development II

Location: Sheraton – Ben Franklin Ballroom I
Date: Tuesday, July 31
Time: 2–2:50 p.m.

Presider: Karen Williams

EB01: 2-2:10 p.m. Inservice Professional Development Using a Free Online Physics Course

Contributed – David E. Pritchard, Massachusetts Institute of Technology, Cambridge, MA 01239; dpritch@mit.edu

Saif Rayyan, Analia Barrantes, MIT

Andrew Pawl, University of Wisconsin - Plattesville

Raluca Teodorescu, George Washington University

Our free online course (http://relate.mit.edu/physicscourse/) is designed for those with a good knowledge of high school Newtonian Mechanics.

MAPs pedagogy[1,2,3] helps students improve their overview of the standard syllabus and their problem-solving skills. Learning modules with e-text, animations, videos, and solved examples each have specific learning objectives. The level is flexible due to use of click to open clarifications and example problems. Blocks of easy, medium, and MIT-level homework problems offer an appropriate challenge for all. Certificates for CEUs will be provided. A huge benefit of the course is that our course content, and many other problems and resources, are available for reuse or repurpose via the free open source LON-CAPA network. We thank Yoav Bergner, Stefan Dröschler, Sara Julin, Boris Korsunsky, Gerd Kortemeyer, and Daniel Seaton for their help with this course.

1. "Modeling Applied to Problem Solving" *AIP Conf. Proc.* **1179**, pp. 51-54 (2009). 2. "Improved Student Performance in Electricity and Magnetism Following Prior MAPS Instruction In Mechanics" *AIP Conf. Proc.* **1289**, pp. 273-276 (2010).
3. "Toward an Integrated Online Learning Environment" *AIP Conf. Proc.* 1289, pp. 321-324(2010).

EB02: 2:10-2:20 p.m. PTRA ToPPS Project at NWOSU II

Contributed – Steven J. Maier, Northwestern Oklahoma State University, Alva, OK 73717; sjmaier@nwosu.edu

In the summer of 2012, the second PTRA ToPPS science institute for Oklahoma middle school and high school teachers was hosted by Northwestern Oklahoma State University.[1,2] This second institute picked up where the first institute left off, including activities investigating momentum, impulse and energy. In this presentation, a synopsis of the status of teaching physics in Oklahoma will be discussed as well as possible developments for the future of professional development in physics in Oklahoma. Also shared will be preliminary results of the institute's effectiveness in building upon participants' content knowledge, pedagogical content knowledge, instructional strategies, professional networking and resources to help their districts and students in their classrooms.

1, www.nwosu.edu/ToPPS
2. Funding (2011 and 2012) made possible by the Oklahoma State Regents for Higher Education Improving Teacher Quality grant through professional development.

EB03: 2:20-2:30 p.m. Ubiquitous Professional Development with the Global Physics Department

Contributed – John B. Burk, St. Andrew's School, 623 Rosalia St. SE, Atlanta, GA 30312; john.burk98@gmail.com

Andy Rundquist, Hamline University

The Global Physics Department (GPD)* is a weekly online gathering of college and high school physics teachers that has become a very convenient and powerful form of professional development for physics teachers across the globe. Past meetings have included presentations from prominent scientists, textbook authors, and many experts in Physics Education Research. This presentation will outline the founding of the GPD, some highlights from past meetings, and discuss current and future plans, including its latest online coaching initiative, where physics teachers are able to submit teaching videos to the group for substantial feedback from a large and diverse collection of physics teachers.

*http://globalphysicsdept.posterous.com/

EB04: 2:30-2:40 p.m. Video Analysis for the Masses?

Contributed – Jonathan C. Hall, Penn State Erie, The Behrend College, Erie, PA 16563 ;jch12@psu.edu

Paul G. Ashcraft, Penn State Erie, the Behrend College

Teachers who already use video analysis are enthusiastic about its usefulness in teaching physics. But for the masses of students to benefit, how can we encourage more teachers to incorporate video analysis into the curriculum? As part of an in-service training program for high school and middle school science teachers, participants were trained in the use of video analysis, and the making of high speed and time-lapse videos. Their feedback regarding video analysis, and barriers to its implementation, will be presented.

EB05: 2:40-2:50 p.m. "Matterpiece" Theater: Helping Students Understand Phase Change

Contributed – Meghan J. Westlander, North Carolina State University Riddick Hall, Rm 224A, 2401 Stinson Drive Raleigh, NC 27695 mjwest3@ncsu.edu

Inspired by Energy Theater, we created a theatrical classroom activity on molecular interactions during phase changes. Our goal was to help build student understanding of macroscopic phase changes and the corresponding microscopic molecular behavior. We did this activity with elementary and middle school teachers during summer physics workshops, but it is appropriate for a wide range of students. Teachers created and performed short skits using the ball and spring model of matter to demonstrate molecular behavior during phase transitions. I will discuss our goals and how we developed the activity. I will then talk about our experience conducting the activity: observations of teachers creating skits, performances, and classroom discussions.

Session EC: Faculty Peer Mentoring

Location: Sheraton – Ben Franklin Ballroom II
Sponsor: Committee on Women in Physics
Date: Tuesday, July 31
Time: 1:30–3 p.m.

Presider: Anne J. Cox

While mentoring often means a more experienced person advising someone with less experience, mutual (or peer) mentoring can be as (or more) valuable.

EC01: 1:30-2 p.m. Mentoring Matters

Invited – Barbara Whitten, Colorado College, Colorado Springs, CO 80903; bwhitten@coloradocollege.edu

Cindy Blaha, Carleton College

Amy Bug, Swarthmore College

Anne Cox, Eckerd College

Linda Fritz, Franklin and Marshall College

We usually think of mentoring as a flow of information and advice from an older, more experienced mentor to a younger mentee. But it can also be useful to have advice from peers. For the past four years, we—five senior women at liberal arts colleges—have participated in a horizontal mentoring alliance that has given all of us important professional and personal support. Our Alliance began as part of an NSF Advance project, the premise of which is that horizontal mentoring between individuals of similar rank, field, academic environment, and perhaps also matched by race and gender, is a highly beneficial enterprise, particularly for underrepresented and/or isolated groups within a profession. Our Alliance has been very successful primarily because it is a resonant phenomenon -- we feel that the other members of the group "get it" (whatever the issue) right away because they've had similar experiences. We will discuss our experiences and suggest ways similar Mentoring Alliances might be established and supported.

EC02: 2-2:30 p.m. Research and Writing Groups Promote Goal Setting and Faculty Success

Invited – Kimberly A. Shaw, Columbus State University, 4225 University Ave., Columbus, GA 31907; shaw_kimberly@columbusstate.edu

Amanda Rees, Columbus State University

Faculty work is often challenging, by its very nature. At regional universities, faculty are often called upon to teach three or four classes a semester, perform a variety of service and committee work, as well as maintain a productive scholarly career. Further, there appears to be a trend toward increasing research expectations on faculty in recent years. Written expectations for successful job performance are often intentionally vague.

We will discuss the history and structure of a faculty peer mentoring group at a regional university. This group structured itself around research and writing goal-setting, both on a weekly and semester basis. Networking and career coaching have also become regular discussion themes in weekly meetings. Members and former members were surveyed regarding perceived benefits of this group, and themes that became apparent in that analysis will be discussed.

Session ED: Preparing Teachers to Integrate Labs into Instruction

Location: Sheraton – Ben Franklin Ballroom III
Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on Laboratories
Date: Tuesday, July 31
Time: 1:30–3 p.m.

Presider: Connie Wells

This is an invited session addressing the training of teachers to integrate laboratory work with instructional lessons in physics. It includes data on the effectiveness of lab work when integrated with instruction, how these changes might be most effectively facilitated, and examples of how this integration is currently working in classrooms.

ED01: 1:30-2 p.m. Learning Science Through the Practice of Science

Invited – James Flakker, Governor Livingston High School, Berkeley Heights, NJ 07922; jflakker@gmail.com

Traditional physics labs have been used as lecture demonstrations or with the intent to verify ideas discussed in lectures. They can often be disconnected with the student's experiences. Inquiry methods such as Investigative Science Learning Environment, ISLE (Etkina and Van Heuvelen, 2001, 2007) provide us with an opportunity to make connections to students' prior knowledge while teaching the scientific abilities and promoting high order thinking skills. We will discuss planning guided-inquiry based labs that focus on learning science by practicing science in a cognitive apprenticeship model. Through examples we will focus on the instructor's role in planning these labs as well as scaffolding student progress and assessment.

ED02: 2-2:30 p.m. Integrating Lab and Lecture in Graduate Physics Courses for Teachers

Invited – Dan L. MacIsaac, SUNY Buffalo State College, Buffalo, NY 14222; dnmacisaac@gmail.com

David S. Abbott, Kathleen A. Falconer, Luanna S. Gomez, SUNY Buffalo State College Physics

We describe graduate physics courses for physics teachers taught since 2002 that blend lab and lecture and prepare teachers for doing the same in their own instruction. The ASU Modeling Physics curriculum (Hestenes et al.), SDSU PET Curriculum (Goldberg et al.) and activities from Chabay and Sherwood are discussed, as is the use of RTOP to promote reflective teaching practice, the use and promotion of reflective writing (reading logs, learning commentaries, daily journals, limited and multiple drafted lab reports), extended classroom discourse and course projects. We report pre- and post-course teacher conceptual learning and efficacy data, and describe ongoing research into the impact of these behaviors in the student learning of the teachers who took our graduate classes.

ED03: 2:30-3 p.m. Lab Activities in Large Enrollment Course for Prospective Teachers*

Invited – Fred Goldberg, San Diego State University, CRMSE, San Diego, CA 92120; fgoldberg@sciences.sdsu.edu

Edward Price, California State University at San Marcos

Heath Kirkwood, San Diego State University

We are currently adapting the small enrollment, discussion and lab-based Physics and Everyday Thinking (PET) curriculum for large-enrollment classes populated mainly by prospective elementary teachers. The new curriculum is called Learning Physics (LEP). To maintain PET's focus on some important practices of science, students spend approximately 50% of the class time working in small groups, conducting simple experiments with hands-on materials, using computer simulations, and periodically sharing their predictions, observations and conclusions with the whole class via clicker questions or by e-mailing diagrams to the instructor. In this talk we will discuss some of the management and pedagogical challenges of doing this in a large enrollment setting, and will briefly describe how we are addressing these challenges.

*Supported by NSF grant 1044172.

Session EE: Antique Electrostatic Apparatus

Location: Sheraton – Ben Franklin Ballroom IV
Sponsor: Committee on Apparatus
Date: Tuesday, July 31
Time: 1:30–3 p.m.

Presider: David Sturm

EE01: 1:30-2 p.m. Experience, Experiment, Entertainment: Electrostatic Apparatus in the Age of Franklin

Invited – Robert A. Morse, St. Albans School, Washington, DC 20016; ramorse@rcn.com

This talk will provide a look at the proliferating development of electrical apparatus both simple and complex which provided puzzles to solve and the experiments to test the theories developed by the electricians of Franklin's century. Hauksbee's equipment for generating electrical effects in vacuum was at the beginning of a long line of development of electrical equipment for study and parlor entertainments. The Leyden jar, the electric wheel, the electrophorus, the torsion balance, and a plethora of electrical generators were available from various instrument makers. By the century's end George Adams's 1799 "Essay on Electricity" offered nearly 100 pieces of electrical apparatus and experiments employing them.

EE02: 2-2:30 p.m. 19th Century Electrostatics and 20th Century "Modern Physics"

Invited – Thomas B. Greenslade, Jr., Kenyon College, Gambier, OH 43022; greenslade@kenyon.edu

By the middle of the 19th century, the subject of electrostatics had become quite static. Physics lecturers had a wide variety of standard demonstrations on which to draw to show the various phenomena of static electricity. Many of these, such as the electrification of a student or the explosion of a mixture of hydrogen and oxygen, were exciting and, so to speak, electrifying. Others, such as the lighting up of eggs by connecting them across large potential differences, were illuminating, if not scientifically useful. Most of these demonstrations have disappeared, but a certain set of demonstrations, involving both high voltages and high vacua, led to discoveries that form the basis of the New Physics at the beginning of the 20th century.

EE03: 2:30-2:40 p.m. The Kelvin Water Dropper and Franklin's Bells

Contributed – Clifford L. Bettis, University of Nebraska-Lincoln, 208 Jorgensen Hall, Lincoln, NE 68588-0299; cbettis@unl.edu

I will show a Kelvin water dropper/Franklin's bells apparatus and will illustrate the principles involved with some demonstrations using equipment that would have been familiar in the 18th and 19th centuries.

EE04: 2:40-2:50 p.m. Under the Influence: A Rebuilt Toepler-Holtz

Contributed – David E. Sturm, University of Maine, Orono, ME 04469-5709; sturmde@maine.edu

This talk includes a discussion and display of a rebuilt early 20th-century Toepler-Holtz machine from the Department of Physics and Astronomy at the University of Maine. Brief comments on the misnaming of these machines, with historical references are included. Notes will be offered on the common confusion of these devices with Wimshurst machines and how to tell them apart. It includes details of the substitute materials used in the repair, period accessories, and other capabilities of these once common machines.

EE05: 2:50-3 p.m. Investigating Gravitational and Coulombian Forces Using an Electrostatic Pendulum

Contributed – David Menard, Ecole Polytechnique Montreal, 2500 Chemin de Polytechnique, Montreal, QC H3T 1J4 Canada; david.menard@polymtl.ca

Didier Robbes, Université de Caen

Emmanuelle Jacqet, Université de Caen

Gilles Le Moroux, Rectorat de l'Académie de Caen

Zahed Bahna Sciencethic

We report on a simple laboratory setup to be used at various stages across a science curriculum. A double pendulum is made out of two polystyrene spheres coated with silver paint and attached to an insulating frame using either nylon or conducting wires. The spheres are charged using various dielectric rods, yielding to electrostatic forces. Their movement is confined in a vertical plane using two guiding wires. The equilibrium angle between the two pendulums is read with an angle ruler fixed to the frame. Many problems can be addressed, such as the fundamental three-forces equilibrium (vertical weight, horizontal Coulomb force and wire reaction) and the demonstration of Coulomb's law. The setup is useful in introducing and mastering physics concepts from high school up to all levels of college education. A series of experiments will be presented here, including the electrostatic carillon and electric field mapping using an electrometer.

Session EF: PER in the Pre-college Classroom

Location: Houston Hall – Class of 49
Date: Tuesday, July 31
Time: 1:30–2:40 p.m.

Presider: Eleanor Close

EF01: 1:30-1:40 p.m. Determining the Effectiveness of PhET Interactive Simulations as Homework

Contributed – Zach B. Armstrong, University of Northern Colorado, Greeley, CO 80639; zarmstrong@greeleyschools.org

Cynthia Galovich, Wendy K. Adams, University of Northern Colorado

The use of simulations to teach science has been shown to be successful in classrooms; however, to our knowledge the effectiveness of simulations as homework has not been evaluated. This study compared the use of simulations in class versus as homework in the instruction of introductory high school physics. Three different simulation activities were examined, covering content on states of matter, friction, electric charge, and electromagnetic induction. Achievement for each activity was measured using pre- and post-tests. No other instruction was given to students between the pre- and post-tests. The initial findings indicate no significant difference for post-test scores or gains between the in-class and homework groups. However, a significant number of students in the homework group did not complete the activity. The prospects for using simulations as homework are promising, but further research is needed on how to design and implement effective activities.

EF02: 1:40-1:50 p.m. Promoting Student Ownership of Learning with Computer Simulations

Contributed - Noah S. Podolefsky, University of Colorado, Boulder, CO 80309-0390; noah.podolefsky@colorado.edu

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

Computer simulations, when properly designed and facilitated, can increase student agency and allow for more student autonomy than traditional educational tools and activities. We consider agency and autonomy key elements of ownership. In a qualitative study involving middle school students using a PhET simulation, one class had five minutes of "free play" before starting a guided-inquiry activity while another class had no free play and began the worksheets immediately. We found qualitative differences between these classes, in particular the degree to which the teacher facilitation was student-centered. Students in the "play" condition received less explicit direction from the teacher, supporting student autonomy. In the "no play" condition, the teacher was more directing, taking more control over student activities and reducing student autonomy. We suggest that "free play" can promote student ownership of the sim as a learning tool and allow teachers to facilitate a more student-centered classroom.

EF03: 1:50-2 p.m. Extending Modeling Instruction with Computational Modeling: A Pilot Study

Contributed – John M. Aiken, Georgia State University, Atlanta, GA 30302; johnm.aiken@gmail.com

John B. Burk, The Westminster Schools

Marcos D. Caballero, University of Colorado Boulder

Scott S. Douglas, Michael F. Schatz, Georgia Institute of Technology

We describe the implementation and assessment of computational modeling in a ninth-grade classroom in the context of the Arizona Modeling Instruction™ physics curriculum. Using a high-level programming environment (VPython), students developed computational models to predict the motion of objects under a variety of physical situations (e.g., constant net force), to simulate real world phenomenon (e.g., car crash), and to visualize abstract quantities (e.g., acceleration). Students were assessed via an assignment that included completing a computational model of a baseball's motion (a new scenario to the students), conceptual questions similar to those appearing on the Force Concept Inventory, and two essay questions, one asking students to extend their computational model with a drag force, the other querying their understanding of while loops. We will describe the common challenges students faced (programming and/or physics errors). We will also address student attitudes towards computation as a tool.

EF04: 2-2:10 p.m. Effects of Educational Games on Students' Academic Achievements in Science Classroom

Contributed – Hilal Co-kun, Erciyes University, School of Education, Kayseri, NA, 38038 Turkey; bakarsu@erciyes.edu.tr

Bayram Akarsu, Erciyes University

Today, the importance of training all individuals equipped with inquiry is accepted by the authorities. In this respect, students' classroom learning and everyday learning both facilitate their understanding and will make it possible to teach students with inquiry ability and help them easily adapt to a changing world. The main purpose of this study is to investigate the academic effect of educational games based on science stories in a seventh-grade elementary science class. In order to achieve that, an experimental study with pre-post tests was administered to an experimental group (N=15) and a control group (N=15) of middle school students. In conclusion, results of the study were analyzed with SPPS 17.00 version software. As a result of study, educational games with science stories revealed some significant differences between each group.

EF05: 2:10-2:20 p.m. Student-Teacher Interactions for Bringing Out Student Ideas About Energy*

Contributed – Benedikt W. Harrer, University of Maine, Orono, ME 04469; benedikt.harrer@maine.edu

Michael C. Wittmann, University of Maine

Rachel E. Scherr, Seattle Pacific University

Modern middle school science curricula use group activities to help students express their thinking and enable them to work together like scientists. We are studying rural eighth-grade science classrooms using materials on energy. Even after spending several months with the same curriculum on other physics topics, students' engagement in group activities seems to be restricted to creating lists of words that are associated with energy. Though research suggests that children have rich and potentially valuable ideas about energy, our students don't seem to spontaneously use and express their ideas in the classroom. Only within or after certain interactions with a teacher do students begin to explore and share these ideas. We present and characterize examples of student-teacher interactions resulting in students' deeper engagement with their ideas about energy. This preliminary analysis of video-recorded classroom dialog is a step toward helping teachers improve their students' learning about energy.

*Supported in part by NSF DUE 0962805.

EF06: 2:20-2:30 p.m. Hands-on Activities and Computer Visualizations for Teaching Middle School Astronomy

Contributed – Reni Roseman, Mercyhurst University, Erie, PA 16546; rrosem59@lakers.mercyhurst.edu

Dyan L. Jones, Mercyhurst University

This talk will describe the results of a research project involving middle school students (seventh grade) that examines how they learn about and understand astronomy. Both hands-on activities and computer visualizations were used to specifically compare their understanding of moon phases and eclipses. The pre-/post-test data and qualitative analysis of the classroom discussions will be presented.

EF07: 2:30-2:40 p.m. Secondary Students Learn Superconductivity from Phenomenology

Contributed – Alberto Stefanel, Research Unit in Physics Education, DCFA of the University of Udine, Via Delle Scienze, 206 Udine, Italy; alberto.stefanel@uniud.it

Marisa Michelini, Lorenzo Santi, Research Unit in Physics Education, DCFA of the University of Udine

A research-based educational path on superconductivity was designed for secondary school students, adopting an inquiry-based approach to the phenomenology of Meissner effect. The perfect diamagnetic property of a superconductor is correlated to the null resistivity through the recognition of the role of electromagnetic induction in the superconductive state. A qualitative introduction of the Cooper pairs formation and correlate gap in superconductor energy levels is proposed to the students to interpret the phenomenology. Research experimentation was carried out using tutorial worksheet with Italian secondary school students to explore how it is possible to introduce superconductivity using a phenomenological approach, the students' main difficulties and their typical learning paths. Data was collected from worksheets and questionnaires. The results are evidence that students are able to describe the null B field and the null resistivity situation in a superconductor using different formal tools.

Session EG: Using a Planetarium to Teach Astronomy

Location: Irvine Auditorium – Amado Recital Hall
Sponsor: Committee on Space Science and Astronomy
Date: Tuesday, July 31
Time: 1:30–2:40 p.m.

Presider: Jeannette Lawler

Digital planetariums are a fairly new technology. Very little has been published about effective educational practices using the immersive capabilities these systems provide. This session provides a forum where contributors can share information about the methods they have found effective. We include those who use planetariums for formal class and laboratories as well as those whose primary focus is fieldtrips and outreach.

EG01: 1:30-2 p.m. Methods of Supporting Student Learning in the Planetarium

Invited – Julia D. Plummer, Pennsylvania State University, College of Education, University Park, PA 16802; jdp17@psu.edu

Kim J. Small, Upper Dublin School District

Learning is an active process in which incoming information is mediated by interaction with prior knowledge and beliefs of the learner. Learning is also shaped by characteristics of the learning environment (including the teacher and peers). This talk presents an analysis of these factors that influence learning outcomes from planetarium programs by drawing on relevant literature about learning in formal environments (e.g. How People Learn, NRC, 1999), informal environments (e.g. Learning Science in Informal Environments, NRC, 2009), and considering the role of spatial thinking and reasoning in the domain of astronomy (e.g. Learning to Think Spatially, NRC, 2006). To illustrate these ideas, we will present a series of studies on what elementary students learn through participation in interactive planetarium programs. This will include discussion of instructional methods, such as kinesthetic engagement and methods of modeling scientific practices, and the affordances made possible by connecting planetarium visits to classroom instruction.

EG02: 2-2:30 p.m. Active Learning in a Planetarium Setting

Invited – Stacy Palen, Weber State University, Ogden, UT 84404; spalen@weber.edu

Teaching astronomy in the planetarium has a number of challenges. From too-comfortable seats to decreased lighting to the often unusual (and static) arrangement of the chairs, it can be difficult to bring the best of collaborative, active learning into this space. Through 14 years of teaching astronomy in planetariums of various shapes and sizes, we have created some useful activities and strategies that overcome these difficulties and turn the experience of class in the planetarium into an interactive free-for-all!

EG03: 2:30-2:40 p.m. Head Mounted Displays in Deaf Science Education

Contributed – Eric G. Hintz, Brigham Young University, Provo, UT 84602; hintz@physics.byu.edu

Michael Jones, Jeannette Lawler, Dale C. Rowe, Ron Proctor, Weber State University

Head mounted displays may remove a logistical barrier in science education for deaf children—particularly in planetariums. Deaf children must split their visual attention between a signer and visual learning aids. This becomes more difficult as the viewing area spans a wider range of the student's field of view and is particularly difficult in a planetarium with viewing area that spans a hemisphere. Interpreters seated at the front of the planetarium are inadequate because they do not move to follow the students' visual attention and must be lit. Displaying a video stream or recording of a signer in a head mounted display may allow students to attend to verbal instruction wherever the student looks. We have built a prototype of such a system and are evaluating how to configure the video and hardware for optimal display of a signer using a head mounted display for children.

Session EH: PER: Problem Solving II

Location: Sheraton – Ben Franklin Ballroom V
Date: Tuesday, July 31
Time: 1:30–3 p.m.

Presider: Amy Robertson

EH01: 1:30-1:40 p.m. An Eye Tracking Analysis of Physics Representations

Contributed – Jennifer L. Docktor, University of Wisconsin - La Crosse, La Crosse, WI 54601; jdocktor@uwlax.edu

Jose Mestre, University of Illinois at Urbana-Champaign

Liz Gire, University of Memphis

Sanjay Rebello, Kansas State University

One key aspect of solving physics problems is the ability to interpret and use multiple representations of information (e.g. words, equations, pictures, diagrams, and graphs). In this talk, we describe a study that uses eye-tracking technology to investigate how students view and comprehend physics representations presented on a computer screen. We also discuss the implications of this research for the design of instructional examples and online learning materials.

EH02: 1:40-1:50 p.m. Do "Eye Catching" Features in Physics Problems Influence Answer Choices?*

Contributed – Adrian Madsen, Kansas State University, Manhattan, KS 66506-2601; adrianc@phys.ksu.edu

Amy Rouinfar, Adam Larson, Lester Loschky, N. Sanjay Rebello, Kansas State University

It has been proposed that "eye catching" features in some physics problems, that are also plausible and relevant, automatically capture students' attention. Other less salient features have little opportunity to be considered. So, students answer the problem based on the most perceptually salient elements of the problem (Heckler, 2011). To test this hypothesis we recorded eye movements of introductory physics students on a set of problems with diagrams. Each diagram contained areas consistent with documented novice-like answers and areas consistent with the scientifically correct answer. We manipulated the luminance contrast of the diagrams to produce three versions of each diagram, which differed by the area with the highest level of perceptual salience. We discuss how the salience manipulations are related to the correctness of answers and eye movements. These results allow us to understand how perceptual salience in a problem diagram influences student answer choice and attention.

*This work supported in part by NSF grant 1138697.

EH03: 1:50-2 p.m. Exploring Representational Fluency with Eye-Tracking

Contributed – Elizabeth Gire, University of Memphis, Memphis, TN 38152; egire@memphis.edu

Jennifer L. Docktor, University of Wisconsin - La Crosse

N. Sanjay Rebello, Kansas State University

Jose Mestre, University of Illinois at Urbana-Champaign

Representational fluency is the ability to competently use different representations of the same information, and is an important skill for solving physics problems. We use eye-tracking technology to explore how visual attention is related to representational fluency. We showed introductory and graduate physics students two different representations (graph, equation, or text) and asked them to judge whether the representations are consistent (could describe the same situation). We compare the gaze patterns of students who made correct judgements versus those who made incorrect judgements, and make comparisons across introductory and graduate student groups.

EH04: 2-2:10 p.m. The Impact of Computer Animation Design on Knowledge Activation During Problem Solving

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

Gary Gladding, University of Illinois at Urbana-Champaign

Instructors frequently observe that students often have significant difficulty activating relevant physics knowledge that they seemingly possess during problem solving. We propose that at least part of the difficulty might be caused by the conventional graphical representation used in teaching these concepts. Most conventional physics representations are developed under the physical limits of pen and paper, and are not optimized to facilitate sense making among novices. When examined from a grounded cognition perspective, some of these representations may interfere with students' proper construction of conceptual understanding, thereby encouraging shallow/rote learning of physics rules. Physics rules learned by rote require a more precise matching of surface features to activate, and pose a higher cognitive cost during implementation. In a clinical study, we demonstrated that by improving the design of physics representation using computer animation, we can change the physics rules activated by students solving certain capacitor circuit problems. Interestingly, this improved design of the representation shares less surface feature similarity with the problem body when compared to the conventional representation and students are observed to spend less time watching the improved design.

EH05: 2:10-2:20 p.m. Free Online Physics Course Emphasizing Problem Solving

Contributed – Saif Rayyan, Massachusetts Institute of Technology, Cambridge, MA 02139; srayyan@mit.edu

Analia Barrantes, David E. Pritchard, Massachusetts Institute of Technology

Andrew Pawl, University of Wisconsin - Platteville

Raluca Teodorescu, The George Washington University

Our RELATE group is currently teaching an online course on Newtonian Mechanics (http://relate.mit.edu/physicscourse/). The course develops more expert-like problem solving skills using the MAPS Pedagogy, [1] and includes hundreds of assessment questions, many based on results from physics education research. Open-source course content (modularized e-text, animations, videos, and solved examples) is divided into learning modules that are mapped to a list of learning objectives. The course is hosted on the LONCAPA network (http://loncapa.org), and anyone in the network can use our course content in their classes. We are currently integrating IRT into this platform, enabling standardized assessment of student and class skill on a national standard that is independent of which problems students work. We thank Yoav Bergner, Stephan Dröschler, Sara Julin, Boris Korsunsky, Gerd Kortemeyer, and Daniel Seaton for their significant contributions.

1. *AIP Conf. Proc.* **1179**, pp. 51-54 (2009).

EH06: 2:20-2:30 p.m. Increasing Problem-Solving Skills in Introductory High School Physics

Contributed – Sean J. Bentley, Adelphi University, Garden City, NY 11530; bentley@adelphi.edu

Elizabeth de Freitas, Adelphi University

The effects of project-based learning in an algebra-based Physics First course on students' problem-solving abilities are explored. A problem-based exam for introductory physics was developed and used with a previously established problem-solving rubric. The exam was administered to freshmen physics classes at three high schools. One of the schools was using a heavily project-based curriculum, while the other two relied primarily on traditional methods. Strong positive correlations in performance and the project-based curriculum were observed, though continued development of the study is ongoing to separate other factors and see if causality exists. The initial data is being used to help refine the measurement instrument and evaluate the curricular elements.

EH07: 2:30-2:40 p.m. Acquiring Mathematical Skills in Physics

Contributed – Jing Wang, Eastern Kentucky University, Richmond, KY 40475; jing.wang@eku.edu

Jerry Cook, Eastern Kentucky University

Students' entering mathematical skill level is usually considered one of the best indicators of their success in introductory physics courses. A common expectation is that students who meet the prerequisite requirement will be well-prepared; however, this is rarely the case. In a recent study at the Department of Physics and Astronomy of Eastern Kentucky University, we collected the students' math diagnostic scores both in physics courses and in an algebra course. Our results suggest that when students take physics, their math diagnostic scores improve significantly, even more so than they do in a traditional mathematics course. As we recently changed math prerequisite, the data both before and after the change will be presented. The talk will focus on the link between the course content and mathematical skill improvement. The correlation between math scores and Force Concept Inventory will be discussed.

EH08: 2:40-2:50 p.m. Understanding Students' Use of Integration in Physics Problem Solving*

Contributed – Dehui Hu, Kansas State University, Manhattan, KS 66506-2601; dehuihu@phys.ksu.edu

N. Sanjay Rebello, Kansas State University

Developing the skills to set up integrals is critical for students' success in calculus-based physics. It requires a high level of understanding of both math and physics concepts. Previous studies have investigated students' poor performance when solving integration problems in the context of electricity and magnetism. However, the reasons for students' difficulties have not been explored in detail. We used the theoretical framework of epistemic games to describe students' use of integration in physics E&M topics. We conducted eight interview sessions with 13 engineering students enrolled in a second-semester introductory calculus-based physics course. We categorize the epistemic games played by the students and described these games in terms of students' moves and knowledge resources associated with these moves. Finally, we discuss how our findings could be used to explain why students encounter the difficulties they do.

*This work supported in part by NSF grant 0816207.

EH09: 2:50-3 p.m. Assessing Student Understanding of Integrals Using Correspondence Between Representations

Contributed – Joshua Von Korff, Kansas State University, Manhattan, KS 66506-2601; vonkorff@phys.ksu.edu

N. Sanjay Rebello, Kansas State University

In traditional coursework, students' problem-solving ability is often assessed solely on the basis of the correctness of their written equations or their numerical answer. Reformed curricula frequently make use of more complex rubrics which may examine students' use of diagrams, ability to plan a solution before performing numerical calculations, or adherence to a certain solution format. Students' oral presentations provide us with a rich data set for assessing their understanding. One advantage of the oral presentation is that the creation of diagrams and graphs is synchronized with spoken words, allowing us to closely examine the correspondences between these representations. We will discuss a method of assessment that makes use of these correspondences. This work supported in part by NSF grant 0816207.

Session EI: Using ISLE to Analyze Simple Experiments

Location: Sheraton – William Penn Suite
Sponsor: Committee on Physics in Undergraduate Education
Date: Tuesday, July 31
Time: 1:30–3 p.m.

Presider: Eugenia Etkina

One of the main goals of the ISLE philosophy is that the students engage in activities that mirror scientific practice. One of these activities is devising and testing multiple explanations of the same phenomenon. It is difficult to find simple experiments suitable for this approach. Presenters in this session will share their experience in choosing and analyzing such experiments.

EI01: 1:30-2 p.m. The Role of ISLE Labs in a Studio Physics Classroom

Invited – David T. Brookes, Florida International University, Miami, FL 33199; dtbrookes@gmail.com

At Florida International University we have successfully implemented the investigative science learning environment (ISLE) in a studio classroom for three years. Experimentation is the core of the ISLE philosophy, but integrating labs into a student-centered studio classroom was a challenging task. In our implementation we paid attention to the following design principles: 1) We ensured that students were aware of the epistemic purpose of each experiment. 2) We implemented ways for students to share their experimental ideas and results with each other. 3) To promote collaboration, experimentation activities were beyond the capability of any individual student in the class. 4) We made experimentation a part of every aspect of the class, not just labs. I will present results that show that our implementation was successful and that students are displaying behavior that suggests they are starting to think and act in ways that are analogous to those of practicing physicists.

EI02: 2-2:30 p.m. ISLE of Change: Labs Before and After

Invited – Mikhail Kagan, Penn State Abington, Abington, PA 19001; mak411@psu.edu

How much impact can switching to ISLE have? What if it is only one or two ISLE elements? As a theoretical physicist, I used to underestimate the value of the lab component in my classes. Before learning about ISLE, I thought of a lab as a mere illustration for what had been learned in lectures. Now I consider Lab as an inalienable part of turning my students into scientists, which, to some extent, can drive the course. Starting with fall 2011, I have systematically implemented ISLE labs in my introductory calculus-based physics classes. The primary philosophical shift was toward (much) fewer instructions for students and more flexibility of their experimental process. From the very first lab I had noticed a dramatic change in pretty much every aspect of the lab, starting with the process itself to the style, clarity and quality of my students' lab reports.

EI03: 2:30-3 p.m. Using ISLE to Solve Experimental Problems

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

Investigative Science Learning Environment (ISLE) provides a framework for construction of new knowledge and for applications of the developed knowledge to experiment-based problem solving. This talk will focus on the latter. An important aspect of using ISLE in problem solving is that students after observing a specific phenomenon need to propose multiple explanations, which they then try to rule out using testing experiments. When searching for multiple explanations, students create links between different physics topics that promote a coherent understanding of the subject, they become more aware of the technical aspects of the observations, they learn to be more patient and not jump to conclusions quickly. Creation of experiment-based ISLE problems is challenging as we need to find experiments that allow students to construct multiple explanations within the given curriculum domain. I will present examples of simple experiments that work as successful ISLE problems at the introductory physics level.

Session EJ: Two-Year Colleges Poster Session

Location: HH - Reading Room Alcove
Date: Tuesday, July 31
Time: 1:30–3 p.m.

EJ01: 1:30-3 p.m. Lab Activities Developed at the IPLWC*

Poster – Thomas L. O'Kuma, Lee College, Baytown, TX 77522-0818; tokuma@lee.edu

Dwain M. Desbien, Estrella Mountain Community College

The Introductory Physics Laboratory Writing Conferences are a series of working conferences to develop laboratory activities appropriate for introductory physics labs at both the college and high school level. From the two IPLWCs, a group of lab activities have been developed and tested at both high schools and two-year colleges. These developed lab activities will be displayed with some developed lab activities available for comments.

These working conferences are part of the ATE Workshops for Physics Faculty project and are directed by Dwain Desbien.
*Sponsored in part by NSF DUE grant 1003633.

EJ02: 1:30-3 p.m. ATE Workshops for Physics Faculty - Year 2*

Poster – Thomas L. O'Kuma, Lee College, Baytown, TX 77522-0818; tokuma@lee.edu

Dwain M. Desbien, Estrella Mountain Community College

The ATE Workshop for Physics Faculty project is a series of workshops and working conferences for two-year college and high school physics faculty. This poster will give information about the project with an emphasis on the last year's five workshops and conferences.
Sponsored in part by NSF DUE 1003633 grant.

EJ03: 1:30-3 p.m. Managing a Dynamic SPS Chapter (at a two-year college)

Poster – Brooke Haag, Hartnell College, Salinas, CA 93901; bhaag@hartnell.edu

Jaime DeAnda, Jose Rico, Hartnell College

The Hartnell College physics club has thrived as an SPS chapter at a two-year college for over 18 years through the efforts of several advisers and a number of enthusiastic students devoted to outreach. It has earned national recognition as well as a local reputation as one of the most dynamic and longest-lived clubs on campus. With a focus on several specific goals including outreach, fundraising, and project construction, the club consistently attracts a following of students led by a core of dedicated officers willing to expend the time and energy necessary for a robust program. In this poster, we present an overview of our outreach, fundraising, and project construction efforts. We also offer recommendations for guiding a successful SPS chapter.

EJ05: 1:30-3 p.m. TYC Meeting: Clickers as an Integral Part of Your Course

Poster – Michael C. Faleski, Delta College, University Center, MI 48710; michaelfaleski@delta.edu

There are many ways in which instructors can engage students in the classroom. The use of a personal response system (PRS), or clickers, is becoming more prevalent at college campuses. Clickers can be used for a variety of activities such as simple attendance taking and answering questions about a topic in lecture. At this past winter's TYC Tandem Meeting, participants were engaged in a sample class as students learning about ideal gas processes and thermodynamics with PV diagrams. Participants not only used clickers to answer questions given to students in actual classes, but also discussed common student responses and places at which misunderstandings occur. This poster will focus on the clicker techniques used in the sample class as well as providing results about the kinds of questions asked.

EJ06: 1:30-3 p.m. TYC Tandem Meeting Video Analysis Workshop Review

Poster – Todd R. Leif, Cloud County Community College, Concordia, KS 66901; tleif@cloud.edu

Robert Hobbs, Bellevue College

The TYC Tandem meeting held at Ontario, CA, in conjunction with the Winter 2012 AAPT Meeting was a successful endeavor for the nearly 70 participants who attended. One of the sessions presented was a video analysis session led by two veteran TYC Physics Instructors Robert Hobbs of Bellevue College and Todd Leif Cloud County Community College. This poster will highlight the information that was presented during the TYC Tandem meeting. Some history of video analysis in the physics classroom and a couple of the instructors interesting "laboratory experiences" will be displayed.

EJ07: 1:30-3 p.m. Using ISLE Labs in the Class

Poster – Mikhail Kagan, Penn State Abington, 1600 Woodland Rd., Abington, PA 19001; mak411@psu.edu

Investigative Science Learning Environment (ISLE) is an inquiry-based teaching/learning approach developed by Etkina et al. Since fall 2011 I consistently implemented some of the ISLE techniques in my classes, mostly in the labs and homeworks. In addition, I took two ISLE labs on Newton's laws and made them part of my class. In the current poster, I describe this two-hour class. At the end, I also share my experiences and observations and provide my students' comments and writing samples.

PLENARY: Space-Time, Quantum Mechanics and the Large Hadron Collider – *Nima Arkani Hamed*

Nima Arkani Hamed

Location: Inn at Penn – Woodlands
Date: Tuesday, July 31
Time: 3:30–4:30 p.m.

Presider: Gay Stewart

Nima Arkani-Hamed is a theorist with wide-ranging interests in fundamental physics, from quantum field theory and string theory to cosmology and collider physics. Formerly on the faculty at Berkeley and Harvard, he has been a professor in the school of natural sciences at the Institute for Advanced Study since 2008. He has taken a lead in proposing new physical theories that can be tested at the Large Hadron Collider at CERN in Switzerland.

Session EK: LHC Data for Physics Teachers and Students

Location: CCH - Claudia Cohen Terrace
Sponsor: Committee on Physics in High Schools
Date: Tuesday, July 31
Time: 1:30–3 p.m.

Presider: Kenneth Cecire

The Large Hadron Collider (LHC) is running at the cutting edge of technology and discovery. LHC detector collaborations have released data for educational use. Session participants will discuss how this data is used effectively for students in schools and for teacher professional development.

EK01: 1:30-2 p.m. Using Real LHC Data in the High School Classroom

Invited – Michael Fetsko, Mills Godwin High School, Henrico, VA 23238; mrfetsko@henrico.k12.va.us

This is an exciting time in the study of particle physics, from the speedy neutrinos to the search for the elusive Higgs Boson; it seems that particle physics is always in the news. The Large Hadron Collider (LHC) at CERN in Geneva, Switzerland, is at the focus of all of this research and you can involve your students in all of the excitement. This presentation will explain a variety of investigations that you can bring into your classroom using real particle physics data that has been released from the two big experiments at the LHC, ATLAS, and CMS. Through these investigations, your students will be able to examine real event displays, calculate invariant rest masses, create and analyze mass plots, and discover particle physics using the same data that researchers all over the world are using.

EK02: 2-2:30 p.m. Understanding Scientific Discovery Through LHC Data

Invited – Marjorie G. Bardeen, Fermilab, Batavia, IL 60555; mbardeen@fnal.gov

Scientific discovery is a journey, not an event. The huge public interest generated by the Large Hadron Collider made us realize that we needed to do more to help students grasp this important "enduring understanding." A suite of activities based on real particle physics data provides teachers with a unique opportunity to broaden a student's frame of reference for science. Students can learn how scientists discover new knowledge and how they talk about their work. We'll introduce activities that will be developed in more depth in subsequent talks and make an easy calculation of particle mass with LHC data, a protractor, and ruler.

EK03: 2:30-2:40 p.m. QuarkNet LHC Boot Camp: Immersion in Particle Physics for Teachers

Contributed – Deborah Roudebush, Oakton High School, Vienna, VA 22181 dmroudebush@fcps.edu

The QuarkNet LHC Boot Camp is a unique one-week program in which teachers learn about particle physics and the Large Hadron Collider through immersion and inquiry. Participating teachers work in teams to understand real data from the CMS detector of the LHC at CERN. Guided by a set of milestones and staff facilitators, the teachers must decide what the data means and how to analyze it. The process of understanding the data leads to professional growth in physics and in understanding teaching and learning.

EK04: 2:40-2:50 p.m. The 2012 Particle Physics Masterclass

Contributed – Shane Wood, Irondale High School, Minneapolis, MN 55408; shanewoodmn@gmail.com

The particle physics Masterclass is a program in which high school students analyze data from CERN's Large Hadron Collider (LHC) experiments to better understand the world of quarks and leptons. This presentation will highlight some of the features of the 2012 Masterclass, and how high school teachers and students may become involved in this exciting collaboration.*

*QuarkNet is funded in part by the National Science Foundation and the US Department of Energy.

EK05: 2:50-3 p.m. Particle Physics Masterclass as a Context for Learning About NOS

Contributed – Michael J. Wadness, Medford High School/QuarkNet, Natick, MA 01760; mjwadness@verizon.net

This research addresses the question: Do secondary school science students attending the Particle Physics Masterclass change their view of the nature of science (NOS)? The Particle Physics Masterclass is a national physics outreach program run by QuarkNet, in which high school physics students gather at a local research institution for one day to learn about particle physics and the scientific enterprise. Student activities include introductory lectures in particle physics, laboratory tours, analysis of actual data from CERN, and the discussion of their findings in a conference-like atmosphere. Although there are a number of outreach programs involving scientists in K-12 education, very few of them have been formally evaluated to determine if they provide adequate learning of NOS. Therefore, the significance of this study is that it investigates the claim that science outreach programs may be designed to address science literacy, specifically as a context for explicit NOS instruction.

Poster Session 2:

Location: Houston Hall – Bistro
Date: Tuesday, July 31
Time: 6–7:30 p.m.

Odd number poster authors should be present 6-6:45 p.m.
Even number poster authors should be present 6:45-7:30 p.m.
(Posters should be set up by 9 a.m. Tuesday and then taken down by 10 p.m. Tuesday)

A - Physics Education Research

PST2A01: 6-6:45 p.m. A Physics Problem Genome Project

Poster – Andrew E. Pawl, University of Wisconsin-Platteville, Platteville, WI 53818; pawla@uwplatt.edu

Online homework holds the promise of individualized tutoring. Before the promise can be realized, however, it is necessary to conduct empirical research on what problem sequences best engage students' interest and intellect in the online environment. To avoid bias in this research, it is necessary to employ randomized problem sequences. I have attempted this in a limited fashion in several courses over the past two years, and am using the experience to set up a freely accessible physics problem server in the LON-CAPA network. Students can log in and choose a topic or theme. The system then presents randomized sequences of related problems. The students' performance, comments, and timeline of interaction will be used to assess the effectiveness of the various sequences in promoting learning and engaging interest. The title of this presentation is an homage to the Music Genome Project's "Pandora" website, which inspired the work.

PST2A02: 6:45-7:30 p.m. Assessing Student Self-Confidence with the CLASS Learning Attitudes Survey

Poster – Andrew E. Pawl, University of Wisconsin-Platteville, Platteville, WI 53818; pawla@uwplatt.edu

David E. Pritchard, MIT

Administering the CLASS to students in the mainstream freshman mechanics course at MIT yields significant negative shifts in all the categories related to problem solving and conceptual understanding. These shifts are consistent with the observations published by the creators of the CLASS. In the MIT sample, these shifts can be ascribed to five statements that unambiguously assess student self-confidence. No substantial shift is observed in statements assessing students' conception of what constitutes problem-solving expertise. By contrast, students enrolled in calculus-based introductory mechanics at the University of Wisconsin-Platteville, a small state engineering school, enter the course with significantly lower rates of expert-like responses in the non-self-confidence statements but similar levels of self-confidence, and leave the course without a significant shift in either category of statements. Substantial remediation of the drop in MIT student self-confidence statements has been achieved by a three-week ReView course employing Modeling Applied to Problem Solving (MAPS) pedagogy.

PST2A03: 6-6:45 p.m. Assessing Students' Transfer of Learning Using Paper and Computer-Based Tests*

Poster – Dehui Hu, Kansas State University, Manhattan, KS 66506-2601; dehuihu@phys.ksu.edu

N. Sanjay Rebello, Kansas State University

We have developed research-based tutorials to facilitate students' application of the integral concept in a physics context. To assess students' transfer of learning, we combine paper-based tests and computer-based tests. Our assessment is based on the theoretical perspective of transfer as sequestered problem solving (SPS) or preparation for future learning (PFL). We investigate students' ability to solve a paper-based test without assistance, but also probe their ability to learn to solve the task with a series of online hints that target the major concepts introduced in the tutorials. Given that the transfer task is a challenging physics problem, the majority of students did not solve the transfer task successfully on the paper-based test. Students' extended learning with online hints provided us deeper insights about how our tutorials facilitated their future learning and limitations of the tutorials.

*This work supported in part by NSF grant 0816207.

PST2A05: 6-6:45 p.m. Modern Physics Labs Using Responsive Inquiry to Create Research Experiences

Poster – Benjamin L. Stottrup, Augsburg College, Minneapolis, MN 55454; stottrup@augsburg.edu

Ravi Tavakley, Augsburg College

Sarah B. McKagan, McKagan Enterprises

Augsburg College offers a sophomore-level modern physics course with associated lab. Traditionally this lab has been used to highlight the early development of quantum theory (photo-electric effect, Franck-Hertz, etc.). We will describe our redesign of this lab to create a semester-long responsive inquiry research experience focused on nanotechnology, materials characterization tools, and biology as an inspiration for engineers. Students gain hands-on experience using scanning electron microscopes, atomic force microscopes, as well as other sample preparation tools, and develop their own research projects using the equipment. A goal of the lab is to give students an experience of what research is like and what a scientist does, in order to improve their self-identity as scientists. The focus on contemporary skill building is intended to meet the changing demographics of our student body (increased enrollment, interest in engineering, and first generation college students). Finally, we address the potential for implementation of this model at other institutions.

PST2A06: 6:45-7:30 p.m. Assessing the Impact of Responsive Inquiry Labs on Students' Science Identities*

Poster – Sarah B. McKagan, McKagan Enterprises, 2436 S. Irving St., Seattle, WA 98144; sam.mckagan@gmail.com

Benjamin L. Stottrup, Augsburg College

We assess the impact of a modern physics lab designed to introduce students to contemporary tools of materials science and nanotechnology, to help them develop scientific research skills, and to help them view themselves as scientists. One goal of our project is to determine if the valuable experiences gained through undergraduate research can be re-enforced, supplemented, or extended to a broader student population through more traditional areas of the curriculum. Through interviews with students in the modern physics lab and with students participating in undergraduate research, we examine how attributes in the lab parallel those in undergraduate research experiences. We assess the impact of labs and undergraduate research experiences on students' understanding of the process of science and what a scientist does, and on their self-identities as scientists. We identify general features of labs, research experiences, and other educational environments that may impact student's self-identities as scientists.

*This material is based upon work supported by the National Science Foundation under Grant No. 0837182.

PST2A07: 6-6:45 p.m. Defining "Research Validation" for PER Users and Researchers*

Poster – Sarah B. McKagan, McKagan Enterprises, 2436 S. Irving St., Seattle, WA 98144; sam.mckagan@gmail.com

Amy D. Robertson, Seattle Pacific University

The PER User's Guide (http://perusersguide.org), a website to help physics instructors apply the results of physics education research (PER) in their classrooms, includes guides to over 50 PER-based teaching methods. We are developing summaries of the "research validation" behind each of these methods. However, there is no consensus in the PER community about what this term means. There are many challenges and critiques of even the most commonly cited definitions of "research validation," and no definition seems appropriate to every context. In this interactive poster, we will present some common definitions, along with challenges, critiques, requirements, and contexts in which each definition may or may not be appropriate. We will solicit feedback, definitions, and concerns from the community.

*This material is based upon work supported by the National Science Foundation under Grant No. 0840853.

PST2A08: 6:45-7:30 p.m. How Energy Theater Supports Participants in Accounting for Energy*

Poster – Sarah B. McKagan, McKagan Enterprises, 2436 S. Irving St., Seattle, WA 98144; sam.mckagan@gmail.com

Abigail R. Daane, Amy D. Robertson, Rachel E. Scherr, Seattle Pacific University

Energy Theater is an embodied learning activity in which participants act out energy transfers and transformations with their bodies. We have observed that participants in Energy Theater are often surprised by scenarios in which large quantities of energy are transformed from kinetic to thermal. This surprise appears to be a result of an expectation that a quantity of energy should be equally "perceptible" in different forms, an expectation that is violated when easily visible kinetic energy transforms into imperceptible thermal energy. We claim that Energy Theater enforces energy conservation in a way that pushes participants to recognize the presence of forms of energy that they do not expect, and to adjust their models of scenarios to take into account counterintuitive phenomena.

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

PST2A09: 6-6:45 p.m. A Refined Pintrich SRL Model for Micro-Analysing Learning and Mentoring

Poster – Zvika Arica, Weizmann Institute of Science, Rehovot, Israel 76000; zvi.arica@weizmann.ac.il

Bat-Sheva Eylon, Weizmann Institute of Science

"Physics & Industry" is a two-year Project-Based Learning program in which high-achieving 11th grade student pairs are tutored by expert physics teachers and high-tech engineers. The project focuses on an authentic technological problem and the design of a functional artifact. During the past six years we have implemented the program with under-achieving students. We aimed to promote their physics knowledge, learning skills, self-efficacy, self-regulation skills and creativity. To attain these goals, the instructional model provided a supportive environment encouraging the students to progress independently as far as possible. Initially, the Pintrich SRL model (Pintrich, 2000) was used to analyze interactions between students and mentors and amongst student themselves. However, since our research required deeper insights, we added a refined encoding of students' and mentors' discourse and actions. Using this encoding in a micro-analysis of extensive video and audio recordings facilitated the characterization of students' and mentors' behavior patterns.

PST2A10: 6:45-7:30 p.m. An Examination of Expert/Novice Positional Identities in the Disciplines*

Poster – Vashti Sawtelle, University of Maryland, Physics Building, College Park, MD 20742; vashti.sawtelle@gmail.com

Chandra Turpen, Edward F. Redish, University of Maryland, College Park

We present a qualitative analysis of a group of students working through a task designed to build connections between biology, chemistry, and physics. During the discussion members of the group explicitly index some of the ideas being presented as coming from "chemistry" and from "physics." While there is evidence that students seek coherence between outside knowledge and in-class knowledge, there is little evidence of reasoning with one another's ideas, resulting in a lack of reconciliation. In this poster we present evidence that the difficulty students face in trying to reconcile each other's ideas can be understood through a positional identity lens. We examine how students position themselves and each other as experts and novices in the disciplines. We argue that this disciplinary positioning contributes to the lack of the reconciliation of ideas for these students.

*Supported by the NSF Graduate Research Fellowship (DGE 0750616), NSF-TUES DUE 11-22818, and the HHMI NEXUS grant

PST2A11: 6-6:45 p.m. Assessing Learned Problem Solving Behavior in the Cognitive Apprenticeship Paradigm

Poster – William A. Schwalm, University of North Dakota, Grand Forks, ND 58202-7129; william.schwalm@und.edu

Mizuho K. Schwalm, University of North Dakota and University of Minnesota-Crookston

With the help of an NSF CCLI grant, introductory laboratories at the University of North Dakota were changed over to a problem-solving format. The laboratory periods focus more closely on problem-solving method, as do the classroom presentations. This has prompted us to develop a new way of assessing student learning in the laboratories. This assessment is based not on learned content but on learning of a problem-solving process within the cognitive apprenticeship paradigm. The instrument we have developed focuses on the first three steps of the Minnesota five-step problem-solving scheme. We attempt to measure the degree to which the importance a student assigns to certain bits of information or cognitive resources matches the importance attached to the same items by several expert problem solvers. Scoring is based on the closeness of fit to the expert responses. We present a description of the instrument and data analysis.

PST2A13: 6-6:45 p.m. Canned or Live? Investigating the Effectiveness of Taped Demonstrations

Poster – Lisa Carpenter, University of Vermont, Burlington, VT 05405; lrcarpen@uvm.edu*

Kelvin Chu, University of Vermont

Kevork Spartalian, University of Vermont

Demonstrations on a variety of topics in introductory physics were shown to classrooms of high school students. Some classes were shown live demonstrations with the demonstration apparatus present, while others were shown taped demonstrations using the same apparatus. Students were given a pre-assessment to determine their prior knowledge of each topic. Students were then engaged in the Interactive Lecture Demonstration (ILD) format, which required them to form and discuss predictions about each demonstration. A post-assessment was administered to assess knowledge gained. Post assessment questions were repeated at the end of the school year in order to determine long-term gains. The data and analysis we present reflect the efficacy of ILDs in the classroom both with and without demonstration apparatus.

*Sponsor: Kelvin Chu

PST2A14: 6:45-7:30 p.m. Extending Modeling Instruction with Computational Modeling: A Pilot Study

Poster – John M. Aiken, Georgia State University, Atlanta, GA 30302-3965; johnm.aiken@gmail.com

John B. Burk, The Westminster Schools

Scott S. Douglas, Michael F. Schatz, Georgia Institute of Technology

Marcos D. Caballero, University of Colorado Boulder

We describe the implementation and assessment of computational modeling in a ninth-grade classroom in the context of the Arizona Modeling Instruction™ physics curriculum. Using a high-level programming environment (VPython), students developed computational models to predict the motion of objects under a variety of physical situations (e.g., constant net force), to simulate real world phenomenon (e.g., car crash), and to visualize abstract quantities (e.g., acceleration). Students were assessed via an assignment that included completing a computational model of a baseball's motion (a new scenario to the students), conceptual questions similar to those appearing on the Force Concept Inventory, and two essay questions, one asking students to extend their computational model with a drag force, the other querying their understanding of while loops. This poster describes the common challenges students faced (programming and/or physics errors). It will also address student attitudes towards computation as a tool.

PST2A15: 6-6:45 p.m. Clicker Engagement in Introductory and Upper-Division Physics Courses

Poster – Patrick B. Kohl, Colorado School of Mines, Golden, CO 80401; pkohl@mines.edu

Todd G. Ruskell, Vince H. Kuo, Colorado School of Mines

Clickers, while perhaps not ubiquitous, have become very common in introductory physics classes where the audience is composed of students from a variety of majors. They have also begun to see use in upper-division physics courses where the audience is almost entirely physics majors.

In this presentation we examine the hypothesis that these substantially different populations will result in different levels of participation and engagement. We have videotaped the audiences of two introductory physics courses and two junior-level physics courses (mechanics and E&M in both cases) during clicker questions and quantified the level of engagement in each. Preliminary results suggest that upper-division majors-only courses exhibit more peer-to-peer interaction and overall engagement than introductory courses.

PST2A16: 6:45-7:30 p.m. Comparing Student Conceptual Understanding of Thermodynamics in Physics and Engineering*

Poster – Jessica W. Clark, University of Maine, Orono, ME 04469; jessica.w.clark@maine.edu

Donald B. Mountcastle, John R. Thompson, University of Maine, Department of Physics and Astronomy

Thermodynamics is a core part of curricula in physics and many engineering fields. Despite the apparent similarity in coverage, individual courses in each discipline have distinct emphases and applications. Physics education researchers have identified student difficulties with concepts such as heat, temperature, and entropy as well as with larger grain-sized ideas such as state variables, path-dependent processes, etc. Engineering education research has corroborated these findings and has identified additional difficulties unique to engineering contexts. We are beginning a project that provides an excellent opportunity for expanding the interdisciplinary research on conceptual understanding in thermodynamics. This project has two goals: first, determine the overlapping content and concepts across the disciplines; second, compare conceptual understanding between these groups using existing conceptual questions from PER and EER. We will present a review of PER and EER literature in thermodynamics and highlight some concepts that we will investigate.

*This project is partially supported by NSF grant DUE-0817282.

PST2A17: 6-6:45 p.m. Computational Modeling as a Promoter of Cognitive Transfer: Pilot Study

Poster – Scott S. Douglas, Georgia Institute of Technology, Atlanta, GA 30309; scott.s.douglas@gatech.edu

Marcos D. Caballero, University of Colorado at Boulder

Michael F. Schatz, Georgia Institute of Technology

We describe a study of the role of computational modeling in recognizing underlying similarities in different problems, a process called cognitive transfer. Previous studies have shown that this crucial process is highly sensitive to context, suggestion, and familiarity with the subject matter. We propose that courses emphasizing computational modeling, in which students repeatedly employ similar lines of code to model different physical systems, foster a more generalized cognitive transfer ability. We performed a think-aloud study on several students (some from a course involving computational modeling, others from a traditional physics course), exposing them to ordered pairs of problems of varying degrees of separation in specific details (molecular mechanics vs. projectile motion) and solution methods (numerical vs. analytical). With these data, we attempt to separate the influence of long-term instruction in computational modeling from the immediate priming effect of solving computational problems, and relate both to the promotion of cognitive transfer.

PST2A18: 6:45-7:30 p.m. Continuing the Comparison Between Graphical- and Text-based Programming Instruction*

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

Richard J. Freuler, John T. Demel, Stuart H. Brand, Engineering Education Innovation Center, The Ohio State University

We previously reported the results of a comparison between two sections of a freshman-level introductory programming course taught in 2008.[1] One was taught using C and C++, while the other was based on LabVIEW. The courses were structured such that they addressed the same basic programming constructs. The original study contained three major comparisons: ability to apply programming knowledge to problem-solving, ability to learn a second programming language (in this case, MATLAB), and epistemological views. Each sample contained 14 students. The C/C++ students were better at applying their skills to a common programming problem, the groups were nearly identical in learning MATLAB, and the LabVIEW students made more progress toward expert epistemological views. Here we report on a slightly larger (N=30 in each group) replication study conducted in 2011.

1. K. A. Harper, R. J. Freuler, J. T. Demel, S. Brand, "Comparing Instructional Effects of Graphics- and Text-Based Programming Languages," 2011 AAPT Winter Meeting, Jacksonville, FL, Jan.11, 2011.

*This project was supported by the National Instruments Foundation.

PST2A19: 6-6:45 p.m. Developing a Conceptual Model for Both Entropy and Energy*

Poster – Abigail R. Daane, Seattle Pacific University, West Seattle, WA 98109; abigail.daane@gmail.com

Stamatis Vokos, Seattle Pacific University

Rachel E. Scherr, Seattle Pacific University

Entropy is typically not a central focus either in introductory university physics textbooks or in national standards for secondary education. However, entropy is a key part of a strong conceptual model of energy, especially for connecting energy conservation to energy degradation and the irreversibility of processes. We are developing a conceptual model of entropy and the second law of thermodynamics as they relate to energy, with the goal of creating models and representations that link energy and entropy in a meaningful way for learners analyzing real-life energy scenarios. We expect this model to help learners better understand how their everyday experiences relate to formal physics analyses. Our goal is to develop tools for use with elementary and secondary teachers and secondary and university students.

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

PST2A20: 6:45-7:30 p.m. Developing a Research-based Interdisciplinary Physics Course for Biologists*

Poster – Edward F. Redish, University of Maryland, College Park, MD 20742-4111; redish@umd.edu

Benjamin W. Dreyfus, Benjamin D. Geller, Vashti Sawtelle, Chandra Turpen, University of Maryland

We have piloted the first iteration of a new physics course for biology majors at the University of Maryland aimed at developing scientific competencies. The curriculum has been developed by an interdisciplinary team of physicists, biologists, and biophysicists, and involves departures from the traditional introductory physics curriculum in choosing physics topics that are most relevant for biology. The development process has also been deeply connected to an ongoing conversation among physicists, chemists, and biologists about creating a common thermodynamics across the scientific disciplines. We have been collecting extensive qualitative and quantitative data from the course, providing the basis for assessment of the course, iterative development of the curriculum, and research on student reasoning in interdisciplinary contexts.

*Supported in part by the HHMI NEXUS project, NSF grant DUE 11-22818, and NSF Graduate Research Fellowship (DGE 0750616).

PST2A21: 6-6:45 p.m. Development of a Standardized Fluids Assessment

Poster – D. J. Wagner, Grove City College, 100 Campus Dr., Grove City, PA 1627; djwagner@gcc.edu

Elizabeth Carbone, Matthew Goszewski, Adam Moyer, Grove City College

Sam Cohen, Dallastown High School/Grove City College

We are developing an FCI-style assessment covering hydrostatic topics commonly included in introductory physics courses. The beta version of this assessment was rolled out in fall 2011, and revisions are ongoing. This poster will present the assessment, along with analysis of the questions and plans for the future. We're particularly interested in receiving suggestions from other educators and in recruiting more beta-testers. Stop by and chat!

PST2A22: 6:45-7:30 p.m. Effect of Paper Color on Physics Exam Performance

Poster – David R. Schmidt, Colorado School of Mines, Golden, CO 80401; dschmidt@mines.edu*

Todd G. Ruskell, Patrick B. Kohl, Colorado School of Mines

A substantial number of studies in the cognitive sciences have established that color, acting as an environmental cue, can significantly affect subject performance on a variety of tasks. However, there is a dearth of research into how this phenomenon manifests itself in 1) the combined conceptual and computational field of physics and 2) the context of preparation (i.e. where subjects prepare for relevant material prior to assessment as opposed to remaining ignorant of the tasks' nature until immediately before assessment). Our experiment involves approximately 450 students in an introductory E&M course in which the paper color used for examinations was varied. Analysis includes raw exam scores and differentiates between students' multiple choice, written response, conceptual, and computational performance. Additionally, we report on the time students require to complete exams and their confidence levels prior to and immediately following assessment.

*Sponsor: Patrick B. Kohl

PST2A23: 6-6:45 p.m. Eliciting Physics Faculty Expectations for Physics Majors

Poster – Renee Michelle Goertzen, Florida International University, Miami, FL 33199; rgoertze@fiu.edu

Eric Brewe Florida, David Brookes, Laird Kramer, Florida International University

As part of a project to investigate the goals physics faculty hold for physics majors, we have interviewed 17 physics faculty about what attitudes and abilities they expect students to have developed by the time they graduate with a bachelor's degree from our institution. Our preliminary analysis of the interviews suggests that some of these goals are both implicit and constructed in-the-moment in response to interview prompts. Understanding the nature of physics faculty expectations will allow us to better assess whether students meet these expectations, as well as whether physics programs standards adequately capture faculty goals. In the longer term, our goal is to investigate whether physics programs are providing sufficient opportunities for students to develop these desired attitudes and abilities.

PST2A24: 6:45-7:30 p.m. Engineering Students' Kinds of Mental Representations in Kinematics

Poster – Bashirah Ibrahim, Kansas State University, Manhattan, KS 66506-2601; bibrahim@phys.ksu.edu

N. Sanjay Rebello, Kansas State University

This study explores the categories of cognitive structures constructed by engineering students taking a calculus-based physics course. A sample of 19 students completed five non-directed tasks, with different representational formats, on the topic of kinematics. Individual interviews were conducted immediately following these tasks. The Johnson-Laird (1983) cognitive framework was applied to classify the participants' mental representations. It proposes three types of internal constructs: propositional representations, mental models, and mental images. The students' written solutions and individual interview responses were related to the cognitive framework to infer about the kind of mental representations. None of the students were classified with a mental model. Most (11 in 19) of the sample constructed propositional representation while the remaining students were identified with a mental image. This outcome indicates that these students have a poor understanding of the various concepts presented by the different tasks. Supported in part by NSF grant 0816207.

PST2A25: 6-6:45 p.m. Evolving Positions and Acknowledged Abilities: Expert Identity Development*

Poster – Idaykis Rodriguez, Florida International University, Miami, FL 33199; irodr020@fiu.edu

Renee Michelle Goertzen, Eric Brewe, Laird H. Kramer, Florida International University

This study examines how graduate students become physics experts in a physics research group using Wenger's apprenticeship framework within a Community of Practice. For an individual, the process of social reconfiguration is a matter of identity development through participation. We analyze data from an ethnographic case study of a biophysics research group with two professors and four graduate students. Data consist of six months of participant observations and video recordings of the group's research meetings, interviews, document analysis, and two months of observations a year later. We present how students' development of community membership is a matter of identification, how an individual is recognized or labeled, and negotiability, how individuals position themselves based on their abilities to negotiate meaning in an interaction. Differences in members' ability to negotiate in an interaction informs us of their evolving position within the research group and the acknowledgement of their abilities and technical expertise.

*Supported by NSF Award # PHY-0802184.

PST2A26: 6:45-7:30 p.m. Experts Solving a Complicated Problem

Poster – Bin Xiao, North Carolina State University, Raleigh, NC 27695; bxiao@ncse.edu

Robert J. Beichner, North Carolina State University

Experts can normally solve end-of-chapter exercises efficiently with high confidence. Some researchers claim the experts are not truly working on "problems" since they usually know how to solve them right from the beginning. To investigate this, we asked several experts to work on simple exercises as well as a complicated circuit problem using a think-aloud approach while simultaneously rating their self-confidence throughout their solution processes. Compared to their performance in solving end-of-chapter exercises, experts spent more time on understanding the problem and showed weaker metacognition while solving the problem.

PST2A27: 6-6:45 p.m. Characterizing and Resolving the Undifferentiated View of Ionizing Radiation

Poster – Andy Johnson, South Dakota Center for the Advancement of Math and Science Education, CAMSE, Spearfish, SD 57799-9005 andy.johnson@bhsu.edu

Natalie Dekay, Rebecca Maidl, CAMSE

The Radioactivity by Inquiry project (NSF DUE grant 0942699) is developing inquiry-based materials for teaching radiation literacy at the high school and college levels. We have found that students initially do not distinguish between radiation and the radioactive source. This has previously been observed by Eijkelhof (1990), Millar & Gill (1996) and Prather & Harrington (2001). The undifferentiated view is that radiation is "bad stuff," that there is no difference between radiation and radioactivity, and that radiation causes contamination. Developing a view of radiation as high-speed, subatomic particles requires distinguishing between radiation and radioactive materials. In this poster we identify and characterize students' initial ideas about radiation in terms of the undifferentiated radiation view and we quantify student progress toward differentiation. We find that differentiating fully and abandoning the view of "radiation as stuff" involves a long and challenging process that some students find difficult to complete.

PST2A28: 6:45-7:30 p.m. Exploring Learning Difficulties Associated with Understanding Ionizing by Radiation

Poster – Andy Johnson, South Dakota Center for the Advancement of Math and Science Education, CAMSE, Spearfish, SD 57799-9005; andy.johnson@bhsu.edu

Anna Hafele, CAMSE

"What does the word 'ionizing' mean in the phrase 'ionizing radiation'?" This question serves as a litmus test for student understanding on how radiation affects matter. The Radioactivity by Inquiry project (NSF DUE grant 0942699) is researching how non-science undergraduates can come to understand the interaction of radiation with matter through inquiry, and why some students fail to understand ionization. Despite carefully planned instruction on ionization, only 12% of students answered this question correctly post-instruction the first time it was asked two years ago. After major effort, we are up to 70% but we find additional problems with ionizing. It appears that understanding ionization requires a mechanistic mental model of atoms as well as differentiating radiation from radioactivity.

PST2A29: 6-6:45 p.m. Exploring "Design" in the Introductory Physics Laboratory

Poster – Jason E. Dowd, Harvard University, Cambridge, MA 02138; jedowd.work@gmail.com

Eric Mazur, Harvard University

Inquiry-based laboratory activities that emphasize scientific reasoning skills are better than more traditional alternatives, but how much "design" is too much? In this study, students in one semester of introductory physics are split into two different "design-focused" sequences of laboratory activities: heuristically scaffolded, ISLE-like (Rutgers) labs and largely exploratory, SCL-like (Maryland) labs. Both sequences are implemented over five biweekly meetings. Written reports were evaluated using the same rubrics as those used to assess scientific reasoning abilities in ISLE labs, so our findings are directly comparable with results reported from Rutgers. We observe slight differences between the two groups along some dimensions that seem to favor the more exploratory sequence, though our clearest observation is that five biweekly meetings is not sufficient for several important abilities. We elaborate on these findings and make suggestions for future implementation of these approaches to introductory laboratories.

PST2A30: 6:45-7:30 p.m. Force Concept Inventory Interviews: Gender Bias and Guessing

Poster – Wendy K. Adams, University of Northern Colorado, Greeley, CO 80639; wendy.adams@unco.edu

Richard D. Dietz, Matthew R. Semak, Courtney W. Willis, University of Northern Colorado

We have been investigating the issue of gender bias in the Force Concept Inventory (FCI) for several years. In introductory physics courses at the University of Northern Colorado (UNC) our female students have much lower pre-test scores (26%) than do their male counterparts (42%). This difference is not consistent with their performance in the physics courses they are taking. UNC accepts students with a wide range of ability, so a large fraction of the pre-test scores are lower than is seen in recent published research. Therefore our students represent the full range of possible pre-test scores. Early this year we turned to think-aloud student interviews on a subset of 19 of the 30 FCI questions. Preliminary results indicate that students who score 20% or lower on the FCI are not guessing; they have reasons for their answers. Furthermore, particular incorrect answers are selected for a variety of reasons.

PST2A31: 6-6:45 p.m. Free Online Physics Course Emphasizing Problem Solving

Poster – Saif Rayyan, Massachusetts Institute of Technology, Cambridge, MA 02139; srayyan@mit.edu

Analia Barrantes, David E. Pritchard, Massachusetts Institute of Technology

Andrew Pawl, University of Wisconsin - Platteville

Raluca Teodorescu, The George Washington University

Our RELATE group is currently teaching an online course on Newtonian Mechanics (http://relate.mit.edu/physicscourse/). The course develops more expert-like problem solving skills using the MAPS Pedagogy, [1] and includes hundreds of assessment questions, many based on results from physics education research. Open-source course content (modularized e-text, animations, videos, and solved examples) is divided into learning modules that are mapped to a list of learning objectives. The course is hosted on the LONCAPA network (http://loncapa.org), and anyone in the network can use our course content in their classes. We are currently integrating IRT into this platform, enabling standardized assessment of student and class skill on a national standard that is independent of which problems students work. We thank Yoav Bergner, Stephan Dröschler, Sara Julin, Boris Korsunsky, Gerd Kortemeyer, and Daniel Seaton for their significant contributions.

1. *AIP Conf. Proc.* **1179**, pp. 51-54 (2009).

PST2A32: 6:45-7:30 p.m. How Do Physics Majors Assert their Physics Identity?

Poster – Sissi L. Li, Catalyst Center, California State University Fullerton, Fullerton, CA 92831; sili@fullerton.edu

Michael E. Loverude, California State University Fullerton

Declaring and pursuing a major is an explicit choice to interact with and join a community. As a part of becoming physics majors, students develop a relationship with the academic and professional physics communities which is shaped by the way the individual makes sense of how to be a part of the physics community. This physics major identity development can be expressed in the ways students engage in their physics classes, the ways they think about physics, and the ways they do physics in their everyday lives. In this study, we examine the ways in which students behave and think "like physicists" as they begin to take upper-division courses in their major. Using classroom observations, individual semi-structured interviews, and written reflective journals, we present common and unusual ways in which students assert their physics identity and propose implications for identity development as physicists.

PST2A33: 6-6:45 p.m. How Numbers Help Students Solve Physics Problems

Poster – Eugene Torigoe, Allegheny College, Meadville, PA 16335 etorigoe@gmail.com

The mathematical solution to a physics problem requires many different types of information to be represented by symbols. Some symbol properties are permanent, such as the association of a symbol with an object. And others change as the solution progresses, such as whether the quantity is known or unknown. Because of the different ways information is represented in numeric and symbolic problem solutions, symbolic problems can often be much more difficult for students than numeric problems. For example, while it is easy to distinguish a known and unknown quantity in a numeric solution, there is no explicit notation in a symbolic solution for such a distinction. The poster will also describe how such differences can affect the strategic choices made by students.

PST2A34: 6:45-7:30 p.m. Implementing SCALE-UP in Physics at UNC-CH

Poster – Duane Deardorff, University of North Carolina, Chapel Hill, NC 27599; duane.deardorff@unc.edu

Alice Churukian, University of North Carolina at Chapel Hill

During the summer of 2010, the Department of Physics and Astronomy at the University of North Carolina at Chapel Hill renovated one of the traditional physics lab rooms into a SCALE-UP (Student Centered Active Learning Environment for Upside-down Pedagogies) style classroom with the first section being taught that fall. This method of instruction provides an opportunity to integrate lecture, lab, and recitation activities in a cohesive way that strengthens and synchronizes aspects of the various components while allowing students to work in groups with hands-on activities in a studio environment. While this instructional methodology has already been implemented in over 100 other schools around the world (and proven to be effective in most cases), this was the first time at UNC-CH. Lessons learned from this experience will be shared.

PST2A35: 6-6:45 p.m. Instructor's Goals for Using Example Solutions for Introductory Physics

Poster – William Mamudi, Western Michigan University, Kalamazoo, MI 49008; william.o.mamudi@wmich.edu

Charles Henderson, Western Michigan University

Shih-Yin Lin, Chandralekha Singh, University of Pittsburgh

Edit Yerushalmi, Weizmann Institute of Science

In light of recommendations from the literature for modeling expert-like problem solving approaches, we investigated instructors' goals for providing example solutions in introductory physics courses. Twenty-four graduate teaching assistants and 30 faculty were asked: 1) in a general context, to describe their main purposes for providing example solutions, and 2) specifically, to identify their considerations when comparing three example solutions that reflect different pedagogical views. Differences between the faculty and TAs will be discussed in order to describe possible progression of ideas throughout an instructor's professional career. For example, faculty explicitly emphasize the importance of developing expert-like problem solving when discussing their goals in the general context. In contrast TAs refer to the goal of developing expert-like problem solving mainly in an implicit manner, when examining specific solutions, and emphasize other values, such as helping students develop conceptual understanding, when asked explicitly on their purposes in the general context.

PST2A37: 6-6:45 p.m. Interactive Learning in French University Physics Classrooms

Poster – Alexander L. Rudolph, Cal Poly Pomona, Pomona, CA 91768; alrudolph@csupomona.edu

Michael Joyce, Brahim Lamine, Université Pierre et Marie Curie

This is a report on a project to introduce interactive learning strategies to physics classes at Université Pierre et Marie Curie (Paris), one of the leading science universities in France. In spring 2012, instructors in over 20 classrooms, enrolling almost 1000 students, implemented Think-Pair-Share questions and Peer Instruction in the main lecture classrooms, and University of Washington "Tutorials in Introductory Physics" in recitation sections. In two of these classes, a second-semester mechanics class, and an introductory E&M class, enrolling 500 and 300 students respectively, pre- and post-instruction assessments (FCI and CSEM respectively) were given, along with a series of demographics questions. Not all lecture or recitation sections in these classes used interactive learning, allowing us to compare the results of the FCI and CSEM between interactive and non-interactive classes taught simultaneously with the same curriculum. We also analyze test results and course grades, as well as the results of student and instructor attitude surveys between classes.

PST2A38: 6:45-7:30 p.m. Interdisciplinary Understanding of Osmosis and Diffusion Among Undergraduate Science Students

Poster – Craig C. Wiegert, University of Georgia, Athens, GA 30602-2451 wiegert@physast.uga.edu

Ji Shen, Dongmei Zhang, Shannon Sung, Kathrin Stanger-Hall, University of Georgia

Our multi-disciplinary collaboration of University of Georgia scientists and educators has been designing test items to assess college-level science students' understanding of osmosis, diffusion, and filtration -- topics that incorporate physical, chemical, biological, and/or physiological knowledge. We present the exploratory data analysis of the first results of administering our assessment items in introductory physics, biology, and physiology courses. In light of the coming revisions to the MCAT, and the growing importance of introductory physics courses that are tailored to the life sciences, results such as ours may help to guide curriculum changes in these introductory courses.

PST2A39: 6-6:45 p.m. Internet Coaches for Problem-Solving in Introductory Physics: Data Analysis

Poster – Qing Xu, University of Minnesota-Twin Cities, Minneapolis, MN 55455; qxu@physics.umn.edu

Ken Heller, Leon Hsu, Bijaya Aryal. University of Minnesota-Rochester

The Physics Education Group at the University of Minnesota has been constructing web-based programs that can provide introductory physics students with coaching in the use of an expert-like framework in solving problems. During the fall 2011 semester, the coaches were introduced into a large (200+ students) section of the introductory mechanics course at the University of Minnesota to assess their educational impact. In this poster, we will present the results of using a problem-solving rubric to analyze students' solutions from problems on mid-semester quizzes and the final exam. The rubric evaluates a student's problem-solving performance along five axes based on expert-novice problem solving research. This work was supported by NSF DUE-0715615.

PST2A40: 6:45-7:30 p.m. Internet Coaches for Problem-Solving in Introductory Physics: Experimental Design

Poster – Leon Hsu University of Minnesota-Twin Cities, Minneapolis, MN 55455 lhsu@umn.edu

Ken Heller, Qing Xu, University of Minnesota

The Physics Education Group at the University of Minnesota has been constructing web-based programs that can provide introductory physics students with coaching in the use of an expert-like framework in solving problems. During the fall 2011 semester, the coaches were introduced into a large (200+ students) section of the introductory mechanics course at the University of Minnesota to assess their educational impact. We describe the design of this experiment, including the construction of comparison groups, student reactions to the computer programs, and lessons learned. A companion poster addresses the data analysis, including results obtained to date. This work was supported by NSF DUE-0715615.

PST2A41: 6-6:45 p.m. Investigating Science Learning Attitudes Among Chinese Students

Poster – Lin Ding, School of Teaching and Learning, The Ohio State University, Columbus, OH 43210; ding.65@osu.edu

Empirical studies aiming at student conceptual learning in physics show that Chinese students overall demonstrate a higher level of content knowledge than do their U.S. counterparts, and that their reasoning skills in basic scientific practices, however, are comparable between the two nations. Since student epistemological ideas exert substantial influences on learning outcomes, it is reasonable to hypothesize, based on the previous literature, that students in the two nations may have different views about what physics is and how physics should be learned. As part of our ongoing project, this study looks into the epistemological beliefs of Chinese students in the learning of physics. We administered the Colorado Learning Attitudes Survey about Science to Chinese high school and college students. Some preliminary results are reported in this paper.

PST2A42: 6:45-7:30 p.m. Investigating Students' Understanding of the Fundamental Theorem of Calculus*

Poster – Rabindra R. Bajracharya, University of Maine, Orono, ME 04469; ab_study@yahoo.com

John R. Thompson, University of Maine

The Fundamental Theorem of Calculus (FTC) is an extremely useful computational tool widely used for solving various physics problems. It is implicitly invoked in the evaluation of integral problems. Research in mathematics education has documented student difficulties with the underlying concepts of the FTC. We are investigating student difficulties with the FTC, and extending the work in mathematics to include relevant situations in physics. Questions administered as written surveys and individual interviews in calculus-based introductory physics and multivariable calculus classes focused on the determination of signs of integrals, primarily in graphical representations. Negative integrals in particular provided a rich context for FTC application. We find that students use the FTC as a computational tool without understanding the underlying concepts. One observed difficulty is an operational confusion between the function endpoints and the antiderivative endpoints when determining the integral signs.

*This work is partially supported by NSF grant DUE-0817282.

PST2A43: 6-6:45 p.m. Investigating Visual Attention in Physics Using Scan-Path Eye Movement Analysis*

Poster – Adrian Madsen, Kansas State University, Manhattan, KS 66506-2601; adrianc@phys.ksu.edu

Adam Larson, Amy Rouinfar, Lester Loschky, N. Sanjay Rebello Kansas State University

Two types of processes, top-down and bottom-up, guide visual attention. Bottom-up processes are fast, automatic processes based on noticeable features in the environment. Top-down processes are based on prior knowledge, goals, and expectations. To investigate how top-down and bottom-up processes influence visual attention in physics problems, we recorded eye movements of 24 individuals on problems with diagrams that contained areas consistent with novice-like responses and areas of high perceptual salience. We used an algorithm that calculates a similarity score between pairs of participants' eye movements. We compared pairs of correct solvers (CC) and pairs of incorrect solvers (II). We found no statistically significant differences between the CC and II comparisons on five of the six problems. This result seems to imply that top-down processes relying on incorrect domain knowledge, rather than bottom-up processes driven by perceptual salience, influence the visual attention of incorrect solvers.

*This work supported in part by NSF grant 1138697.

PST2A44: 6:45-7:30 p.m. Item Response Theory and Collaborative Filtering: Is Your Course Unidimensional?

Poster – Yoav Bergner, Massachusetts Institute of Technology, Cambridge, MA 02139; bergner@mit.edu

Stefan Droschler, Ostfalia U. & MIT

Daniel Seaton, David E. Pritchard, Massachusetts Institute of Technology

Gerd Kortemeyer Michigan State University

Online homework is a natural way to assess what students know, but the questions themselves may not always fit the bill. Items may be flawed, too hard or too easy, or they may measure abilities that are different from the intended ones. Item response models not only measure student abilities independently of which subset of questions they answer, but these models also detect flaws in the questions. We demonstrate how collaborative filtering (used by Netflix to predict which movies you might like) can be used to analyze student response data, motivating and extending a class of item response models. Analysis shows that chemistry homework assigned using LON-CAPA at MSU indicates two-dimensional skill and discrimination, whereas the Mechanics Baseline Test at MIT is unidimensional.

PST2A45: 6-6:45 p.m. Knowledge Integration While Interacting with an Online Troubleshooting Activity: Findings

Poster – Edit Yerushalmi, Weizmann Institute of Science, Rehovot, 76100 Israel; edit.yerushalmi@weizmann.ac.il

Menashe Puterkovski, Esther Bagno, Weizmann Institute of Science

A troubleshooting activity was carried out by an e-tutor in two steps. First the student diagnoses a mistaken statement, then the student compares his diagnosis to an exemplary diagnosis provided by the e-tutor. To examine whether and how the activity attains its objective—to engage students in a process of clarifying and repairing the mistaken ideas underlying the mistaken statement, we studied the discourse between students working with the e-tutor on a statement implying that because there is no current on an open switch in a DC circuit, according to Ohm's law the potential difference is necessarily zero. We present an analysis showing how the activity triggered students to explicate multiple alternative interpretations of the principles and concepts involved and attempt to align conflicting interpretations. We discuss how successive amendations gradually culminated in the elaboration of students' understanding of these concepts.

PST2A46: 6:45-7:30 p.m. Knowledge Integration While Interacting with an Online Troubleshooting Activity: Methodology

Poster – Menashe Puterkovski, Weizmann Institute of Science, Rehovot, 76100 ISRAEL; puterkov@gmail.com

Esther Bagno, Edit Yerushalmi, Weizmann institute of Science

A troubleshooting activity was carried out by an e-tutor in two steps. First the student diagnoses a mistaken statement attributed to the virtual student "Danny", then the student compares his/her own diagnosis to an exemplary diagnosis provided by the e-tutor. These steps are based on three design principles: 1) Eliciting common misinterpretations. 2) Incorporating knowledge integration processes. 3) Inspiring a non-judgmental argumentative environment. These activities aim to provide students with ample opportunities to recognize, acknowledge and attempt to resolve conflicts between possible interpretations of scientific concepts and principles. This talk will focus on the design of the artifacts implemented in these activities (mistaken statements and exemplary diagnoses) and the methodology used to explore the following questions: To what extent do knowledge integration processes take place? How do students make use of the opportunities provided by the activity to negotiate and possibly elaborate alternative interpretations of physics concepts and principles?

PST2A47: 6-6:45 p.m. Making Sense of Friction as an Interaction Using System Schema

Poster – Brant Hinrichs, Drury University, Springfield, MO 65802; bhinrichs@drury.edu

After learning Newton's second law, students in a university modeling-based introductory physics class are asked to imagine a box sliding across a floor and slowing to a stop. Although they've had extensive experience with friction in the context of energy, this is their first exposure to friction within the context of forces. They are asked to make different representations for this scenario, including a system schema, and force diagram. During their small group work, students quickly run into a difficulty: there are only two interactions with the box (contact, gravitational), so there should only be two forces, yet the box is slowing, which means it must have unbalanced forces in the direction of acceleration. In this talk, I present evidence from the student-led whole class discussion showing how the class uses the System Schema to help reason about this problem in a productive manner and come to a useful consensus.

PST2A48: 6:45-7:30 p.m. Optics Concept Assessment

Poster – Timothy T. Grove, IPFW, Fort Wayne, IN 46805; grovet@ipfw.edu

Mark F. Masters, IPFW

Ernest Behringer, Eastern Michigan University

In order to assess student learning of optics, we have created an optics concept assessment exam. Optics is a broad sub-field of physics (wave model of light, ray model of light, mirrors, lenses, interference, etc.) and this exam was designed to assess a broad range of these basic tenets. Testing for common misconceptions while using plain, student language, we have probed to better understand student thinking. We will show our preliminary findings.

PST2A49: 6-6:45 p.m. Particle Physics Masterclass as a Context for Learning About NOS

Poster – Michael J. Wadness, Medford High School/QuarkNet/UMass Lowell, Natick, MA 01760; mjwadness@verizon.net

This research addresses the question: Do secondary school science students attending the Particle Physics Masterclass change their view of the nature of science (NOS)? The Particle Physics Masterclass is a national physics outreach program run by QuarkNet, in which high school physics students gather at a local research institution for one day to learn about particle physics and the scientific enterprise. Student activities include introductory lectures in particle physics, laboratory tours, analysis of actual data from CERN, and the discussion of their findings in a conference-like atmosphere. Although there are a number of outreach programs involving scientists in K-12 education, very few of them have been formally evaluated to determine if they provide adequate learning of NOS. Therefore, the significance of this study is that it investigates the claim that science outreach programs may be designed to address science literacy, specifically as a context for explicit NOS instruction.

PST2A50: 6:45-7:30 p.m. Pedagogical Motivations and Practices of New Faculty Following Participation in an Intensive Physics Education Focused Workshop

Poster – Melissa Dancy, University of Colorado, Boulder, CO 80305; melissa.dancy@gmail.com

Charles Henderson, Western Michigan University

In our previous work we interviewed faculty retrospectively about their decision-making regarding research-based reforms. In order to develop a more in-depth understanding we are currently following 15 physics faculty during the change process. We report on interviews of 15 physics faculty pre- and post-semester for the two semesters they taught an introductory course following their participation in the Physics and Astronomy New

Faculty Workshop. All faculty interviewed were in their beginning years as an instructor and expressed a strong interest in integrating Physics Education Research in their teaching practice. In this poster we present an analysis of the research-based instructional practices these faculty implemented, including the ways in which they modified practices and the reasons behind their decisions to implement and modify.

PST2A51: 6-6:45 p.m. Physics Pedagogy and Assessment in Secondary Schools: Key Findings

Poster – Melissa M. Nemeth, Bogan HS, 3939 W. 79th St., Chicago, IL 60652; melissamnemeth@gmail.com

Gordon P. Ramsey, David W. Haberkorn, Loyola University Chicago

As physics provides a crucial link between mathematics and science, high school physics teachers are under constant pressure to deliver the best education possible. Our research aims to uncover current best practices in secondary physics education and make recommendations based on our key findings. With the knowledge that students' socioeconomic status and teachers' experience affects the way physics is taught, we surveyed teachers in the categories of demographics, student and teacher backgrounds, teaching practices, and assessment techniques. Using current education research, we created a measuring tool to rank and quantify responses in these categories. We used these numbers to quantify the key findings presented. Our main objective is to make recommendations of specific ways to make high school physics more engaging with the ultimate goal of ensuring higher student success in college and beyond. See talk by Gordon P. Ramsey and poster by David Haberkorn for further details.

PST2A53: 6-6:45 p.m. Physics Students' Use of Layers and Representations to Understand Integrals*

Poster – Joshua Von Korff, Kansas State University, Manhattan, KS 66506-2601; vonkorff@phys.ksu.edu

N. Sanjay Rebello, Kansas State University

Students' understanding of integration can be analyzed in terms of layers and representations. "Layers" are mathematical objects or procedures that are used to construct an integral: each integral can be conceptualized as a sum of many products. Representations are ways of expressing these layers in written or spoken form, including verbal, diagrammatic, symbolic, graphical, and tabular representations. We present an analysis of physics students' work in terms of layers and representations, and describe course materials designed to help students view integrals in terms of layers. The layers and representations framework has often been applied in a mathematics context; we present a modification of the layer structure that is useful in a physics context.

*This work supported in part by NSF grant 0816207.

PST2A54: 6:45-7:30 p.m. Physics Teaching Assistants' Beliefs and Practices: Applying a Framework

Poster – Benjamin T. Spike, University of Colorado, Boulder, CO 80309-0390; spike@colorado.edu

Noah D. Finkelstein, University of Colorado - Boulder

Increasing attention is being paid to the role of Teaching Assistants (TAs) in supporting research-based instructional environments. We build upon a broad foundation of research in the nature of teacher knowledge to develop an analytic framework for how TAs talk about and enact their roles as teachers. In a previous work,[1] we began to outline a framework for TA pedagogical knowledge and highlighted examples of emergent differences between TAs along one particular dimension, Agency. In this paper, we extend this framework to include additional dimensions of goals and assessment in order to provide a more complete description of the pedagogical knowledge TAs draw upon when talking about and engaging in teaching practices. Using examples drawn from several semesters of TA interviews and classroom videotape, we then show the utility of this framework and describe instances of coordination and incoordination between TA beliefs and practices.

1. B.T. Spike and N.D. Finkelstein, PERC 2011.

PST2A55: 6-6:45 p.m. Pilot Testing of the Modeling Instruction Curriculum

Poster – Jared L. Durden, Florida International University, Miami, FL 33199; jdurd001@fiu.edu

Eric Brewe, Florida International University

At Florida International University we are developing a curriculum guide and set of comprehensive video and digital resources to support the implementation of Modeling Instruction. In preparation for dissemination of the curriculum materials and instructor support guide, we pilot tested the curriculum guide. An instructor with no previous experience teaching introductory physics using Modeling Instruction utilized the curriculum guide and instructor resources. To better understand how to support Modeling Instruction curriculum use, we conducted interviews with the instructor during and after the semester. We have identified three types of instructional resources germane to implementing Modeling Instruction. The instructor brought considerable resources based on prior teaching experiences. Several resources were developed during the instruction with assistance of the curriculum materials. Finally, several resources were not developed. We investigate the role that these resources play in instruction and how to structure faculty professional development that supports the development of instructional resources.

PST2A56: 6:45-7:30 p.m. Preliminary Investigations of Physical Science Teacher Content Knowledge and PCK*

Poster – Daniel P. Laverty, University of Maine, Orono, ME 04469; daniel.laverty@maine.edu

John R. Thompson, MacKenzie R. Stetzer, University of Maine

There is ongoing discussion of the extent to which specific strands of teacher professional development influence student learning. We describe research efforts exploring the roles of teacher content knowledge and pedagogical content knowledge, particularly teacher knowledge of student ideas (KSI), in the context of the Maine Physical Sciences Partnership (MainePSP). The primary focus of the MainePSP is the professional development of physical science instructors in grades 6-9 via curriculum renewal using common instructional resources across multiple school districts. This particular study looks to assess teacher content knowledge and KSI in order to explore their respective effects on student learning in specific contexts, including density and mechanics. We will describe our methods, present preliminary results, and outline recommendations for further investigation.

*This work is partially supported by NSF grant DUE 0962805.

PST2A57: 6-6:45 p.m. Pre-service Physics Teachers' Moral Sensitivity in the Context of Physics-Related Socioscientific Issues

Poster – Sungmin Im Daegu, University 201 Daegudaero, Jillyang, Gyeongsan, Gyeongsangbukdo, 712714 South Korea; ismphs@daegu.ac.kr

Since promoting scientific literacy for all students has been emphasized as a main goal of secondary school science, there are extensive discussions to argue how to define scientific literacy in a manner of functional form and how to promote it. Many studies support that achieving functional scientific literacy requires attention to moral factors associated with socioscientific issues (SSI) and moral implications of decisions made in the context of SSI. Although there is an increasing amount of research on SSI in the field of secondary science education and science teacher education, much has been focused on students rather than teachers, and interest in the context of biological or environmental issues such as global climate change, genetic engineering, stem cell research, and many modern health care options. The purpose of this study is to investigate pre-service physics teachers' moral sensitivity in the context of physics-related socioscientific issues (SSI). Moral sensitivity in this study was defined as the ability to recognize when a situation contains a moral aspect. When confronted with a situation, such as SSI, a person with moral sensitivity is aware of how possible resolutions of the situation have the potential to affect others in a negative manner. In this talk, the result and its significance would be discussed in the context of seeking viable strategy to confront moral aspect of physics teaching.

PST2A58: 6:45-7:30 p.m. Proportional Reasoning Competence Among Different Student Populations

Poster – King Wong, Western Washington University, Bellingham, WA 98225-9164; wongk4@students.wwu.edu*

Andrew Boudreaux Western Washington University

A collaborative project between Western Washington University, Rutgers University, and New Mexico State University seeks to understand students' competence level on proportional reasoning. We have been collecting and analyzing data from introductory physics and science education courses using a set of assessment tasks. We utilize the notion of constructs to categorize student thinking according to repetitive patterns. Results suggest that, when students confront ratio and proportion problems, they often experience a gap between the mechanics of the mathematical operations and the conscious understanding of what they are doing. In this poster we will share results of our findings from different courses, institutions, and student populations. Supported by NSF grants DUE-1045227, DUE-1045231, DUE-1045250.

*Sponsor: Andrew Boudreaux

PST2A59: 6-6:45 p.m. Research on Coherence Seeking Across Disciplinary Boundaries*

Poster – Chandra Turpen, University of Maryland, College Park, MD 20742; Chandra.Turpen@colorado.edu

Benjamin W. Dreyfus, Benjamin Geller, Vashti Sawtelle, Edward F. Redish, Department of Physics, University of Maryland

We analyze coherence-seeking in ongoing student activity from a video-recorded discussion section. Here, students engage in a task designed to build connections between physics and biology. We present evidence of students 1) spontaneously bringing in unanticipated outside knowledge into their reasoning in this physics course and 2) seeking connections between the course material and other things they know. Throughout this process, we examine both implicit and explicit indexing of the disciplines throughout the reasoning episode to show that often these connections span disciplinary boundaries. Independent of whether reconciliation is achieved, we see coherence-seeking reasoning practices that students are engaged in as essential to scientific practice and as such we claim that those practices should be a focus of our assessment efforts.

*Supported by the NSF Graduate Research Fellowship (DGE 0750616), NSF-TUES DUE 11-22818, and the HHMI NEXUS grant.

PST2A60: 6:45-7:30 p.m. Research on Students' Reasoning About Interdisciplinarity*

Poster – Benjamin Geller, University of Maryland, College Park, MD 20742; geller@umd.edu

Benjamin W. Dreyfus, Vashti Sawtelle, Chandra Turpen, Edward F. Redish, Department of Physics, University of Maryland

We present qualitative data of undergraduates describing the relationship between scientific disciplines. Rather than viewing biology, chemistry, and physics as existing in disconnected silos, these students often describe the relationships in a hierarchical or horizontal fashion. The hierarchical arrangements order the disciplines by degree of system complexity, or by the scale used to examine a particular system. For example, a student might view the full description of folded proteins at the top (biology), chemical reactions involving proteins' functions as chemistry, and motion of the protein's individual atoms as foundational (physics). Other students describe a horizontal view of disciplinary boundaries, without a foundational bottom but maintaining overlapping realms of interest. Others want physics embedded in a context that positions its relationship to biology via analogy. We examine evidence that students' conceptions are unstable and context-dependent, and suspect that these conceptions are related to course messaging in a bidirectional manner.

*Supported by the NSF Graduate Research Fellowship (DGE 0750616), NSF-TUES DUE 11-22818, and the HHMI NEXUS grant.

PST2A61: 6-6:45 p.m. Student Difficulties in Translating Between Mathematical and Graphical Representations in Introductory Physics

Poster – Alexandru Maries, University of Pittsburgh, 5813 Bartlett St., Pittsburgh, PA 15217; alm195@pitt.edu

Chandralekha Singh

Prior research suggests that introductory physics students have difficulty with graphing and interpreting graphs. We investigate introductory physics students' difficulties in translating between mathematical and graphical representations and effect of scaffolding on students' performance. We gave a typical problem that can be solved using Gauss's law involving spherically symmetric charge distribution (a conducting sphere concentric with a conducting spherical shell) to 96 calculus-based introductory physics students. We asked students to write a mathematical expression for the electric field in various regions and asked them to graph the electric field. We knew from previous experience that students' have great difficulty in graphing the electric field for this problem. Therefore, we implemented two scaffolding interventions to help them. Students who received the scaffolding support were either 1) asked to draw the electric field in each region first (before having to plot it as a function of distance from the center of the sphere) or 2) asked to draw the electric field in each region and asked to explicitly evaluate the electric field at the beginning, mid and end points of each region. The comparison group was only asked to plot the electric field at the end of the problem. We also conducted recorded interviews with individual students in order to better understand how the interventions impacted them. We will present some surprising results.

PST2A62: 6:45-7:30 p.m. Student Generated Content for Learning

Poster – Ross K. Galloway, University of Edinburgh, King's Buildings, Edinburgh, EH9 3JZ United Kingdom; ross.galloway@ed.ac.uk

Simon P. Bates University of Edinburgh

Morag M. Casey University of Glasgow

We report on an extensive, multi-institutional and multi-disciplinary project to evaluate student learning as a result of student engagement with content creation: specifically, the generation of course questions. The project involves the deployment of the PeerWise online system with undergraduate physics, chemistry, and biology students at multiple undergraduate levels at a number of universities. We find high levels of student engagement with the system, coupled with generally high-quality student contributions. We present evidence that suggests that meaningful participation in content generation tasks enhances student learning, as measured by typical course assessments. We find similar effects at multiple levels and across disciplines and institutions; beneficial aspects are also found for students with a range of abilities within the classes, suggesting that our mode of implementation has wide applicability. We highlight cognitive scaffolding tasks that we believe promote effective student engagement with the activity.

PST2A63: 6-6:45 p.m. Students' Use of Real-World Knowledge During Collaborative Physics Problem Solving

Poster – Mathew Martinuk, 2264 Ferndale St., Vancouver, British Columbia, V5L1Y5 Canada; martinuk@physics.ubc.ca

In this poster I will describe students' use of their real-world knowledge and their epistemological framing during collaborative group recitation problems in an introductory algebra-based physics course for non-physics majors. Analysis of 14 different student groups working on three different recitation problems reveals that: 1) Despite significant prompting within the problems and support in lecture, over half of the groups do not make significant use of their real-world knowledge as a part of their solution to the recitation problems. 2) Students that do make use of their real-world knowledge do so during conceptual discussion, but not during procedural discussion. Implications for instruction and future research will be discussed.

PST2A64: 6:45-7:30 p.m. Students' Individual Performance After Group Interaction

Poster – Bijaya Aryal, University of Minnesota-Rochester, Rochester, MN 55904; baryal@umn.edu

Prior studies report the enhancement of students' task performance in group settings. Nonetheless, it is important for students to complete tasks in individual settings at some points of learning experiences as individual decision making is essential in everyday and professional lives. This study examined the effect of ordering group and individual exercise on students' subsequent individual problem-solving performance. Series of individual and group assignments having similar underlying physics principles were designed and implemented for two semesters of a physics course. The first two assignments of each series were used to help consolidating students' prior learning and the third assignment was used to examine their transfer of learning. This presentation describes some of the findings from last two semesters regarding the students' performances in learning consolidation phase. In addition, it reports the effects of ordering group and individual activities on students' subsequent individual transfer of learning.

PST2A65: 6-6:45 p.m. Students' Response Patterns to Research Tasks with Alternative Questioning Formats

Poster – Jeffrey M. Hawkins, The University of Maine, Orono, ME 04469; United States jeffrey.hawkins@maine.edu

Brian W. Frank, Middle Tennessee State University

Michael C. Wittmann, John R. Thompson The University of Maine

Teachers, researchers, and curriculum developers utilize the results of formative assessment to elicit students pre-instruction physics ideas. In canonical physics education research tasks, students are asked to identify a correct answer and justify their answer choice. However, we find that students often know more than is revealed by their answers to these question formats. In two research tasks, students were either given the correct answer and asked to justify it, or they were asked which response they would eliminate and to provide a justification for why that response is incorrect. These tasks were randomly administered, online, to students in the first semester of an introductory calculus-based physics course. We present results from these pre-tests, comparing the types of reasoning and frequency of responses across question types. We find that the variations in responses given by students are context dependent.

PST2A66: 6:45-7:30 p.m. Student-Teacher Interactions for Bringing Out Student Ideas About Energy*

Poster – Benedikt W. Harrer, University of Maine, Orono, ME 04469; benedikt.harrer@maine.edu

Michael C. Wittmann, University of Maine

Rachel E. Scherr, Seattle Pacific University

Modern middle school science curricula use group activities to help students express their thinking and enable them to work together like scientists. We are studying rural eighth-grade science classrooms using materials on energy. Even after spending several months with the same curriculum on other physics topics, students' engagement in group activities seems to be restricted to creating lists of words that are associated with energy. Though research suggests that children have rich and potentially valuable ideas about energy, our students don't seem to spontaneously use and express their ideas in the classroom. Only within or after certain interactions with a teacher do students begin to explore and share these ideas. We present and characterize examples of student-teacher interactions resulting in students' deeper engagement with their ideas about energy. This preliminary analysis of video-recorded classroom dialog is a step toward helping teachers improve their students' learning about energy.

*Supported in part by NSF DUE 0962805

PST2A67: 6-6:45 p.m. Switching Behavior in the Peer Instruction Classroom

Poster – Kelly A. Miller, Harvard University, Cambridge, MA 02138-3800; United States kmiller@seas.harvard.edu

Julie Schell, Harvard University

Peer instruction, a teaching strategy designed to increase student interaction, has been shown to improve student learning and retention in physics courses. In the classroom, students respond to conceptual questions, discuss with peers and then respond again. Student response patterns (or switching) provide the instructor with real-time feedback of student understanding and are used to guide the discussion during class. But how do these switching patterns relate to other dimensions of student learning? Does switching tell us more about students' confidence than understanding? How can we better understand this behavior that is essentially steering the course? We analyze the relationship between "switching" variables and other student metrics to better understand how the dynamics of student interaction lead to improved student learning.

PST2A68: 6:45-7:30 p.m. Teaching Assistant Perceptions of Uncivil Student Classroom Behavior

Poster – Jennifer Blue, Miami University, Oxford, OH 45056; bluejm@muohio.edu

Julie Semlak, Miami University

In this study, we ask graduate student teaching assistants to respond to a list of uncivil undergraduate student behaviors. Some examples of these are texting during class, doing work for other classes, and packing up books before the class is over. Our survey lists several of these behaviors and asks for participants to indicate how bothered they are by each behavior. Undergraduate student and faculty perceptions of uncivil behavior have already been studied, but this is the first study of its kind to survey graduate students, who are in the unique position of being both students and instructors. Findings from this study can be used in teaching assistant development and support.

PST2A69: 6-6:45 p.m. Teaching to Learn: Exploring the Experiences of First Time Learning Assistants

Poster – Kara E. Gray, University of Colorado, Boulder, CO 80309; kara.gray@colorado.edu

Valerie K. Otero, University of Colorado-Boulder

This physics education research explores, from the participants' perspective, the Colorado Learning Assistant program. Interviews, written records, and videos of first-time physics Learning Assistants (LAs) were analyzed. Experiences include the challenges LAs face, how they address these challenges, and their adoption and adaption of the teaching philosophy of the LA program. Findings suggest that through participating in teaching activities as LAs, students generate different ways of speaking and behaving that change their identities as physics teachers and learners. We conclude that the repetition of thinking about how students learn, constructing interventions, and reflecting on the results of their actions leads LAs to converge on certain ways of behaving and talking that are more closely aligned with the goals of the LA program. We hypothesize that pedagogical concepts such as formative assessment and dialogic discourse made available through the pedagogy course assist greatly in students' convergence on desired practices.

PST2A70: 6:45-7:30 p.m. The Effects of ICT and Cooperative Learning in Thermodynamics

Poster – David DM Méndez, Universidad Internacional de La Rioja, Avda Gran Via Rey, Juan Carlos I, 41 Logroño, NY 26002, Spain; david.mendez@unir.net

This teaching research has the objective to show a comparison between traditional methodology, ICT and cooperative learning with 14-year-old students in thermodynamics. This study was motivated by the failure of students at these ages. We had 93 students divided in three homogenous groups: one group follows traditional methodology, another cooperative learning, and the third ICT. The teacher explained concepts of density, pressure, volume, temperature, and heat. We investigated alternative conceptions, verified the homogeneity of the groups, measured motivational change generated by these methodologies and the learning of theory, exercises and problems at the end of the explanations. The results brought us to the conclusion that traditional teaching did not motivate and can even demotivate, ICT and cooperative learning caused a positive motivational change in the attitude of students toward thermodynamics; the results of cooperative learning were the best, followed by the results of the ICT students. Traditional methodology results came in the third.

PST2A72: 6:45-7:30 p.m. Using a Roller Coaster to Teach Physics: A PBL Implementation*

Poster – Aaron M. Adair, Ohio State University, Columbus, OH 43210; adair.65@osu.edu

Jing Han, Lei Bao, Ohio State University

Project-based learning (PBL) methods are effective means of instruction, but they are not yet widely used in physics teaching, let alone taking into account the results of PER. Here we present a curriculum that uses the construction of a roller coaster to teach students the concepts of centripetal force, potential energy, linear and rotational kinetic energy, as well as considerations of energy loss through friction. Lab sessions are designed to have students encounter concepts students are likely to be mistake about. We provide two versions of this sort of instruction: a more guided lab curriculum, and a more open lab curriculum. Not only can these versions of PBL labs be useful for interested instructors, but they can be instrumental in helping teachers develop their own PBL curricula.

*Supported in part by NIH Award RC1RR028402 and NSF Awards DUE-0633473 and DUE-1044724.

PST2A73: 6-6:45 p.m. Using Community Expertise to Enhance Curricular Reform and Professional Development*

Poster – Dedra N. Demaree, Oregon State University, Corvallis, OR 97331; demareed@physics.oregonstate.edu

Wendi Wampler, David Bannon, Oregon State University

Oregon State University (OSU) is working on an NSF-funded collaboration with a range of faculty within OSU and two local Community Colleges. The overall purpose of this project is three-fold: to better coordinate our introductory courses, to develop and share the best of our curricular activities, and to document the shared knowledge in a way that helps incoming/rotating instructors adopt the courses. We are developing a community of practitioners with a shared vocabulary and refined discourse on curricular issues. One method used in the project is having an observer in the classroom, which all community members feel is highly valuable. We have extended this model to peer teaching where neither teacher is viewed as the expert; this holds promise for an authentic model of professional development. This poster will outline the main project goals, our model for community and professional development, and our outcomes to date.

*This work is supported by an NSF CCLI Phase 1 grant.

PST2A74: 6:45-7:30 p.m. Using Eye-Trackers to Study Student Attention During Physical Science Lectures

Poster – David Rosengrant, Kennesaw State University, Kennesaw, GA 30144; drosengr@kennesaw.edu

Bonnie Stacey, Elizabeth Carroll, Kennesaw State University

This study investigates the gaze patterns of pre-service elementary education students in their physical science lecture. Our goal is to better understand the relationships between gaze patterns and student attention during class. If we better understand what keeps our students' attention or what distracts them, then we can have increased attention which increases what they learn. To accomplish this task, we used a portable eye-tracker: Tobii Glasses. These glasses eliminate the need for subjects to focus on a computer screen or carry around a backpack-sized recording device. We are able to record what a person sees, what they say or hear, and most importantly where they are looking. This investigation includes when, for how long,and what students focus on in the classroom (i.e. demonstrations, instructor, notes, board work, and presentations) during a normal lecture. The results are the initial data analysis of a year-long study over two separate semesters.

PST2A75: 6-6:45 p.m. Using Student Provided Problem Comparisons to Observe Epistemic Reasoning Trends

Poster – Frances A. Mateycik, Penn State Altoona, Altoona, PA 16601; fam13@psu.edu

Kendra E. Sheaffer, Penn State Altoona

Compare and contrast strategies may be used to facilitate students' identification of important information within problems (Chi et. Al., 1981; Jonassen, 2000). As part of a larger study students enrolled in a spring 2011, algebra-based physics course were asked to choose the two problems they found to be the most similar in each of their weekly homework assignments. The two problems selected were then explicitly compared and contrasted in writing. The written statements were then collected by the researchers and divided by clause topics and further categorized into levels of epistemic reasoning. Emergent trends regarding how students' level of epistemic reasoning changes throughout the semester and how the physics context may elicit variance in the observable epistemic reasoning will be discussed.

PST2A76: 6:45-7:30 p.m. Validating a Short Hydrostatics Assessment

Poster – Ying Chen, Kansas State University, Manhattan, KS 66502; cying@phys.ksu.edu

Eleanor Sayre, Kansas State University

As part of a large investigation into when students learn and forget introductory physics topics, we are developing a short survey on hydrostatics. The survey focuses on students' understanding of Archimedes' principle and Pascal's law. In this poster, we report on early validation interviews with introductory calculus-based physics students using a think-aloud protocol, and the modifications to the survey items which result.

PST2A77: 6-6:45 p.m. Writing and Evaluating Explanations in a Large Enrollment Physics Course*

Poster – Fred Goldberg, San Diego State University, CRMSE, San Diego, CA 92120; fgoldberg@sciences.sdsu.edu

Edward Price, Paul Heft, California State University at San Marcos

Scott Patterson San Diego State University

We are currently adapting the small enrollment, discussion and lab-based Physics and Everyday Thinking (PET) curriculum for large enrollment classes populated mainly by prospective elementary teachers. The new curriculum is called Learning Physics (LEP). To maintain PET's focus on some important practices of science, we have students engage in the practice of writing and evaluating explanations. Students do this online, using the Calibrated Peer Review (CPR) system developed at UCLA. After the instructor develops the explanation tasks, the students write their own explanations, practice evaluating "calibrated" explanations, and then evaluate three of their peer's explanations as well as their own. In our poster we will briefly describe the components of the CPR system, some of the explanation tasks we have developed for the LEP course, and our initial analysis of how the process is going.

*Supported by NSF grant 1044172

B - Introductory Courses

PST2B01: 6-6:45 p.m. Adapting the AAPT Photo Contest to the Classroom

Poster – Sytil Murphy, Shepherd University, Shepherdstown, WV 25443; smurphy@shepherd.edu

The AAPT High School Physics Photo Contest (HSPPC) is designed to give high school students and their teachers the opportunity to explore, both written and pictorially. Students in introductory physics and physical science courses often do not see how the physics they are learning is present in their everyday lives. By adapting the HSPPC to an extra credit project in my introductory physics and physical science courses, my students were able to explore the physics around them. As in the HSPPC, students submitted a picture with an accompanying written explanation. Photos and explanations were judged on both their physics content and artistic merit.

PST2B02: 6:45-7:30 p.m. Distraction in the Classroom: Digital Devices and Student Performance

Poster – Bethany R. Wilcox, University of Colorado, Boulder, CO 80302; Bethany.Wilcox@colorado.edu

Douglas Duncan, Angel R. Hoekstra, University of Colorado at Boulder

The recent increase in use of digital devices such as laptop computers, iPads, and web-enabled cell phones has generated concern about how technologies affect student performance. Combining observation, survey, and interview data, we assess the effects of technology use on student learning. We report initial data, gathered in eight large introductory science courses, showing a significant negative correlation between in-class phone use and final grades, with use of cell phones corresponding to a drop of 0.36 +/- 0.08 on a 4-point scale. These findings are consistent with research[1] suggesting students cannot multitask effectively. While 75% of students reported regular cell phone use, systematic in-class observations suggest undergraduates typically under-report the frequency of their use of digital devices. In addition, we report findings from our current research, which attempts to replicate our initial findings in six additional science courses.

1. E.Ophir, C.Nass, & A.D. Wagner, *Proc. Natl. Acad. Sci*. **106**, 15583-15587

PST2B03: 6-6:45 p.m. Group Quizzes as an Assessment that Supports Learning

Poster – Joss Ives, University of the Fraser Valley, Abbotsford, British Columbia, V2S 7M8 Canada; joss.ives@ufv.ca

These group quizzes, facilitated by the Immediate Feedback Assessment Technique (multiple-choice scratch and win sheets), are written immediately following quizzes that were written individually by the students. The individual portion of the quiz allows for a portion of the student's marks to be based on individual achievement. The group portion allows for student learning and plenty of student celebration. My implementation of these quizzes will be detailed along with preliminary measures of student learning at three times: at the time that the group quiz was written, during the next class period, and on the final exam.

PST2B04: 6:45-7:30 p.m. Implementation of Active Learning Methodologies in Introductory Physics*

Poster – Hugo Alarcon, Universidad Tecnica Federico Santa Maria, Av. Espana 1680 Valparaiso, 2340000 Chile; hugo.alarcon@usm.cl

Gonzalo Fuster, Claudio Figueroa Universidad Tecnica Federico Santa Maria

The Universidad Tecnica Federico Santa Maria is a well-known Chilean institution focused on educating engineers. All students entering college must take Introduction to Physics, which is prior to a traditional introductory mechanics course. This course is centered on developing basic tools that will serve the student in subsequent calculus-based physics courses, such as problem- solving skills. Recently the course has been redesigned to incorporate methodologies that promote active learning, such as peer instruction, collaborative activities, similar to Washington tutorials, and context-rich problems. To do this, professors have been trained extensively in both methodologies and classroom management in the SCALE-UP environment. They have also had to design the concept tests and the context-rich problems according to the course program. In this work we will present the strategy used to achieve an early implementation and the results.

*This work has been supported by the Government of Chile through the grant MECESUP FSM-1106 and FSM-0802.

PST2B05: 6-6:45 p.m. Investigating Students' Affective Experience in Introductory Physics Courses

Poster – Jayson M. Nissen, University of Maine, Orono, ME 04469; jayson.nissen@maine.edu

Jon T. Shemwell, MacKenzie R. Stetzer, University of Maine

Improving non-cognitive outcomes such as attitudes, efficacy, and persistence in physics courses is an important goal in physics education. This investigation implemented an in-the-moment surveying technique called the Experience Sampling Method (ESM)[1] to measure students' affective experience in physics. Measurements included: self esteem, cognitive efficiency, activation, intrinsic motivation and affect. Data are presented showing contrasts in students' experiences, (e.g., in physics vs. non-physics courses).

1. R. Larson and M. Csikszentmihalyi, "Validity and Reliability of the Experience-Sampling Method". *J Nerv Ment Dis*.,**175**(9):526-36 (1987).

PST2B06: 6:45-7:30 p.m. LEAP – A Learner-Centered Environment for Algebra-based Physics

Poster – Paula V. Engelhardt, Tennessee Technological University, Cookeville, TN 38505; engelhar@tntech.edu

Steve J. Robinson, Tennessee Technological University

This poster will focus on the curriculum development work that we have been doing with our algebra-based course sequence. LEAP is part of an NSF-funded grant (DUE-0737324) that is guided by research on student learning in physics and builds on the work of the NSF-supported project, Physics for Everyday Thinking (PET). Students work in groups to develop their understanding of various physics phenomena including forces, energy, electricity and magnetism, light and optics. Students utilize hands-on experiments and computer simulations to provide evidence to support their conceptual learning. Traditional problem solving is scaffolded by using the S.E.N.S.E. problem solving strategy. An overview of the curriculum and assessment results will be presented.

PST2B07: 6-6:45 p.m. Mathematical Models in Introductory Physics and Physical Models in Calculus

Poster – Natalia Schkolnikov, Hampton University, Hampton, VA 23668; natalia.schkolnikov@hamptonu.edu

Michael Ganzburg, Hampton University

We discuss interaction between mathematics and physics in introductory physics and calculus courses taught at Hampton University. Often students from underrepresented groups in science and engineering feel disconnected from physics and mathematics, because they do not see hidden relations between physical and mathematical laws and real world problems. We report on our efforts to overcome insufficient mathematical skills of some students in introductory physics courses by introducing simplified mathematical models of physical processes and connecting them to topics from various areas of science and technology, such as space exploration, signal processing, and biomedical sciences. On the other hand, we discuss our attempts to animate calculus symbolism by immersing limits, derivatives, and integrals into physical models of motion, work, and electricity.

PST2B08: 6:45-7:30 p.m. Team Teaching: Benefits for Instructors and Students in Introductory Physics

Poster – Krista E. Wood, University of Cincinnati, Cincinnati, OH 45140; Krista.Wood@uc.edu

Joseph S. Gallagher, University of Cincinnati

It's summer and an introductory physics course needs to be offered. You don't want to teach all summer, but think students need a full term to digest the material. What about sharing a class with a colleague? Could it work? This poster will highlight the successes and challenges of team teaching an introductory physics course during a summer term. We will discuss the benefits two physics instructors experienced by working together to teach a summer introductory physics course. The planning process encouraged substantial reflection on how to teach the course and learning from one another. The students benefited from similar teaching styles, yet different perspectives. We will also discuss lessons learned and opportunities to improve.

PST2B09: 6-6:45 p.m. Pre Course Student Curiosity Questions as Motivators for Class Lessons*

Poster – Katrina M. Hay, Pacific Lutheran University, Tacoma, WA 98447; hay@plu.edu

Carolina C. Ilie, State University of New York Oswego

Truth seeking is the foundation of science. Investigation and observation involve asking questions. As physics teachers, one of our goals is to train our students to ask good questions. In seven physics classes, mostly calculus-based introductory level, students were asked to digitally submit a "curiosity question about the natural world" before they attended the first class session. A collection of these unrestrained questions can be used throughout the term directly in class lessons, as inspiration in continued learning and to make interdisciplinary connections. In addition, the questions reveal student passions and motivators.

*Website where a list of past student questions can be found: http://www.plu.edu/~haykm/Curiosity_Campaign.html

PST2B10: 6:45-7:30 p.m. Team Re-testing as an Alternative to Post Exam Review

Poster – Richard Zajac, Kansas State University-Salina, Salina, KS 67401; rzajac@sal.ksu.edu

Spending lecture time going over an exam after your students have taken it can feel like a waste of class time. Students' lack of engagement in such reviews suggests the need for an alternative way to revisit and reinforce important content. In lieu of such post exam reviews, for the past several semesters we have tried having students re-take unit exams within small teams following their individual exam in an introductory physics course. The particular scheme employed allows more useful data to be collected to monitor student gains, assess course outcomes, and ultimately to evaluate the merits of this method. Collected student feedback is presented and intriguing performance trends are analyzed. Less formally, it is recognized that team re-testing can provide students some additional gratification on an emotional level.

PST2B11: 6-6:45 p.m. Using Tracker for the Determination of Coefficients of Friction

Poster – Norely Useche-Baron, IED Leonardo Posada Pedraza, Diagonal 2B 82 30 int 4 ap 114, Bogotá, 0000; Colombia; norely_useche@hotmail.com*

Cristian Otero-Carrillo, IED Leonardo Posada Pedraza

As a project of the course of dynamics, a student raises questions for his or her peers to be answered individually by each student in the form of prediction, including an experimental approach to determine coefficients of friction between different materials. Groups of three students discuss their answers and give solutions to the questions and propose an experiment to determine the coefficients of static and dynamic friction. Eventually they develop the experience suggested by the course, and the videos are taken and analyzed with Tracker.

*Sponsor: Fabian Martinez-Velandia

PST2B12: 6:45-7:30 p.m. Think Your Students' Math Skills Are Bad? Well, They're Worse!

Poster – Robert A. Cohen, East Stroudsburg University, East Stroudsburg, PA 18301; rcohen@esu.edu

Mary Anne L. Moore, Jeffery Spirko, East Stroudsburg University

We have examined the basic math skills of our students and found that a significant population have never understood fractions (e.g., which is bigger: 5/7 or 8/9). We will discuss the implications for physics, especially in regard to how these students have managed to pass math and physics courses (some up to calculus) and what we can do to address their weaknesses.

C – Special Programs for High Performing High School Students

PST2C01: 6-6:45 p.m. High School Students, Magnetic Field and its Nature of Pseudovector

Poster – Stefano Vercellati, Physics Education Research Unit, University of Udine, Via Delle Scienze, 208 Udine, UD 33100 Italy; stefano.vercellati@uniud.it

Marisa Michelini, Lorenzo G. Santi, Physics Education Research Unit, University of Udine

The analysis of the nature of the magnetic field offers the ideal framework in which students could address the mutual integration between mathematical and physical aspects experimentally facing the analysis of the phenomenology. With the aim of investigating how high school students face experimental situations in which the phenomenology grounds the theory and the mathematics offers its formalism as the best language to describe the explored phenomena, an activity concerning the pseudovectorial nature of the magnetic field was performed in a course held in the context of a summer school for skilled students. The focus of the research was on the ways in which the students' reasoning evolves, addressing the property of symmetry of the magnetic field in a proposed situation. The results of this experimentation will be presented and discussed.

PST2C02: 6:45-7:30 p.m. Summer School on Modern Physics for Talented Students

Poster – Marisa Michelini, Physics Section of DCFA - University of Udine, Via Delle Scienze, 208 Udine, IT 33100 Italy; marisa.michelini@uniud.it

Sri P. Challapalli, CIRD University of Udine

Giuseppe Fera, Emanuele Pugliese, Alessandra Mossenta, Physics Section DCFA - University of Udine

To support the motivation of talented students is a task often disregarded by the school today. In the IDIFO3 project—"Innovation in Physics Teaching and Guidance," the Physics Education Research Unit (PERU) of the University of Udine in Italy has designed and implemented a national biennial summer school, in its third edition in 2011. The summer school provides the basic foundation for the construction of formal thinking, interpretation of phenomena, design of a reasoning path, and providing an overall conceptual framework about important aspects on various of topics of Modern Physics, such as quantum mechanics, relativity, superconductivity, electromagnetism and condensed matter physics. A group of 40 students with the highest marks in physics from different schools all over the Italy were selected to explore and experience these new terms in modern physics during an intensive week. The characteristics of the activities proposed and learning outcomes performed at three different levels such as for students, teachers, and university researchers based on the Inquired Based Learning (IBL) work sheets will be presented.

PST2C03: 6-6:45 p.m. Mass in Classical and Relativistic Physics for Talented Students

Poster – Alberto Stefanel, University of Udine, Chemistry, Physics and Environment Department, Via Delle Scienze, 206 Udine, Italy 33100; alberto.stefanel@uniud.it

Emanuele Pugliese, University of Udine

In summer school IDIFO3 (Udine, 2011) both construction of and deepening into fundamental concepts of modern physics were proposed to high school talented students. A tutorial was made up, in which inertial and gravitational meanings were scanned according Newton and Mach. Proper time and 4-displacement allowed the definition of quadrimomentum through analogy reasoning. Relativistic kinetic energy was defined through expansion of the temporal component in the Newtonian limit. Mass was conceptually extended to relativity by means of rest-energy concept. The ways of looking at mass as well as the scientific meanings produced in students were analyzed, also considering the "quantity of matter." Relativistic mass was inquired separately, as an important spin-off. The analysis of data gave information about pupils' learning of mass-energy equivalence and allowed to recognize five physical representations of mass known in literature.[1]

1. A. Domenéch et al (1993), *International Journal of Science Education,* **15**, 163-173.

PST2C04: 6:45-7:30 p.m. Teaching and Learning Superconductivity in Secondary School

Poster – Alberto Stefanel, Research Unit in Physics Education, DCFA, University of Udine, Via Delle Scienze, 206 Udine, IT 33100 Italy; alberto.stefanel@uniud.it

Marisa Michelini, Lorenzo Santi, University of Udine

Nowadays superconductivity can be brought into the educational laboratory both for qualitative exploration, and measurements with sensors interfaced to the computer. A research educational path of superconductivity for the high school level was designed. It adopts an inquiry-based approach that involves students in problem-solving activities to construct a phenomenological description of superconductivity. The focus of the proposal is the exploration of the Meissner effect using the conceptual tools of electromagnetism. To account for the superconducting transition, a qualitative introduction of the Cooper pair formation and related gap in the superconductor energy levels is also proposed to the students. Research was carried out using experimentations tutorial worksheets in Italian secondary schools. From monitoring tools analysis used in the experimentation, it is possible to document the educational activity carried out with students, their main difficulties and their main learning results for what concerns the magnetic property of the superconductor, how students link the magnetic property of a superconductor and the electric properties of it, and construct model on superconductivity.

D – Post Deadline Posters

PST2D01: 6-6:45 p.m. Biofuels: Production and Quantification Methods for Undergraduate Laboratories

Poster – Kevin Clark, Gustavus Adolphus College, Saint Peter, MN 56082; kclark3@gustavus.edu, chuck@gustavus.edu*

Amy Audette, Colleen Jacks, Jeff Jeremiason, Dwight Stoll, Gustavus Adolphus College

Ethanol and biodiesel are alternative energy sources currently being explored as viable substitutes for petroleum fuels. Novel ethanol production methods involving modification of gene expression to alter metabolism of Escherichia coli have been developed and are a major focus of this research. Potential for undergraduate laboratory exercises based on the analysis of E. coli fermentation products for ethanol content have been investigated. An outline of GC-FID determination of ethanol concentrations in E. coli fermentation products is presented. Biodiesel is an alternative energy source composed of long-chain fatty acid esters produced by the transesterification of methanol or ethanol and triacylglycerides found in plant oils. Production and quantification of fatty acid esters is the second major focus of this research, specifically those produced from ethanol. Development of a two-dimensional gas chromatography system (GCxGC) capable of performing complex separations involving fuel blends was initiated. A laboratory method utilizing GCxGC is outlined.

*Sponsor: Charles Niederriter

PST2D02: 6:45-7:30 p.m. Comparison of Two Methods for Characterizing Quantum Dot Size

Poster – Joseph F. Kozminski, Lewis University, Romeoville, IL 60446; kozminjo@lewisu.edu

Russell Johnson, John Ephriam, Jason J. Keleher, Lewis University Department of Chemistry

The size-dependent properties of semiconducting quantum dots (QDs) make them ideal candidates for tunable absorbers/emitters in a wide range of applications. In the Advanced Lab setting, the size of QDs is typically approximated using the Effective Mass Approximation (EMA) model to relate the absorbance wavelength to the bandgap separation of the semiconducting nanoparticle. While the EMA model has proven effective in approximating QD size, it does not provide information about the overall hydrodynamic radius of the QDs, which is highly dependent on the capping agents used to stabilize the particles. Longer chain or bulkier capping agents increase the hydrodynamic radius of the QDs. This work employs Dynamic Light Scattering (DLS) to characterize the hydrodynamic radius of QDs prepared in aqueous solution with various capping agents and reveals the complimentary nature of EMA and light scattering methods to provide a detailed picture of the QD's structure.

PST2D03: 6-6:45 p.m. Wind Turbine and Geothermal Lab Development

Poster – Amy Audette, Gustavus Adolphus College, Saint Peter, MN 56082; aaudette@gustavus.edu, chuck@gustavus.edu*

Kevin Clark, Charles Niederriter, Jeff Jeremiason, Collen Jacks, Gustavus Adolphus College

As part of an NSF grant, new lab experiences are being developed in a variety of areas, including wind and geothermal energy. A MET station was installed in order to provide students with wind speed and direction data to use to assess the potential for energy production. A 2.0 kW Skystream turbine was installed on the edge of the Gustavus campus which will enable students to get some experience working with a small turbine. In order to test the effectiveness of ground source geothermal, an experimental loop was installed under Gustavus' new West Mall. The temperature at various distances from the loop is measured to allow students to determine how well the ground acts as a reservoir. In addition, a "sprinkler system" was installed to allow the water content of the ground near the loop to be altered so that students can explore its effect.

*Sponsor: Charles Niederriter

PST2D05: 6-6:45 p.m. Inspiring Black Women Physicists

Poster – Katemari Rosa, Teachers College, Columbia University, New York, NY 10027; katemari@gmail.com

The underrepresentation of women in STEM fields is a well-known issue. However, there is a particular group, namely Black women, that are even more underrepresented and often times have their struggles neglected. Black women in STEM fields experience what is called a double subordination because they face the hurdles women in science experience in addition to the challenges Black people face. This study will focus on Black women in physics, one of the fields with the smallest women representation. As part of a larger biographical study, this poster will address what do women physicists of African descent identify as obstacles and opportunities in their career paths. Analyzing the narrative of a successful Black woman physicists, within a critical race theory framework, we will discuss the strategies that she used to overcome these obstacles and what supported these opportunities.

PST2D07: 6-6:45 p.m. A Mechanical Analog of Nuclear Magnetic Resonance

Poster – Mark F. Masters, IPFW, Fort Wayne, IN 46805; masters@ipfw.edu

Srikanth Dasari, Gregory Adams, IPFW

In our modern physics laboratory sequence, we use "Tracks" in which the students perform a series of related investigations that build on each other. Typically a track has at least one investigation that is a mechanical analog of a modern physics investigation. One of those tracks is Nuclear Magnetic Resonance (NMR). The apparatus in this investigation is typically a black box system in which it is difficult to visualize what is physically happening. Using a spherical Neodymium magnet in an air-bearing and two sets of Helmholtz coils to provide guide and excitation fields we are able to mechanically simulate NMR.

PST2D08: 6:45-7:30 p.m. Employing Joule-like Experiments in Teaching the Concept of Energy

Poster – Yaron Lehavi, The David Yellin Academic College of Education, Jerusalem, 93303 Israel; Yarlehavi@gmail.com

Bat-Sheva Eylon, Weizmann Institute, Israel

Joule's famous series of experiments are claimed to demonstrate the equivalence between what he called heat and other phenomena: chemical, electrical, electro-magnetic, hydro-dynamical and mechanical. However, despite the latter's special historical and conceptual importance (Arons, 1999; Sichau, 2000), it was excluded from the curricula, symbolizing degradation in the status of energy conservation in physics education (Robinault, 1998). We developed a low-cost device for measuring energy change via temperature measurement, in such processes as change in velocity, height, and shape. The results of the measurements enabled us to arrive empirically to the formulae which relates energy change (e.g. change in kinetic energy or gravitational potential energy) to the change in the characterizing parameters of each process (e.g. speed or height). The implications of such experiments for teaching the concept of energy will be discussed.

PST2D09: 6-6:45 p.m. Tutorials in Lab: Building on the Book

Poster – John W. Zwart, Dordt College, Sioux Center, IA 51250; zwart@dordt.edu

Kayt E. Frish, Dordt College

Tutorials in Introductory Physics[1] provides excellent exercises to help students develop their conceptual understanding of physics. We have begun to incorporate tutorials in a lab setting, building on a tutorial exercise using related lab activities in order to deepen student insights. Two examples of the lab activities are presented: an expansion of the ?Models for Circuits? tutorials adding batteries in series and parallel while measuring voltages, and a hands-on implementation of the ?Pressure in a Liquid? tutorial where pressure as a function of water depth is measured followed by an exercise in measuring pressure at various locations in a stoppered U shaped tube.

1. Lillian C. McDermott, Peter S. Shaffer, and the Physics Education Group, *Tutorials in Introductory Physics*, Prentice Hall, 2002.

PST2D10: 6:45-7:30 p.m. Eye-Gaze Patterns While Interpreting Kinematics Graphs

Poster – Jennifer L. Docktor, University of Wisconsin-La Crosse, La Crosse, WI 54601; jdocktor@uwlax.edu

Jose Mestre, University of Illinois at Urbana-Champaign

Liz Gire, University of Memphis

Sanjay Rebello, Kansas State University

Proficient problem solvers are able to interpret and use multiple representations of information (e.g. text, equations, pictures, diagrams, and graphs). In this study, introductory physics students viewed several kinematics graphs on a computer screen and were asked to select a numbered region of the graph corresponding to a text description of motion. We present an analysis of subjects' performance on the items and eye-gaze fixation patterns recorded using an eye tracker.

PST2D11: 6-6:45 p.m. Reforming Teacher Professional Development in Preparation for the Next Generation Science Standards

Poster – Jennifer L. Docktor, University of Wisconsin-La Crosse, La Crosse, WI 54601; jdocktor@uwlax.edu

Gubbi Sudhakaran, University of Wisconsin-La Crosse

Physical science is frequently identified as an area of weakness for elementary and middle school teachers. We will discuss the design of professional development workshops that integrate the Framework for K-12 Science Education and the draft Next Generation Science Standards into activities, specifically for the topics of Matter, Force and Motion, and Energy. Materials were developed as part of a project funded by a U.S. Department of Education Math Science Partnerships Program grant through the Wisconsin Department of Public Instruction.

PST2D12: 6:45-7:30 p.m. Teaching Physics Through NASA Satellite Imagery

Poster – Susan Kelly, NASA Education Ambassador, Bridgewater, CT 06752; susankelly.ct@gmail.com

A wide variety of NASA remote-sensed images are freely available online. These images can be used as a platform to present a variety of secondary-level physics topics. Analysis of satellite images through open source software provides opportunities for students to calculate velocity of hurricanes and melting rate of polar ice. NASA Landsat images invite opportunities for students to practice unit conversions and analyze the characteristics associated with different wavelengths. Samples of classroom-tested activities and corresponding online resources will be presented.

PST2D14: 6-6:45 p.m. Assessing Student Learning of Error Propagation in the Undergraduate Lab

Poster – Brent W. Barker, Michigan State University, East Lansing, MI 48824-1321; barker@nscl.msu.edu

A pre- and post- survey was conducted during an introductory calculus-based physics course to test students' basic skills in error-propagation. Additionally, students participated in a "think-pair-share" activity during the course. Overall, based on the surveys, students improved, especially in the case where they did not have any misconceptions initially. Qualitative assessment of the think-pair-share activity contrasts with the results of the post-survey.

PST2D15: 6:45-7:30 p.m. Visual Thinking in a First Calculus-based Physics Sequence

Poster – Norma M. Chase, Massachusetts College of Pharmacy and Health Sciences, Boston, MA 02115; norma.chase@mcphs.edu

It is essential that students learn to relate verbal and mathematical descriptions of physics concepts and principles to happenings in the world —sequences of events that they can "see in their mind's eye." However, many students have little or no experience with "visual thinking." The author has sought to make physics accessible for all students by developing and using a large collection of instructive simulations and videos as lecture demonstrations and homework assignments. For students who have not internalized a vocabulary of visual images, videos play the role of welcoming "foreign film subtitles." For those possessed of rich visual imaginations, and substantial physics backgrounds, several videos provide invitations to delve still deeper. In this poster presentation, the author will display (screen prints of) selected videos, discuss the use of "video analogies" to facilitate problem solving, and also suggest some ways to guide students around specific roadblocks in "spatial processing".

PST2D17: 6-6:45 p.m. Why the Third Semester Should be Waves

Poster – David H. Kaplan, Southern Illinois University-Edwardsville, Edwardsville, IL 62026; dkaplan@siue.edu

A cause of the relatively high attrition rate of intermediate-level undergraduate physics majors is lack of preparation from already overflowing introductory courses. Even in basic Modern Physics courses, students are expected, perhaps with rapid piecemeal "coverage," to understand and use concepts of wave superposition, completeness, Fourier Bandwidth theorems, Fourier transforms and more. Exacerbating the problem is the implicit demand on students to mentally distinguish the new mathematics from the new and novel physics they are learning. Not surprisingly, often the result is reversion to memorization without understanding and frustration. The author describes how a dedicated third-semester course that carefully acclimates the student to how to approximate, properties of waves, wave equations, mode expansions, etc., in a comfortable classical setting, and which provides needed intuition on Fourier methods, can significantly help lessen this problem without sacrificing efficiency in the overall program. He also discusses what such a course should include.

PST2D18: 6:45-7:30 p.m. From Rube Goldberg to Reuben's Tube: Science Alive in Videos

Poster – Kenneth DeNisco, 1 HACC Dr., Harrisburg, PA 17110; krdenisc@hacc.edu

For this poster presentation, a number of YouTube video clips will be shown on the iPad, along with a display of screen shots and accompanying PowerPoint slides for classroom use. Two Rube Goldberg videos are particularly useful for demonstrating multiple physic principles, including kinematics —"The Cog" by Honda[1], and "This Too Shall Pass" by the band OKGo.[2] The Ruben's Tube video[3] is excellent for helping students to visualize standing wave patterns through the use of propane flames. Since the actual device is somewhat dangerous and difficult to build, a video clip provides an easy classroom substitute.

1. http://www.youtube.com/watch?v=_ve4M4UsJQo
2. http://www.youtube.com/watch?v=qybUFnY7Y8w
3. http://www.youtube.com/watch?v=HpovwbPGEoo

PST2D19: 6-6:45 p.m. Earthquake Physics: Understanding Earthquake Interaction by Listening to Seismic Data

Poster – Chastity Aiken, Georgia Institute of Technology, School of Earth & Atmospheric Sciences, Atlanta, GA 30332; chastity.aiken@gmail.com

Zhigang Peng, Georgia Institute of Technology, School of Earth & Atmospheric Sciences

One earthquake can influence subsequent earthquakes. To demonstrate such earthquake interactions, seismologists have used in the past "snapshot" static images of seismograms. Although static images can, by themselves, convey basic information about the spatial distribution of earthquakes, adding auditory information could help to provide additional details on the temporal evolution of the earthquake sequences. Recently, we have used standard tools such as MATLAB and Quick Time Pro to produce animations with time-compressed sounds to demonstrate both immediate aftershocks and remotely triggered tremors related to the 2011 magnitude 9.0 Tohoku-Oki, Japan, earthquake. Here we show our development in this direction that includes multiple parameters of earthquakes and seismic waves to present the physical concepts of earthquake triggering.

PST2D20: 6:45-7:30 p.m. Managing Large-Scale Introductory Labs

Poster – Larry Bortner, University of Cincinnati, Cincinnati, OH 45221-0011; bortnelj@ucmail.uc.edu

Problems arise as the number of sections of a lab course increase. These include the large variability of grading styles among instructors and the constant or dwindling population of instructors to teach more and more classes. Traditional assessments of quizzes and lab reports are used in the physics labs taught at the University of Cincinnati. A nontraditional assessment, techniques used to promote fair and balanced grading, and various methods used to decrease instructor workload will be presented.

Demo Show

Be astounded by fantastic physics demonstrations and effects put on by The Third Eye. **Open to all!**

Tuesday, July 31
9 - 10 p.m.
Inn at Penn - Woodlands Ballroom

Call for Nominations

The AAPT Awards Committee is seeking nominations for the following Awards. All AAPT members are urged to review the descriptions of these awards on the AAPT website and then, following instructions available at a link on that website, to nominate individuals deemed worthy of consideration for any of these awards. The Nomination Form is at http://www.aapt.org/Programs/awards/.

Robert A. Millikan Medal

Oersted Medal

Melba Newell Phillips Medal

Paul E. Klopsteg Klopsteg Memorial Award

Richtmyer Memorial Award

John David Jackson Excellence in Graduate Education Award

David Halliday and Robert Resnick Excellence in Undergraduate Physics Teaching Award

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

AAPT Distinguished Service Citations

Session FA: Bridge Experiences: Increasing Participation of Underrepresented Minorities in Doctoral Education

Location: Sheraton - Ben Franklin Ballroom I
Sponsor: Committee on Graduate Education in Physics
Date: Wednesday, August 1
Time: 8:30–10 a.m.

Presider: Renee Michelle Goertzen

FA01: 8:30-9 a.m. APS Bridge Program: Enhancing Diversity in Physics Graduate Education

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

Peter Muhoro, American Physical Society

Underrepresented minorities in physics receive about 9-10% of all undergraduate degrees, and only about 5-6% of all PhDs. To bring the fraction of students who receive PhDs up to that of those who receive bachelor degrees requires understanding and overcoming the various barriers. The American Physical Society (APS), in conjunction with a broad coalition of partners, is embarking in a long-term effort aimed at closing this gap, and improving graduate education for all students. In this presentation, we will discuss the basic components of the program, look at data we know, and discuss data we hope to gather to inform and promote these efforts.

FA02: 9-9:30 a.m. The Imes-Moore Fellows Program: A New Bridge Program at the University of Michigan Aimed to Enhanced Diversity in Applied Physics

Invited – Cagliyan Kurdac, University of Michigan, Ann Arbor, MI 48109-1120; kurdak@umich.edu

The Applied Physics Program at the University of Michigan allows graduate students to do research at the frontier between the physical sciences and technological applications, which is not readily accommodated by traditional single-focus graduate programs. In the last two decades, the program has attracted many underrepresented minority and female students, matched these students with faculty with research programs that are beyond the traditional boundaries of physics, and provided the support structure and mentorship that was needed for the students to succeed. Building on our success, we have recently launched a master's bridge program, the Imes-Moore Fellows Program, designed to prepare students from underrepresented groups for doctoral studies in applied physics. The program has currently seven graduate students and is fully integrated with our doctoral program. In this talk, I will discuss some of the challenges and opportunities associated with starting a master's bridge program.

FA03: 9:30-10 a.m. Fisk/Vanderbilt Master's to PhD Bridge Program

Invited – David J. Ernst, Vanderbilt University, Nashville, TN 37235; david.j.ernst@vanderbilt.edu

Keivan Stassun, Arnold Berger, Kelly Holley-Bockelmann, Vanderbilt University

The salient features of the Fisk/Vanderbilt Master's to PhD Bridge Program in physics, astronomy, materials science, chemistry, and biology will be presented. The program will this year make Vanderbilt the number one producer of African-American PhDs in physics, astronomy, and materials science and has made Fisk University the number one producer of master's degrees awarded to African-Americans. Our recruiting plan will be described, as well as the concept of "unrealized potential" used in selecting students. The necessity of intensive mentoring and how to fulfill that need will be presented. Sources of funding for the program will be reviewed, and some thoughts on future directions for the program will be presented.

Wednesday, August 1 Highlights

REGISTRATION 8 a.m.–3 p.m. HH - Reading Room

Great Book Giveaway &
Winter Meeting 2013 – New Orleans Kick-off
10:30–11 a.m. HH - Reading Room

AWARDS 11 a.m.–12:15 p.m. Inn at Penn

Philip Sadler – Millikan Medal, "Separating Facts From Fads: How Our Choices Impact Students' Performance and Persistence in Physics"
AAPT Distinguished Service Citations
AIP Children's Science Writing Award

CRACKERBARRELS, 12:15–1:15 p.m.

–Do We Have Standards?	HH - Class of 49
–For Faculty in Small Departments	IA - Amado
–For PER Graduate Students	CCH - Terrace

COMMITTEE MEETINGS

Programs II	7-8:30 a.m.	Sheraton - Chestunt
COGS	7-8:30 a.m.	IA - G01
Nominating II	12:15-1:15 p.m.	IA - G01
Bauder	12:15-1:15 p.m.	IA - G7
Audit	12:15-1:30 p.m.	IA - G16

PHYSICS EDUCATION RESOURCE CONFERENCE

Banquet, 6:30 p.m.	Sheraton - Ben Franklin
Poster Session, 8:30 p.m.	HH - Hall of Flags

KEY: IA = Irvine Auditorium
HH = Houston Hall
CCH = Claudia Cohen Hall

Session FB: PER: Investigating Classroom Strategies II

Location: HH - Class of 49
Date: Wednesday, August 1
Time: 8:30–10:30 a.m.

Presider: Beth Lindsey

FB01: 8:30-8:40 a.m. Using Time-on-Task Measurements to Understand Introductory Physics Classes

Contributed – John C. Stewart, University of Arkansas, Fayetteville, AR 72701; johns@uark.edu

A 10-year study of how students use their out-of-class time in an introductory physics class is presented. The study is used to evaluate the extent to which a student's performance on hourly exams or on conceptual inventories is predictable by his or her study habits. The correlation of good study habits with good performance is evaluated. The study tracks student behavior through a major curricular revision to determine the extent to which student habits react to changes in a physics class. The study also investigates the role of technical changes such as the introduction of an online homework system and a web-based testing tool on time use.

FB02: 8:40-8:50 a.m. How to Help Students be Prepared for the Exam

Contributed – Witat Fakcharoenphol, University of Illinois Urbana-Champaign, Urbana, IL 61801; fakchar1@uiuc.edu

Computer-based practice exams and immediate feedback with worked out solutions can improve the performance on later problems with identical solutions. However, immediate feedback and worked out solutions fall short in helping students transfer the conceptual and procedural knowledge to slightly different problems.* Nevertheless, the students who started using our practice exam at least two days before the exam performed better on the real exam than students who started and completed our practice exam later, especially on the problem types they missed on the practice exam. This suggests that the practice exam can provide formative assessment to students, but the feedback system has to be adjusted. One possible feedback system might be providing students personal tutors and enough time to improve. We did a preliminary clinical study on a series of practice exams with tutors to quantify the possible help from tutors.

* *Phys. Rev. ST Physics Ed. Research* **7,** 010107 (2011)

FB03: 8:50-9 a.m. Investigating Student Interaction with Smartphysics, A New Online Homework System

Contributed – Noah Schroeder, University of Illinois Urbana-Champaign, Urbana, IL 61801; noschroeder@gmail.com

Gary Gladding, Tim Stelzer, University of Illinois Urbana-Champaign

In the fall of 2010 the University of Illinois implemented a new online homework system, Smartphysics, for introductory physics classes. Smartphysics includes new features such as instant feedback specialized to unique student mistakes, which can help correct small mathematical mistakes as well as conceptual ones. Another feature is the ability to delay feedback on certain questions until after that homework's deadline, acting as an in-the-moment assessment of student performance. This can act as formative assessment for students, and might lead to a way to offer students a prediction of their performance on subsequent exams. Results concerning student behavior and the correlation of performance on delayed feedbacks to other variables will be shown.

FB04: 9-9:10 a.m. Instructional Strategies that Optimize Student Use of Interactive Video Vignettes*

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

Robert Teese, Rochester Institute of Technology

David Jackson, Dickinson College

The LivePhoto Physics Group has begun developing and evaluating a series of short single topic video expositions for introductory students that incorporate video analysis activities. These vignettes are designed for web delivery as ungraded exercises to supplement textbook reading, or serve as pre-lecture or pre-laboratory activities. Each vignette combines narration, a real-world video segment, and video analysis tools designed to enable students to master concepts or learn data collection and analysis techniques. As part of this work the team is developing new techniques for web-based educational research that allows for the collection of data on student learning and motivation. Details of the interactive video vignette for projectile motion will be presented along with results of a pilot study that investigated the efficacy of techniques for motivating students to complete the vignette. The study involved multiple sections of calculus- and algebra-based physics courses across several institutions.

*Work supported by the NSF TUES Program (DUE #1123118 & 1122828).

FB05: 9:10-9:20 a.m. Clicker Engagement in Introductory and Upper-Division Physics Courses

Contributed – Patrick B. Kohl, Colorado School of Mines, Golden, CO 80401; pkohl@mines.edu

Todd G. Ruskell, Vince H. Kuo, Colorado School of Mines

Clickers, while perhaps not ubiquitous, have become very common in introductory physics classes where the audience is composed of students from a variety of majors. They have also begun to see use in upper-division physics courses where the audience is almost entirely physics majors.
In this presentation we examine the hypothesis that these substantially different populations will result in different levels of participation and engagement. We have videotaped the audiences of two introductory physics courses and two junior-level physics courses (mechanics and E&M in both cases) during clicker questions and quantified the level of engagement in each. Preliminary results suggest that upper-division majors-only courses exhibit more peer-to-peer interaction and overall engagement than introductory courses.

FB06: 9:20-9:30 a.m. Fostering and Assessing Student Self-Directed Learning in a Physics Class

Contributed – Yuhfen Lin, Florida International University, Miami, FL 33133; yuhfenlinb@gmail.com

David T. Brookes, Florida International University

The ability to learn on one's own could be one of the most valuable skills any student can acquire in school. In physics, students generally expect to be taught, or they don't believe that they can learn without the instructor's help. Due to their lack of confidence in physics, when students are given the opportunity to learn on their own, they often give up without trying. For instructors who are interested in getting students to self-direct their learning, it is important to provide both extra motivation and matching assessment to encourage students to take on the challenge. In this talk, we will show how building a learning community can lower student resistance to instructional reform, at the same time increasing student confidence in their ability to complete difficult tasks. We will also show how we used self-directed-learning assessments to both motivate students as well as to assess their progress.

FB07: 9:30-9:40 a.m. Change Is Hard: Improving the Propagation of Educational Innovations*

Contributed – Raina M. Khatri, Western Michigan University, Kalamazoo, MI 49008; raina.m.khatri@wmich.edu

Charles Henderson, Western Michigan University

Renee Cole, University of Iowa

Jeff Froyd, Texas A&M University

Although there are many talented people developing new ways of teaching undergraduate science more effectively, these innovations are not being used as widely as they should be. We are at the early stages of a larger effort designed to help curriculum developers incorporate propagation strategies from the beginning of their projects. To understand which strategies work best for certain projects, we have spoken with NSF program directors and analyzed responses to a survey of NSF-funded curriculum developers. One finding is that NSF directors have different views from developers about which propagation strategies are most successful. Developers tend to think of dissemination primarily as "getting the word out" by, for example, publishing a paper or giving a conference talk. NSF program directors, however, would like to see more active approaches, such as increasing the number and variety of development collaborators and holding workshops.

*Supported by NSF#1122446.

FB08: 9:40-9:50 a.m. Affordances Gained by Teaching Reforms in a Studio Setting

Contributed – Wendi N. Wampler, Oregon State University, Corvallis, OR 97333; wamplerw@onid.orst.edu

David Bannon, Dedra Demaree, Oregon State University

Traditional teaching environments often make it difficult for faculty to achieve their instructional goals and to implement reforms. Oregon State University (OSU) introduced a SCALE-UP inspired studio to facilitate student-centered, interactive learning for students in the calculus-based introductory physics courses. This talk will present the affordances gained by faculty members implementing reforms in the studio environment. We investigated two instructors: an experienced PER member and an experienced faculty member taking on new reforms. They were observed as they taught in both traditional and studio-style classrooms, as well as interviewed throughout the three terms of the calculus-based introductory physics course at OSU. The focus will be on how the studio helps instructors better align their teaching experiences with their philosophies and goals, as well as how it promotes better teaching habits.

FB09: 9:50-10 a.m. A Framework for Documenting Physics Teaching Assistants' Beliefs and Practices

Contributed – Benjamin T. Spike, University of Colorado, Boulder, CO 80309-0390; spike@colorado.edu

Noah D. Finkelstein, University of Colorado Boulder

Physics Teaching Assistants (TAs) in transformed environments are subject to increased demand to engage with student ideas and support classroom norms that may be very different from those they experienced as learners. Therefore these environments offer a rich opportunity to examine how TAs' beliefs coordinate with their instructional practices in ways that may either support or inhibit the use of research-based instructional strategies. In this talk we describe the importance of a framework for analyzing TAs' beliefs and practices, argue the need for linking these two domains, and present a framework for doing so. Using examples drawn from several semesters of TA interviews and classroom videotape, we then show the utility of this framework and describe instances of coordination and incoordination between TA beliefs and practices.

FB10: 10-10:10 a.m. Pilot Testing of the Modeling Instruction Curriculum

Contributed – Jared L. Durden, Florida International University, Miami, FL 33199; jdurd001@fiu.edu

Eric Brewe, Florida International University

At Florida International University we are developing a curriculum guide and set of comprehensive video and digital resources to support the implementation of Modeling Instruction. In preparation for dissemination of the curriculum materials and instructor support guide, we pilot tested the curriculum guide. An instructor with no previous experience teaching introductory physics using Modeling Instruction utilized the curriculum guide and instructor resources. To better understand how to support Modeling Instruction curriculum use, we conducted interviews with the instructor during and after the semester. We have identified three types of instructional resources germane to implementing Modeling Instruction. The instructor brought considerable resources based on prior teaching experiences. Several resources were developed during the instruction with assistance of the curriculum materials. Finally, several resources were not developed. We investigate the role that these resources play in instruction and how to structure faculty professional development that supports the development of instructional resources.

FB11: 10:10-10:20 a.m. Project-based Learning: A Review and an Implementation*

Contributed – Aaron M. Adair, The Ohio State University, Columbus, OH 43210; adair.65@osu.edu

Lei Bao, The Ohio State University

Endeavoring to find effective teaching pedagogies, inquiry methods have become increasingly popular in PER. Here we review one inquiry method, Project-Based Learning (PBL). The overview includes its foundations, major characteristics, and effectiveness compared to traditional methods. We find that overall PBL is usually better than traditional teaching, but there are conditions that need to be met for implementing a PBL curriculum successfully. This includes both classroom considerations as well as administration issues. If these problems can be successfully navigated, then PBL has good reason to be more widely implemented. This leads to the next stage: building PBL curricula to teach physics. We then discuss a new PBL curriculum using roller coaster projects to teach physics.

*Supported in part by NIH Award RC1RR028402 and NSF Awards DUE-0633473 and DUE-1044724 .

FB12: 10:20-10:30 a.m. Pedagogical Practices of New Faculty Following Participation in an Intensive Physics Education Focused Workshop

Contributed – Melissa Dancy, University of Colorado, Boulder, CO 80305; United States melissa.dancy@gmail.com

Charles Henderson, Western Michigan University

In our previous work we interviewed faculty retrospectively about their decision-making regarding research-based reforms. In order to develop a more in-depth understanding we are currently following 15 physics faculty during the change process. We report on interviews of 15 physics faculty pre- and post-semester for the two semesters they taught an introductory course following their participation in the Physics and Astronomy New Faculty Workshop. All faculty interviewed were in their beginning years as an instructor and expressed a strong interest in integrating Physics Education Research in their teaching practice. In this talk we present an analysis of the research-based instructional practices these faculty implemented, including the ways in which they modified practices and the reasons behind their decisions to implement and modify.

Session FC: *Panel:* Multi-Disciplinary Based Education Research Groups

Location: Sheraton - Ben Franklin Ballroom II
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Space Science and Astronomy
Date: Wednesday, August 1
Time: 8:30–10:30 a.m.

Presider: Eric Brewe
Discussant, Jose Mestre

Panelists:

–Warren Christensen, North Dakota State University

–Laird H. Kramer, Florida International University

–Scott V. Franklin, Rochester Inst. of Tech.

–Michael C. Wittmann, University of Maine

–Noah Finkelstein, University of Colorado, Boulder

Session FD: Reforming the Introductory Physics Course for Life Science Majors VII

Location: Irvine Auditorium - Amado Recital Hall
Sponsor: Committee on Physics in Undergraduate Education
Date: Wednesday, August 1
Time: 8:30–10:30 a.m.

Presider: Juan Burciaga

The invited speakers focus on the challenges and problems associated with reforming the introductory physics course for life science majors. There is a mini-poster session following the invited talks.

FD01: 8:30-9 a.m. Quantitative Introductory Science for the Next Generation of Life Scientists

Invited – Joshua Shaevitz, Princeton University, Princeton, NJ 08544; jshaevitz@gmail.com

The biological sciences have shifted over time from qualitative observations toward more quantitative and physical descriptions of nature. While it is clear that the traditional natural sciences of physics and chemistry have much to contribute to the education of biology students, the conventional introductory sequences in these disciplines have not been targeted for the education of modern life scientists. At Princeton University, we have addressed this issue through an experiment called "Integrated Science" that comprises a year-long, double course that substitutes for introductory physics and chemistry and focuses on areas that enable mathematical thinking while making connections to the biological sciences wherever possible. The course is taught at the level of an honors physics course and provides an alternative path into multiple majors: physics, chemistry, biology, and computer science. I will describe the curriculum we have developed and the results we have seen over the past eight years.

FD02: 9-9:30 a.m. Authentic Physical Foundations of Biological Functioning – Progress Beyond Relevant Examples

Invited – Nancy L. Beverly, Mercy College, Dobbs Ferry, NY 10522; nbeverly@mercy.edu

As a sign of recognition that life science students need help with transfer and attitude, most algebra-based introductory physics texts now include examples with biological or medical context. Typically, these examples are add ons to the traditional structure, with its unfortunate default focus on solving "problems" exemplified by the typical end-of-chapter problems. This is particularly inappropriate for the life science student, for whom authentic analysis of real interdisciplinary phenomena utilizing quantitative information would be optimal. Despite the complexity of biological systems, the simple models of introductory physics can be used in authentic exploration of the physical foundations of biological processes and medical functions, in laboratory, classroom, and homework activities.

FD03: 9:30-10 a.m. General Physics for Life Science Majors at the University of Wisconsin-Madison

Invited – Mark Rzchowski, University of Wisconsin, Madison, WI 53706; rzchowski@physics.wisc.edu

The Physics Department at the University of Wisconsin-Madison has four distinct two semester introductory physics sequences, one of which primarily serves Life Science majors. Over the last several years, the Physics Department has worked with various Life Science departments and faculty to modify the content and pedagogy of this calculus-based general physics course. I will discuss our interactions with departments across campus, the input we received from them, resultant revisions to the course, connections with Life Sciences during the course, the student experience, and the relative contribution and importance of the different course components.

FD04: 10-10:30 a.m. The Revised MCAT: Implications for Physics for the Life Sciences

Invited – Robert C. Hilborn, American Association of Physics Teachers, College Park, MD 20740; rhilborn@aapt.org

In February 2012, the Association of American Medical Colleges released information on the revised Medical College Admissions Test (MCAT) with the expectation that the new exam will go live in 2015. The revision was based on recommendations from the report on Scientific Foundations for Future Physicians (SFFP) and input from medical school and undergraduate faculty members. In this talk, I will describe the revised MCAT and how those revisions and the SFFP recommendations are likely to affect introductory physics courses for the life sciences.

FD05: 8:30-10:30 a.m. Entropy in Biophysics, Biology, and Research

Poster – Mark Reeves, George Washington University, Washington, DC 20052; reevesme@gwu.edu

Rahul Simha, Robert Donaldson, George Washington University

Diffusion and entropy are very important for understanding biophysical processes at the cellular level, but students have and maintain very strong misconceptions about these two topics. We have developed a first-semester IPLS course, in which roughly 1/3 of the class time is dedicated to teaching statistical physics, and the students are exposed to biology in a physics context. Students are introduced to statistics by considering simple coins flips. We move on from these to large numbers of coins and flips per coin and thereby to a meaningful physical model by connecting to Java-based simulations of the random walk problem. Hands-on exercises take this further by having the students directly observe entropically driven aggregation, Brownian motion, and stochastic and deterministic motion in cells. The material that we teach in the IPLS course is followed up in their introductory cellular biology course where the physics is retaught in a biological context.

FD06: 8:30-10:30 a.m. Are Hybrid Physics Courses as Effective as Traditional Courses?

Poster – Carl Schmiedekamp, Penn State University Abington, Abington, PA 19001; cws2@psu.edu

An introductory, first semester, algebra-based, physics course was presented to two course sections during the same semester. This course is taken primarily by life-science majors at the university. One section was taught face-to-face. The hybrid section met half as often and utilized only face-to-face problem sessions and laboratory exercises. Students in both sections were given the same evaluations, including common exams, homework and laboratory exercises. The influence of course structure on student learning results is compared.

FD07: 8:30-10:30 a.m. Research on Students' Interdisciplinary Reasoning About ATP*

Poster – Benjamin W. Dreyfus, University of Maryland, College Park, MD 20742-4111; dreyfus@umd.edu

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

Students' sometimes contradictory ideas about ATP (adenosine triphosphate) and the nature of chemical bonds have been studied in the biology and chemistry education literature, but these topics are rarely part of the introductory physics curriculum. We present qualitative data from an introductory physics course for undergraduate biology majors that seeks to build greater interdisciplinary coherence and therefore includes these topics. In these data, students grapple with the apparent contradiction between the energy released when the phosphate bond in ATP is broken and the idea that an energy input is required to break a bond. We see that students' perceptions of how each scientific discipline bounds the system of interest can influence how they justify their reasoning about a topic that crosses disciplines. Building interdisciplinary coherence requires attending to these interdisciplinary issues, as part of both curriculum design and education research.

*Supported by the NSF Graduate Research Fellowship (DGE 0750616), NSF-TUES DUE 11-22818, and the HHMI NEXUS grant.

FD09: 8:30-10:30 a.m. Introductory Physics Course for Life Science Students

Poster – Phil Lockett, Centre College, Danville, KY 40422; lockett@centre.edu

I have developed a one-semester algebra-based introductory physics course for life science students. The course assumes students have completed a one-semester physics course covering the basic concepts of mechanics. My primary goal in the class is to relate everything I teach to the life sciences. I also emphasize important physical models such as the simple harmonic oscillator and random walk. The class focuses on oscillations, waves, sound, fluids, thermal physics, optics and the interaction of radiation with matter. The lab is an integral part of the course and includes experiments that expose students to Fourier analysis, ultrasound propagation in solids, nuclear decay and attenuation, and x-rays. The choice of topics was guided by the BIO 2010 and AAMC-HHMI reports on improving the education of life science students.

FD10: 8:30-10:30 a.m. Investigating Student Understanding of Viscosity Using a Resource Framework

Poster – Dan E. Young, University of New Hampshire, Durham, NH 03824; deq27@wildcats.unh.edu*

Dawn Meredith, Matthijs van den Berg, University of New Hampshire

James Vesenka, University of New England

Kelvin Chu, University of Vermont

For introductory life science students, fluid dynamics is a topic that is important, relevant to biology, and yet difficult to understand conceptually. Our study focuses on probing understanding of pressure differentials and friction which underpin ideas of viscosity and fluid flow. Data was collected from think-aloud/demonstration interviews. The data was analyzed using the resource framework to look for productive student reasoning such as a microscopic viewpoint and gradient driven flow. Knowledge of these resources will guide development of instructional materials.

*Sponsor: Dawn Meredith

FD11: 8:30-10:30 a.m. IPLS Student Reasoning about the Mathematical Description of Oscillations

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

Gillian Galle, University of New Hampshire

Many students in the introductory physics course for life science students have difficulty making sense of trigonometric functions in a physics context. In particular, data shows that the role of the 2*pi/T in the argument is not understood. We investigated several approaches to bridge from commonly held previous knowledge to the target concept, and found that several approaches did not work. However, the idea of 2*pi/T as a pseudo conversion factor was productive for many students.

FD12: 8:30-10:30 a.m. Student Conceptions of Fluid Dynamics

Poster – James Vesenka, University of New England, Biddeford, ME 04005; jvesenka@une.edu

Katherine Misaiko, University of New England

Bernoulli's principle (BP) is a confounding concept for students partially because of the counterintuitive relationship between speed and pressure. When applied correctly BE is quite useful in helping to quantify a variety of important and common biological phenomena. Complicating matters are the many phenomena erroneously attributed to BP on the web, some of which are assimilated into instruction. BP's mathematical representation, the Bernoulli equation (BE), may be partially responsible for some of the alternative conceptions. We are investigating student conceptions of fluid dynamics to help students properly use BP/BE. Our interviews indicate that: 1) Successful students use multiple-particle models in order to describe pressure at a microscopic level. 2) Closely aligned with the first, is the importance of understanding the concept of a vacuum. Ultimately we seek to help students correctly employ BP through the use of graphical and diagrammatic representations, in addition to BE. Supported by DUE 1044154

FD13: 8:30-10:30 a.m. Preliminary Analysis of a Biology-based Physics Curriculum: Questions and Foundations

Poster – Juan R. Burciaga, Mount Holyoke College, South Hadley, MA 01075; jburciag@mtholyoke.edi

For the last five years the physics department of Mount Holyoke College has offered an innovative algebra-based/biology-based introductory physics sequence. But how can we compare a physics course whose goals are fundamentally different from the mainstream physics curricula? What criteria can we apply to curricula of different courses, that allows us to critically examine the effectiveness of the pedagogy used to write the textbook and establish the lab environment, irrespective of their goals? The material (text and lab environment) of the two-semester course will be extensively evaluated during the 2012/13 semester. This poster is an early outline of the assessment criteria that will be used to evaluate the course pedagogy.

FD14: 8:30-10:30 a.m. A New Order on a Classic Sequence

Poster – Robert A. Cohen, East Stroudsburg University, East Stroudsburg, PA 18301; rcohen@esu.edu

Mary Anne L. Moore, East Stroudsburg University

After years of trying different orders and approaches, we feel we've obtained an optimal order of physics topics within a traditional two-semester algebra-based physics sequence. We'll share what we've found, along with results that illustrate the success of the sequence.

FD15: 8:30-10:30 a.m. Integrating Biomedical Contexts in a Three-Staged Instructional Model

Poster – Bijaya Aryal, University of Minnesota - Rochester; 300 University Square, Rochester, MN 55904; baryal@umn.edu

Marian Aanerud, Robert Dunbar, Rajeev Muthyala, University of Minnesota - Rochester

We have designed a theme-based physics learning experience for health science majors. A semester of learning experience is divided into theme-based modules. A three-week-long module has three stages of teaching/learning activities. Each module starts with the concept construction stage where students are expected to explore concepts and relations of concepts within the module through concrete experiences and instructor guidance. Instructors in the next stage facilitate in consolidating students' learning using conceptual clicker questions, group-problem-solving activities and individual tasks. The activities of the third stage, usually designed through interdisciplinary collaboration, provide opportunities for students to apply the concepts learned in the earlier stages to biomedical contexts. In this presentation, we describe the learning stages and explain rationale and philosophy of the instructional model. Likewise, we provide some examples of integrated biomedical contexts and also report the preliminary assessment of the instructional model.

FD16: 8:30-10:30 a.m. Why a Models Approach Makes Reform both Doable and Successful

Poster – Wendell H. Potter, University of California, Davis, CA 95616; potter@physics.ucdavis.edu

Structuring introductory courses around central and important models, coupled with an emphasis on reasoning and sense making, offers pedagogical, epistemological, and content-organizational advantages compared to traditional approaches enshrined in large lecture-based and large textbook-defined courses. It is difficult to make significant progress in the reform of a particular aspect of the course for life science majors, e.g., in pedagogy, without simultaneously tackling all essential aspects together, simply because they are so interrelated. Success with reformed pedagogical approaches is tightly coupled to epistemological stances of students, which are in turn tied closely to the tasks they are asked to perform in both physics and in previous courses. These tasks, primarily finding answers to end-of-chapter numerical "problems," are in turn driven by the topic-centered, answer-focused way content is presented in standard textbooks. A models approach brings all elements together naturally and provides a rational approach to successful reform as will be illustrated.

FD17: 8:30-10:30 a.m. Teaching Problem Solving with the Brain in Mind

Poster – Maria Babiuc-Hamilton, Marshall University, Huntington, WV 25701; babiuc@marshall.edu

Problem solving is a skill that takes practice and time to fully develop. Exciting discoveries in neuroscience provide us with sound empirical data about how our brain changes through learning and offers suggestions to make teaching more effective. The most significant finding is the major role emotions and background knowledge is playing in learning new material. Modern classroom settings do not allow for the one-on-one emotional bridge between mentor and mentee. In order to overcome this impediment we make extensive use of office hours to talk with each of the students and determine what they know already. New knowledge needs to be kept simple, and build it up gradually through many examples, making sure students learn the unifying concepts. Brain-based learning will not solve all our educational problems, but by adjusting our teaching methods to take into account the lessons learned from brain research, we benefit both students and instructors.

FD18: 8:30-10:30 a.m. Light Absorption and Pulse Oximetry

Poster – Ralf Widenhorn, Portland State University, Portland, OR 97201 United States ralfw@pdx.edu

Justin C. Dunlap, Misti Byrd, Casey Norlin, Portland State University

We will present a laboratory activity that introduces concepts from optics in a way that is relevant to life science majors and pre-health students. The physics of light absorption is taught through the exploration of how a pulse oximeter is capable of non-intrusively measuring the oxygen content of blood as well as a patient's pulse rate. Alternative to working with blood, we demonstrate how a common pH indicator, bromothymol blue, can be used to simulate oxygenated and de-oxygenated hemoglobin. Common physics laboratory equipment such as a light sensor and spectrometer are utilized and explained. After introducing carbon dioxide into bromothymol blue, changes in intensity due to absorption are confirmed both visually as well as by measuring intensities at two discrete wavelengths. The results from this experiment are used to demonstrate how oxygen concentrations in blood are determined using pulse oximetry.

FD19: 8:30-10:30 a.m. Pendulum Laboratory Exercise Incorporating Bio-mechanical Model

Poster – Elliot Mylott Portland State University SRTC, 1719 SW 10th Ave., Room 134 Portland, OR 97201 emylott@pdx.edu

Angela Steichen, Justin Dunlap, Ralf Widenhorn Portland State University

Laboratory exercises to study the dependence of a pendulum's period on mass, length of the pendulum arm, and amplitude displaced, along with conservation of mechanical energy, are commonly found in general physics curriculum. We present a modification on the typical pendulum lab with the goal of showing students, in particular pre-health students, that pendulum like behavior is seen in many real world phenomena, and in particular is found in something as common as a human walking. This has particular relevance to student?s whose careers will incorporate the study of bio-mechanics where the inverted-pendulum-model of walking for bipeds is a common model on which to base more complex systems. Students learn the basics found in most pendulum labs, then study how a simple pendulum behaves after rotating the mass around 180° to form an "inverted pendulum," and finally how that motion can model a portion of a human's walking motion.

FD20: 8:30-10:30 a.m. The Pre-Health iCollaborative Project: How Can AAPT and PER help?

Poster – Patricia E. Allen Appalachian State University, Boone, NC 28608 allenpe@appstate.edu

Juan R. Burciaga, Mount Holyoke College

AAMC (Association of American Medical Colleges) has recently redefined its understanding of the expectations of students pursuing medical degrees. This has resulted in a revision of the MCAT and a vision of a recommended undergraduate curriculum based on pre-health competencies. Pre-Health iCollaborative is a new project established by the AAMC to provide a free online, searchable collection of instructional resources to support undergraduate faculty of all science disciplines who work with students preparing for medical school. Teaching resources, effective practices, and strategies for including pre-health competencies into existing courses will be made available to faculty at all institutions. (Sample materials can be found at www.aamc.org/icollaborative/pre-health.) In this paper, we will describe the status of the project, with a focus on how the PER (Physics Education Research) community can contribute to the success of this project.

Session FE: Developing Students' Scientific Literacy

Location: Sheraton - Ben Franklin Ballroom IV
Date: Wednesday, August 1
Time: 8:30–8:50 a.m.

Presider: Kathleen Falconer

FE01: 8:30-8:40 a.m. General Science Materials for Developing Students' Scientific Literacy: Part I

Contributed – Jeffrey Marx, McDaniel College, Westminster, MD 21157; jmarx@mcdaniel.edu

Karen Cummings, Southern Connecticut State University

Under an award from the National Science Foundation, we have begun the development, implementation, and assessment of undergraduate, general-science-level course materials with a primary and explicit goal of improving students' scientific reasoning ability, science process skills, and understanding of the nature of science (collectively: "scientific literacy"). In this course, specific science content serves not as the principle focus, but only as a mechanism to more deeply engage the students. In this, the first of two talks, we will present our arguments for why such materials are important, provide a general overview of how our materials are organized, and outline the various facets of scientific literacy addressed by our materials. Finally, we will discuss the progress of implementation at the speaker's home institute.

FE02: 8:40-8:50 a.m. General Science Materials for Developing Students' Scientific Literacy: Part II

Contributed – Karen Cummings, Southern Connecticut State University, New Haven, CT 06515, cummingsk2@southernct.edu

Jeffrey D. Marx, McDaniel College

Under an award from the National Science Foundation, we have begun the development, implementation, and assessment of undergraduate, general-science-level course materials with a primary and explicit goal of improving students' scientific reasoning ability, science process skills, and understanding of the nature of science (collectively: "scientific literacy"). In this course, specific science content serves not as the principle focus, but only as a mechanism to more deeply engage the students. In this, the second of two talks, we will present example materials and discuss the progress of implementation at the speaker's home institute.

Session FF: Interactive Lecture Demonstrations – What's New? ILDs Using Clickers and Video Analysis

Location: Sheraton - Ben Franklin Ballroom IV
Sponsor: Committee on Educational Technologies
Co-Sponsor: Committee on Research in Physics Education
Date: Wednesday, August 1
Time: 9–10 a.m.

Presider: Priscilla Laws

FF01: 9-9:30 a.m. Interactive Lecture Demonstrations: Active Learning in Lecture Including Clickers and Video Analysis

Invited – David R. Sokoloff, 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 microcomputer-based tools have led to the development of the Activity Based Physics Suite.[1] Most of the Suite materials are designed for hands-on learning, for example student-oriented laboratory curricula such as RealTime Physics. One reason for the success of these materials is that they encourage students to take an active part in their learning. This interactive session will demonstrate, through active audience participation, Suite materials designed to promote active learning in lecture, Interactive Lecture Demonstrations (ILDs),[2] including those using clickers and video analysis.

1. E.F. Redish, *Teaching Physics with the Physics Suite* (Wiley, Hoboken, NJ, 2004). 2. David R. Sokoloff and Ronald K. Thornton, *Interactive Lecture Demonstrations* (Wiley, Hoboken, NJ, 2004).

FF02: 9:30-10 a.m. Interactive Lecture Demonstrations: Effectiveness in Teaching Concepts

Invited – Ronald K. Thornton, Center for Science and Math Teaching, Tufts University, Medford, MA 02155; csmt@tufts.edu

David R. Sokoloff, University of Oregon

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

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

Session FG: Introductory Courses

Location: Sheraton - Ben Franklin Ballroom V
Date: Wednesday, August 1
Time: 8:30–10:30 a.m.

Presider: Gerald Feldman

FG01: 8:30-8:40 a.m. Cognitive Development in a Group-Centered Problem-Solving Classroom

Contributed – Joshua S. Ridenour, The George Washington University, Washington, DC 20052; jrideno6@gwmail.gwu.edu

Larry Medsker, Siena College

Raluca Teodorescu, Gerald Feldman, The George Washington University

Nawal Benmouna, Montgomery College

Developing competency in problem solving and enhancing conceptual understanding are primary objectives in introductory physics, and many techniques and tools are available to help instructors achieve them. Pedagogically, we use an easy-to-implement intervention, the ACCESS protocol, to develop and assess problem-solving skills in our SCALE-UP classroom environment for algebra-based physics. Based on our research and teaching experience, an important question has emerged: while primarily targeting improvements in problem-solving and cognitive development, is it necessary that conceptual understanding be compromised? To address this question, we gathered and analyzed information about student abilities, backgrounds, and instructional preferences. We report on our progress and give insights into matching the instructional tools to student profiles in order to achieve optimal learning in group-based active learning. The ultimate goal of our work is to integrate individual student learning needs into a pedagogy that moves students closer to expert-like status in problem solving.

FG02: 8:40-8:50 a.m. Promoting Critical Thinking in a SCALE-UP Environment at a Community College

Contributed – Nawal Benmouna, Montgomery College, Gaithersburg, MD 20877; nawal.benmouna@montgomerycollege.edu

Gerald Feldman, The George Washington University

Larry Medsker, Siena College

Critical-thinking skills are identified across disciplines as being the primary competency for academic success. Physics courses can provide the ideal vehicle for helping students develop such skills by focusing on the cognitive aspects of physics instruction in an active-learning environment. Through a collaborative NSF/TUES grant with George Washington University, we have incorporated a SCALE-UP-inspired approach into a "thinking skills" curriculum based on a taxonomy of cognitive skills in a General Physics I algebra-based class at Montgomery College. Critical-thinking skills are practiced repeatedly within each step of the problem-solving instructional approach used. We will report on the adaptation of the SCALE-UP environment at a Community College, the development of assessment tools to evaluate students' critical thinking, and how the assessment results were used to implement changes.

FG03: 8:50-9 a.m. Getting Students to Read the Textbook Before Class

Contributed – Cynthia E. Heiner, Carl Wieman Science Education Initiative, University of British Columbia, Vancouver, BC, V6T1Z4 Canada; heiner@phas.ubc.ca

Traditionally, students are introduced to a topic for the first time in lecture; however, students can read the textbook before coming to class -- making lecture their second exposure. Unfortunately most students do not read the textbook. Our approach to encourage students to read before class, which was inspired by Just-in-Time-Teaching,[1] has two key components: (1) the reading is very specific, and (2) a follow-up online quiz has questions that explicitly refer to the textbook. We have introduced such pre-reading assignments into a first-year physics course predominantly for life science majors. With this approach, 85% of students reported reading the textbook on a regular basis. I will present survey evidence that students recognized the textbook as being helpful to their learning and that pre-readings helped students to develop more sophisticated questions during lecture.

1. G. Novak, E. Patterson, A. Gavrin, and W. Christian, *Just-in-Time Teaching: Blending Active Learning and Web Technology*, Prentice-Hall, Upper Saddle River, NJ, (1999).

FG04: 9-9:10 a.m. How Different Incentives Affect Homework Completion in Introductory Physics Courses

Contributed – Frederick J. Kontur, United States Air Force Academy, USAF Academy, CO 80840; frederick.kontur@usafa.edu

Nathan B. Terry, United States Air Force Academy

We examine the amount of homework completed by students in two calculus-based introductory physics courses (Mechanics, Electricity and Magnetism) when three different incentives are used: (1) awarding points for homework completion in an online system; (2) administering homework quizzes that require students to solve a homework problem that was previously assigned; (3) allowing students to use their completed homework as a reference when taking quizzes on problems related to but not coming from the homework. In the latter two cases, none of the assigned homework was directly graded; homework completion was measured by periodic random checks during class of students' workbooks. To our knowledge, this is the first study that quantitatively compares homework completion for ungraded versus graded homework in an introductory physics course. Other variables that may affect homework completion, such as incoming student aptitude and student perception of the value of homework, are also analyzed.

FG05: 9:10-9:20 a.m. Homework Effectiveness in Two Introductory Physics Courses

Contributed – Nathan B. Terry, United States Air Force Academy, USAF Academy, CO 80840; nathan.terry@usafa.edu*

Fred Kontur, United States Air Force Academy

We consider the effectiveness of homework as a learning tool in multiple sections of two introductory calculus-based physics courses offered during several semesters. During these courses, both online and written homework were used. Correlation measurements from semesters where online homework was used indicated that homework was the least effective type of assignment for preparing students for exams; grades on both laboratory and pre-class assignments had a consistently higher correlation to exam success. We replaced online homework with written homework included as part of a comprehensive class journal. This study examines the effectiveness of course homework assignments before and after the introduction of the journal in several ways. First, we analyze how homework patterns relate to student performance on quizzes and exams. Second, we consider student responses to mid- and end-of-course surveys. Third, we examine insights collected during student focus group interviews.

*Sponsor: Fred Kontur

FG07: 9:20-9:30 a.m. Theory and Practice vs. Lecture and Lab/Teaching Introductory Physics

Contributed – Mikhail M. Agrest, College of Charleston, Charleston, SC 29414; agrestm@yahoo.com

The historical, methodological, technological, and administrative reasons lead to the tradition of having science classes taught as lectures and labs. Originated as sharing knowledge with larger groups of people, lectures became more a theoretical portion while labs were invented to give students the opportunity to learn via hands-on experience and to apply the theoretical knowledge acquired in lectures into real life. Development of theory and practice of teaching and learning invented new concepts and methods. One dimensional lecturer/student speaking/hearing flow of information was replaced by multidimensional methods.[1] Visual learners are pleased by abilities of modern visual aids technology. Demonstrations are forcing out conceptual teaching that is sometimes replaced by consideration of examples led practically to solving problems and replacing recitations sections. Things aren't always what they seem.[2] Misinterpreting observations, creating inadequate shortcuts became one of the learning problems. Advantages and disadvantages of the theoretical (lecture) classes and practical (labs and recitations) will be discussed.

1. M. Agrest, *Lectures on Introductory Physics I and II.* 249 pp. and 252 pp. with illustrations Thomson Learning. ISBN 1426625596, (2007).

2. Mikhail M. Agrest, "Things are not always what they seem," AAPT Winter 2009 Meeting, Chicago.

FG08: 9:30-9:40 a.m. Statics and Dynamics of Walking a Narrow Path: A Bird's Perspective

Contributed – Zdeslav Hrepic, Columbus State University, Columbus, GA 31904; drz@columbusstate.edu

While we still do not have a definitive answer about the reason(s) for which birds stand on one leg, a list of suggestions has been offered both by expert ornithologists and amateur birdwatchers. We offer a perspective grounded in statics and rotational dynamics that has not been suggested in the literature. The discussion has implications for bird study, and it can also be used as a rich context for teaching statics and dynamics topics at levels ranging from conceptual courses to advanced mechanics. Paper associated with the presentation is available in the March 2012 issue of *The Physics Teacher.*

FG09: 9:40-9:50 a.m. Pictorial Representations for Sound Standing Waves in Introductory Physics Textbooks

Contributed – Liang Zeng,The University of Texas-Pan American, Edinburg, TX 78539; zengl@utpa.edu

Chris Smith, Department of Chemistry,The University of Texas-Pan American

Jennifer Rodriguez, Edgar Corpuz, The University of Texas-Pan American

We reviewed at least 10 commonly used textbooks in introductory physics and found that pictorial representations for sound standing waves of air columns in tubes can be categorized into several typical models. A quasi-experimental study was conducted to investigate the comparative effectiveness between one pictorial representation model and the supporting text in a textbook and our self-composed pictorial representation model and supporting text in helping students learn the underlying concepts of sound standing waves. We found that students were confused with some aspects of the textbook's pictorial representations and incomplete supporting text. The results of this study can provide a basis for publishers to improve their pictorial representations and texts and for instructors to facilitate comprehensive explanations to enhance student conceptual understanding in sound standing waves.

FG10: 9:50-10 a.m. Using Play Dough to Understand Nuclear Reactors

Contributed – Erin De Pree, St. Mary's College of Maryland, St. Mary's City, MD 20686; ekdepree@smcm.edu

Many introductory physics courses briefly cover nuclear reactors. We present a kinetic activity to help students understand and remember how a nuclear reactor work. Each group of three to four students builds their own nuclear reactor using play dough. Groups often build different kinds of reactors and compare them afterwards.

FG11: 10-10:10 a.m. Collision Between a Disk and a Rod: Do They Stick?

Contributed – Carl E. Mungan, U.S. Naval Academy, Annapolis, MD 21402-1363; mungan@usna.edu

A small puck makes a perfectly inelastic collision with the end of a thin uniform rod lying at rest on frictionless ice. (In a perfectly inelastic collision, the normal component of the relative velocity between the contact points on the objects is zero after the collision.) Given the geometry, the masses, and the initial speed of the puck, the motion of the system immediately after the collision will be the same regardless of whether the puck sticks to the rod or not, IF the puck strikes the end of the rod perpendicularly. However, if the disk strikes at an angle (relative to the axis of the rod) other than 90 (or 0) degrees, then the final motion will be different if the puck sticks than if it does not. This example illustrates why one should NOT define "perfectly inelastic" as "the two objects stick together."
See Example 11.9 in the 7th edition of Serway & Jewett *Physics for Scientists and Engineers.*

FG12: 10:10-10:20 a.m. Acronyms (vowels: mathematical operations)

Contributed – Shannon Schunicht, M & W inc., 6773 Bendwood, College Station, TX 77845.3005; sschunicht@gmail.com

When instructing physics, formulas are continually espoused with applications, historical highlights, and derivatives in the same orderly fashion. Students have other classes and assignments. Physics now becomes second, if not discarded altogether. While in the Army, Mr. Schunicht was involved in a mid-air collision rendering three weeks of unconsciousness. Pragmatic discoveries were made to compensate for the residual memory deficits. The most valuable was having each vowel represent a mathematical operation, i.e. "a" multiplication to imply "@", "o" for division to mean "over", "i" for subtraction to signify "minus", "u" for addition to symbolize "plus", and "e" for "equals". Most constants, and variables are indeed consonants, e.g. "c" = "speed of light" & "z" = "altitude. ADDITIONAL LETTERS may be inserted for intelligibility, but need be CONSONANTS An acronym for The Quadratic Equation is; exCePT i buiLD rabbiTS 4 caTS oN 2 HaTS. Remembers Dr. Seuss?? The possibilities of this mnemonic technique are limitless as Delta X => 0 *

*The application of this mnemonic technique [vowels: mathematical operations] to Western languages is remarkable; however its application to Eastern characters has yet to be explored...

Session FH: Teacher Preparation

Location: Sheraton - William Penn Suite
Date: Wednesday, August 1
Time: 8:30–10:30 a.m.

Presider: Connie Wells

FH01: 8:30-8:40 a.m. Analyzing Future Teacher Reflections

Contributed – Marina Malysheva, Rutgers University, New Brunswick, NJ 08901; malyshev@eden.rutgers.edu*

Marianne Vanier, Eugenia Etkina, Rutgers University

Being able to reflect on your teaching is one of the skills that is very important for a teacher. The instructors (Learning Assistants and Teaching Assistants) in a reformed introductory physics course at Rutgers University post their reflections and discuss their teaching in an online environment. We analyzed this rich set of data using the grounded theory approach, and developed a coding system. The analysis of reflections allows us to identify possible relationships between the expected and observed student difficulties, the types of proactive and reactive teaching strategies the instructors choose, their perception of student understanding and learning processes, and trace the changes in their self-perception and their approaches to classroom situations. In this talk, we will describe the process through which we came up with the categories for our coding system.

*Sponsor: E. Etkina

FH02: 8:40-8:50 a.m. Investigation of Evolution: What Are Future Teacher Reflections Telling Us?

Contributed – Marianne Vanier, Rutgers University, New Brunswick, NJ 08901; marianne.vanier@rutgers.edu

Marina Malysheva, Eugenia Etkina, Rutgers University

Pre-service physics teachers at Rutgers University teach laboratories and recitations in a reformed introductory physics course for science majors. In September 2011 a few students who had previously taken this physics course were hired as learning-assistants (LA) to help pre-service teachers during recitations. Both groups reflected daily on their teaching experiences. We collected their weekly reflections and analyzed them using the coding scheme that was developed for this purpose. We agreed upon 24 codes; for each code we assigned three levels (1- general/superficial comment, 2- some depth in comment, 3- deep and rich comment) in order to specifically track the evolution of the content of their reflections from one recitation to the next and over the whole semester. We focused on the expected and observed student difficulties, the types of proactive and reactive teaching strategies they chose/used to remediate these student difficulties, and the changes in their approaches to classroom situations.

FH03: 8:50-9 a.m. Authoritative Sources in a Physics Class for Future Elementary Teachers

Contributed – Paul Hutchison, Grinnell College, Education Department., Grinnell, IA 50112; hutchiso@grinnell.edu

Eric Kuo, University of Maryland, College Park

This talk presents data from a physics course for elementary education majors that focuses on science "as an integrated body of knowledge and practice" (Duschl et al., 2007, p. 7)[1] rather than solely conceptual or factual knowledge. As such, the course emphasizes the process of "figuring things out" rather than relying on scientific authority to determine the merit of an idea. One view of such a course supports student sense-making by removing authoritative sources from these classes. This prevents rote memorization of content knowledge, something we worry about. Yet, interacting productively with authoritative sources is a part of expert scientific practice. So we want students to interact with authoritative texts in ways that support "figuring things out" rather than rote memorization. In this talk we report on how authoritative sources were introduced in our course, describe the positive and negative effects, and offer our reflections on what we learned from using them.

1. R.A. Duschl, H.A. Schweingruber, & A.W. Shouse, *Taking science to school: Learning and Teaching science in grades K-8*. Washington, DC: The National Academies Press (2007).

FH04: 9-9:10 a.m. How Can a PhysTEC Teacher in Residence (TIR) Facilitate Uncommon Conversations for the Common Good?

Contributed – Alma Robinson, Virginia Tech, Blacksburg, VA 24061; alma.robinson@vt.edu

At Virginia Tech, the TIR teaches a Physics Teaching and Learning course to pre-service K-12 teachers, undergraduate physics majors, graduate teaching assistants in physics, and graduate students in education. In addition to the essential lessons on PER and pedagogy, we also invited a diverse array of experts, from an actor to a psychologist, to give talks on how we can best utilize knowledge from their fields to become more effective physics teachers. Perhaps the most unusual conversation, however, was when our students shared with our physics faculty what they've learned about teaching physics. This talk will focus on the lessons learned from these uncommon conversations.

FH05: 9:10-9:20 a.m. Orienting Students to Participate in an Inquiry-based Physics Course

Contributed – Jon D. H. Gaffney, University of Kentucky, Lexington, KY 40504; jon.gaffney@uky.edu

Elementary and middle school education majors at the University of Kentucky are required to take a physics content course called Physics and Astronomy for Teachers (PAT). Because PAT is constructivist and inquiry-based, it is different from other required university science courses. A previous study revealed that student expectations about what they were going to do in the course differed substantially from what they reported actually doing. To orient the students to the pedagogy required in PAT, I now spend the whole first class demonstrating the mechanics of the course. In this talk, I will share some activities I have compiled and discuss how I use these activities to try to shift students' expectations for the course as well as explicitly model and discuss ways for them to effectively participate in the course.

FH07: 9:20-9:30 a.m. Role a TIR Plays in Creating a Community of Physics Teaching Professionals

Contributed – Katie Beck, 222 Hanover Dr., Costa Mesa, CA 92626; kbboogie@yahoo.com

It is lonely being the only high school physics teacher on a campus. Where can a teacher go for help or collaboration? One of the goals of PhysTEC at California State University, Long Beach is to create a community of physics teachers in order to address these concerns. This talk will discuss several events and opportunities that a TIR and the CSULB PhysTEC team have given in order to help foster a community of physics teaching professionals; monthly demo day, monthly newsletter, biannual physics teacher open house, and pedagogical content knowledge course (PHYS 490) offered to in-service and pre-service teachers.

FH09: 9:30-9:40 a.m. Secondary Teacher Preparation at the University of Northern Colorado

Contributed – Cynthia Galovich, University of Northern Colorado, Greeley, CO 80639; cynthia.galovich@unco.edu

Wendy K. Adams, Robert Reinsvold, University of Northern Colorado

The University of Northern Colorado (UNC) leads all public and private Colorado institutions in total enrollment in educator preparation programs with 3,770 students. UNC supplies 54% of the state's new teachers with degrees from Colorado schools. The science and mathematics teacher licensure programs typically maintain an enrollment of 250 to 300 students and

UNC is one of only three institutions in the state with a Science Teacher Education Program having National Recognition from NCATE/NSTA. In this presentation we'll discuss the features of the science teacher preparation program and how the tight collaboration between the content areas and the College of Education and Behavioral Sciences creates an efficient and effective system for education of high school science teachers.

FH10: 9:40-9:50 a.m. Using RTOP to Develop Pedagogical Content Knowledge in Pre-service Candidates

Contributed – Joseph L. Zawicki, SUNY Buffalo State College, Buffalo, NY 14222; zawickjl@buffalostate.edu

Kathleen A. Falconer, Luanna Gomez, Dan MacIsaac, Lowell Sylwester, SUNY Buffalo State College

The Reformed Teacher Observation Protocol (RTOP) has been used to measure the student-centeredness and level of inquiry in science classrooms. Teacher candidates, and new teachers, often focus on the content, not on the learners; pedagogical content knowledge is not just pedagogy—it is pedagogy and content within the context of the learner. The RTOP explicitly demands new teachers and teacher candidates to focus on what, precisely, the learner is doing within the classroom culture. Candidates completing a final science teaching methods course before student teaching were introduced to the RTOP as a tool to reflect on teaching practices. To critically assess their own microteaching experiences, as well as their future classroom lessons, candidates received standard RTOP training and developed an understanding of RTOP through classroom discourse and scoring.

FH11: 9:50-10 a.m. The Scarlet Letter – Can a Physics Failure be a Teacher?

Contributed – Donald G. Franklin, Retired- Adjunct Status, Mercer University, Hampton, GA 30228; dgfrank1@aol.com

In this world of recycling can we look for teacher candidates who were admitted to physics and engineering programs but graduated in other fields? Do we brand them forever as woefully inadequate for physics in our high schools for the rest of their lives, or do we consider that they all had the qualifications to enter the program, but other reasons caused them to leave their major. I am suggesting developing a two-week summer program to help these candidates find their worth and become physics and physical science teachers. At the end of the two weeks, the candidates would be tested to see if they have the ability to conduct labs and develop the classroom into a successful experience for the students.

FH12: 10-10:10 a.m. Engaging Pre-Service Elementary Teachers in Science Outreach

Contributed – Marina Milner-Bolotin, The University of British Columbia, I Vancouver, BC, V6T 1Z4 Canada; marina.milner-bolotin@ubc.ca

In Canada in order to be admitted into the Elementary Teacher Education Program, a student must have earned a Bachelor Degree (90% will have a BA) and have taken at least one post-secondary science lab course. Thus the majority of teacher-candidates have a very limited science knowledge and an unlimited mathematics and science anxiety. The Second Family Science Day at the Faculty of Education at the University of British Columbia attracted more than 200 guests. However, what made this event different from anything else is that it was organized and led by future elementary teachers. This was one of the few experiences where they could not only enjoy science, but also share their positive science experiences with others. More than 30 pre-service elementary teachers participated in the event and all of them expressed their satisfaction, as well as increased willingness to teach science to their future elementary students.

Session FI: Teaching Physics Around the World

Location: Sheraton - Ben Franklin Ballroom III
Sponsor: Committee on Physics in Undergraduate Education
Co-Sponsor: Committee on History and Philosophy in Physics
Date: Wednesday, August 1
Time: 8:30–10:30 a.m.

Presider: Saif Rayyan

FI01: 8:30-9 a.m. Preparing Teachers for the Use of ICT in the Framework of Inquiry Based Science Education

Invited – Ton L. Ellermeijer, Foundation C.M.A., van Leijenberghlaan 124, Amsterdam, 1082 DB, Netherlands; ton@cma-science.nl

Ewa Kedzierska, Foundation C.M.A.

The European Community wants science education to change in direction of IBSE (Rocard Report). Today several large projects involving many countries are addressing this challenge. The main focus is on preparing and supporting teachers by providing them with innovative curriculum materials and teacher training activities (as well pre-service as in-service). For a long time we have known that ICT might stimulate and enable physics education in a direction that brings (high school) students in a similar position as researchers in science. The powerful tools available (from measurement with sensors, advanced video-analysis to numerical modeling) facilitates realistic and authentic research projects by students. Still many teachers around the world have not been able to apply these possibilities, also due to lack of training. In the framework of the ESTABLISH project (EC-funded) we now develop training and support for teachers as much as possible suitable for on-line use.

FI02: 9-9:30 a.m. Innovative Physics Teaching in the Czech Republic

Invited – Rod Milbrandt, Rochester Community and Technical College, Rochester, MN 55904; rod.milbrandt@roch.edu

The author spent 2009-10 on sabbatical at the Physics Education Department of Charles University in Prague. This talk will focus on physics teaching in the Czech Republic, and especially on innovative methods being used by teachers participating in the Heureka project, a long-term collaboration of Czech physics teachers. Observations on teacher education at Charles University, and some of its unique characteristics, will also be discussed.

FI03: 9:30-10 a.m. Piano ISS – Improving Science Teaching in Italy

Invited – Silvano M. Sgrignoli, A.I.F. Associazione, per l'Insegnamento della Fisica (IT), via F. Coghetti, 236 Bergamo, I 24128 Italy; sisgri@iol.it

Piano ISS is an important, large-scale activity aimed at improving the teaching/learning of science in Italy, from elementary school to the first two years of upper secondary (6 to 15 year-old students). It started in 2006 after one year of preparatory work, and it is based on a project devised by three teachers' associations, AIF (Physics), ANISN (Natural Sciences), and DD/SCI (Chemistry), and by the Science Museums of Milan and Naples. It has been officially adopted by the Ministry of Education. Piano ISS is based on the idea that guided collaboration of teachers, involved in action-research activities with the advice of experts and organized around local support structures in the schools ("presidi"), is crucial for a significant improvement of school practices. I will describe how Piano ISS was first implemented throughout the country in 100 "presidi"—each one having three tutor/teachers—and will analyze how it evolved, how it was managed through four different governments following one another, what are the present outcomes, and which difficulties are being faced at the moment.

FI04: 10-10:10 a.m. Science Education Delegation to India, Oct., 2011

Contributed – Celia Chung Chow, CSU, 9 Andrew Drive, Weatogue, CT 06089-9726; cchungchow@comcast.net

Elizabeth Chesick, The Baldwin School

Understanding Indian science education and interaction with Indian science teachers at eight schools in two cities, New Delhi and Jaipur, India, Oct. 9-17, 2011.

FI06: 10:10-10:20 a.m. Experimenting an Inquiry-based Intervention Module on Electromagnetism with Talented Students

Contributed – Stefano Vercellati, Physics Education Research Unit, University of Udine, Via Delle Scienze, 208 Udine, UD 33100 Italy; stefano.vercellati@uniud.it

Marisa Michelini, Physics Education Research Unit, University of Udine

An experimental inquiry-based learning path on electromagnetic phenomena was experimented during the 2011 Summer School of Modern Physics of Udine. The research was focused on the investigation of the ways in which skilled Italian students (selected from the best high school students in physics) constructed the formal thinking, anchoring (or not) their reasoning to the magnetic field lines representation. This representation, first used in the learning path as qualitative descriptor, will be improved as a quantitative representation able to describe the main characteristics of the magnetic field. The characteristics of magnetic field were built interpreting the phenomena from qualitative to a quantitative level and the ways in which is possible to produce induction and the Faraday's law were addressed and interpreted by the students. Data collected, using personal worksheets and recording of the lecture will be discussed.

Session FJ: PIRA Session: International Outreach

Location: CCH - Claudia Cohen Terrace
Sponsor: Committee on Apparatus
Date: Wednesday, August 1
Time: 8:30–10 a.m.

Presider: David Maiullo

FJ01: 8:30-9 a.m. Outreach in the Classroom: Boosting Interest in Physics by Integrating Virtual Instrumentation Within Demonstrations and Student Labs

Invited – Urs Lauterburg, Physikalisches Institut, University of Bern, Sidlerstrasse 5, Bern, BE 3012, Switzerland; urs.lauterburg@space.unibe.ch

After discussing ways to increase the impact factor of physics demonstration experiments and student labs with the help of virtual instruments, the presentation will focus on two recently developed examples: 1) The Hopf-Pendulum demonstration experiment which represents a simple mechanical system that shows how the transition between its inherent steady states is driven by chaotic properties. 2) The Doppler lab experiment, an apparatus that lets the students explore and investigate the Doppler effect by measuring and analyzing the acquired signals of rotating sound sources.

FJ02: 9-9:30 a.m. Empowering Teachers with Inquiry Teaching Competence by Updating their Own Learning

Invited – Xingkai Luo, Research Institute of Science Education & Faculty of Physics, Guangxi Normal University, Guangxi 541004; China xingkailuo@vip.163.com

Inquiry-based science teaching at school levels driven by the new national curriculum in China has been widely recognized as a big challenge for most practicing school science teachers who had not been taught in such a way in their own schooling years. High-quality professional development focusing on enhancing current and future teachers' competence in inquiry teaching becomes crucially important. Such demand motivated the author and colleagues to focus their attention on preparing new teachers empowered with competence in teaching science by inquiry in implementing the new national curriculum. This talk presents a systematic effort aimed at updating the university students as future teachers with their own learning first. It includes: 1) Updating the physics/science teacher education program at Guangxi Normal University in light of scientific inquiry ideas; 2) Providing encouraging and supporting environment for teacher students to learn inquiry teaching by doing inquiry and doing inquiry teaching, especially involving them in devolving and using low-cost but high education value experiments; 3) Constructing new-type university-school and extra-school educational institutes alliance providing teacher students not only platform for doing clinical teaching practice conveniently but also opportunity for trial school-based curriculum development and science teaching in informal setting. Reflection from different channels sees the promise not only to remarkable enhancement of teacher students' competence but also to closing the gaps between research and classroom, academics and practices. Some examples selected in a format of demo and video will be presented during the talk.

FJ03: 9:30-10 a.m. Physics Outreach Programs in the European Union

Invited – Stanley J. Micklavzina, University of Oregon, Eugene, OR 97403; stanm@uoregon.edu

From January–June of 2012 I did sabbatical leave work in Lund Sweden to develop an outreach program and activities for the MAX-lab Synchrotron Radiation Laboratory. Through this effort, I have been exposed to various outreach programs from all parts of the E.U. These outreach programs vary in style and are utilized by universities, research laboratories, and private corporations. I will give an overview of some of these programs and will also include information about a conference that is organized to support various outreach efforts for all countries in the E.U called EuroPhysicsFun.

Session FK: Assessing Pedagogical Content Knowledge in Teacher Preparation

Location: Houston Hall - Golkin
Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on Research in Physics Education
Date: Wednesday, August 1
Time: 8:30–10 a.m.

Presider: Paula Heron

FK01: 8:30-9 a.m. Flight Simulator for a Physics Teacher

Invited – Eugenia Etkina, Rutgers University, New Brunswick, NJ 08901; eugenia.etkina@gse.rutgers.edu

Flight simulators prepare pilots in training for the routine and extreme situations. The simulators also allow flight instructors to assess how new trainees can fly the plane in a regular situation, how they respond to the changes of the conditions, and to provide instant feedback. How can we use the concept of a simulator to help future teachers prepare for the challenges of a high school physics classroom? In this talk I will describe how one can use microteaching (microteaching happens when pre-service teachers teach lessons to their peers who play the role of high school students, the word micro does not mean short duration of the lesson) for this purpose. Microteaching involves planning the lesson, assembling and testing equipment, and enacting the lesson in the classroom. Formative assessment of each step that pre-service teachers undertake in this process allows for instant feedback, corrections and improvements in the lesson.

FK02: 9-9:30 a.m. Assessing Teachers' Knowledge and Skills of Formative Assessment

Invited – Jim Minstrell, FACET Innovations, 1314 NE 43rd St., Suite 207, Seattle, WA 98105; JimMinstrell@FACETInnovations.com

Min Li, University of Washington

Ruth A. Anderson, FACET Innovations

In this paper we discuss the development of valid and reliable pen and paper, scenario-based tasks for assessing teachers' skills and knowledge at three critical aspects of formative assessment: 1) Anticipating or knowing typical student responses in solving conceptual problems or explaining critical events in physics; 2) Interpreting student work to determine strong and problematic aspects and to identify possible cognitive or experiential needs of the students; and 3) Acting to adapt or design one or more actions (lessons or feedback) that are likely to address student learning needs and promote clearer understanding. Characterizations of teachers' actions were derived and codified using results from two sources: think-aloud interviews with teachers and responses to subsets of tasks by teachers in various professional development venues. The tasks, the identification of learning needs, and the resulting interpretive frameworks can be used for professional development of teachers' practices in the teaching of physics.

FK03: 9:30-9:40 a.m. Pedagogical Content Knowledge of Inquiry Science Instruction: Operational Models

Contributed – David Schuster, Western Michigan University, Physics Department and Mallinson Institute for Science Education, Kalamazoo, MI 49008; david.schuster@wmich.edu

Betty Adams, Bill Cobern, Brandy Skjold, Western Michigan University

National Science Education Standards advocate inquiry-based science instruction throughout K-12. This is a demanding task, requiring teachers to successfully integrate content knowledge, inquiry knowledge, pedagogy knowledge, and knowledge of learners. Theoretical knowledge of each is not enough; a teacher must bring all of them to bear in a case-based fashion for teaching specific topics in classroom situations. We call this combination "pedagogical content knowledge of inquiry science instruction." It is important to have ways of promoting and assessing it during teacher preparation. Yet there are disparate ideas about what constitutes inquiry instruction, and an even greater range of classroom practices. We use operational models to characterize some constructs involved, e.g. PCK, scientific inquiry, guided inquiry vs. other instructional modes, teaching orientations, science concept development vs. investigative process skills, narrative framing and discourse. This is valuable to clarify in its own right, but also gives a basis for devising assessment items for formative and summative use during teacher preparation.

FK04: 9:40-9:50 a.m. Assessing Pedagogical Content Knowledge of Inquiry Science Instruction: Case-based Instruments

Contributed – Betty Adams, Western Michigan University, Mallinson Institute for Science Education, Kalamazoo, MI 49008; b.adams@wmich.edu

David Schuster, Bill Cobern, Brandy Skjold, Western Michigan University

Prospective teachers' science content knowledge is assessed during their preparation, but it is just as important to assess their integrated knowledge of how best to teach particular science topics by inquiry, i.e. what we may call "pedagogical content knowledge of inquiry science instruction." This requires a new type of assessment. We have developed case-based assessments in both MCQ and Likert formats. A typical item presents a realistic teaching vignette for a particular topic, poses a question about instructional approach, and offers response options reflecting a spectrum of teaching orientations ranging from direct instruction through guided inquiry to open discovery. Sets of tested and refined items are compiled into Pedagogy of Science Teaching Tests (POSTT), with versions for various topics, grade ranges and facets of instruction. These have summative and research uses, but perhaps more importantly, individual items can be used formatively during teacher preparation to promote active problem-based discussion of science inquiry pedagogy. We discuss example items.

FK05: 9:50-10 a.m. Assessing the PCK of In- and Out-of-Field Physics Teachers

Contributed – Jennifer J. Neakrase, New Mexico State University, Las Cruces, NM 88003; neakrase@nmsu.edu

Pedagogical content knowledge (PCK) refers to how a teacher represents and formulates the subject being taught in order to optimize student understanding. Within physics, PCK is described as "an application of general, subject-independent knowledge of how people learn to the learning of physics." In choosing or designing successful lessons, a physics teacher must weave their knowledge of the discipline with knowledge of how students learn. When there is no certified physics teacher available, other "out-of-field" teachers are asked to fill the role. An out-of-field teacher may have adequate general knowledge of how students learn, but inadequate knowledge of the discipline of physics. This difference in knowledge between an in- and out-of-field physics teacher should be reflected in their PCK. This paper discusses how PCK of in- and out-of-field teachers can be assessed through a mixed-method design, which includes analysis of interviews, observations, and concept maps.

FK06: 10-10:10 a.m. A Q Approach to Understanding Physics LAs' Views on Teaching*

Contributed – Geraldine L.. Cochran, Florida International University, Miami, FL 33199; moniegeraldine@gmail.com

David T. Brookes, Eric Brewe, Laird H. Kramer, Florida International University

Previously, we presented the results of semi-structured interviews with Physics LAs at Florida International University regarding their views on reflective practice in the LA program and focused on central themes shared by the Physics LAs. Analysis of the interviews also revealed that the LAs have varying views in regard to their teaching experiences and how they engage in reflection. To better understand the various views held by our LAs we will use Q methodology as a framework for determining typologies among Physics LAs. As a part of this framework, participants sort a sample of statements according to their agreement with the statement. The first step in using this framework is creating the concourse, the set of statements from which the sample of statements is taken. In this presentation, we will discuss the development of our concourse from LA interviews, LA writing assignments, and a review of the literature.

*Research funded by NSF grant # 0802184

Awards Session

Location: Inn at Penn - Woodlands Ballroom
Date: Wednesday, August 1
Time: 11 a.m.–12:15 p.m.

Presider: Jill Marshall *Presenter: David Sokoloff*

2012 AAPT Robert A. Millikan Medal – Philip M. Sadler

Philip Sadler

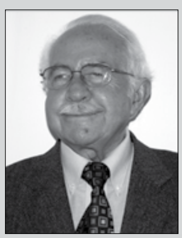
Separating Facts From Fads: How Our Choices Impact Students' Performance and Persistence in Physics

Philip Sadler, Harvard-Smithsonian Center for Astrophysics, Cambridge, MA 02138; psadler@cfa.harvard.edu

The United States is unique in the variety of teaching methods and curricula chosen for use in science classrooms. Because of this natural variation, we have utilized epidemiological methods to mine the backgrounds of college students taking introductory science courses for predictors of performance and persistence while controlling for demographic differences. In surveying thousands of students in randomly selected introductory college biology, chemistry, and physics courses across the U.S., we have put to the test educators' beliefs about the kinds of preparatory experiences and key resources that predict both persistence and successful performance. I will report on our findings on the value of lab experience, technology, demonstrations, content coverage, block scheduling, class size, Advanced Placement courses, project work, and mathematics preparation. We have also gauged the effectiveness of classroom instruction at the middle school level, examining the role of teacher subject matter knowledge and pedagogical content knowledge on student gains in physical science. Of particular interest is teacher awareness of common student misconceptions and how this impacts student learning.

2012 AAPT Distinguished Service Citation Awardees

Eugenia Etkina
Rutgers University
Department of Physics



J. D. Garcia
University of Arizona
Department of Physics

Chandralekha Singh
University of Pittsburgh
Department of Physics

2012 AIP Science Communication Award: Writing for Children

Pat Murphy
author of
The Klutz Guide to the Galaxy

The 2012 award in the Writing for Children category goes to Pat Murphy for her book *The Klutz Guide to the Galaxy*. Like other *Klutz* books, this winning entry comes with the tools children need to experiment and explore. Pat was a senior writer at the Exploratorium, San Francisco's museum of science, art, and human perception. Today, Pat writes and manages the creation of science books and products for Klutz. She also is an award-winning science fiction and fantasy author.

– Bo Hammer, AIP, presenter

CRKBRL 6: Do We Have Standards? Moving Towards a Definition of Physics Mastery

Location: Houston Hall - Class of 49
Sponsor: Committee on Physics in Undergraduate Education
Date: Wednesday, August 1
Time: 12:15–1:15 p.m.

Presider: Andy Gavrin

The need to quantify and document student learning in physics courses and programs is growing. Consider these developments: (1) The publication of "Academically Adrift" has raised serious concerns among university administrators, legislators, and not a few parents about the value of a college education. (2) Most, if not all, regional accreditors now require substantial assessment efforts at all levels for institutions to maintain accreditation. (3) ABET accreditation of engineering programs no longer requires that students take specific physics courses, accepting any demonstration of competency, and medical schools are expected to follow this example within a few years. How shall physics programs react? The issue will not go away. One method would be for each department to develop and validate its own assessment methods. Another would be for the physics professional societies to develop and distribute assessment resources. Join us to discuss how to address the problems and potential benefits of these and other solutions.

CRKBRL 7: Crackerbarrel for PER Graduate Students

Location: CCH - Claudia Cohen Terrace
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Graduate Education in Physics
Date: Wednesday, August 1
Time: 12:15–1:15 p.m.

Presider: Deepika Menon

This session would allow PER graduate students to discuss current issues and concerns they might have to help them excel in their field.

CRKBRL 8: Crackerbarrel for Faculty in Small Departments

Location: Irvine Auditorium - Amado Recital Hall
Sponsor: Committee on Professional Concerns
Co-Sponsor: Committee on Physics in Two-Year Colleges
Date: Wednesday, August 1
Time: 12:15–1:15 p.m.

Presider: Dyan Jones

This will be an informal gathering to discuss the challenges associated with being in a small department, both at four-year and two-year institutions. We would like to specifically focus on successful strategies for building collaborations with other departments and institutions.

Session GA: Teaching Physics in Urban and Suburban Settings

Location: Sheraton - Ben Franklin Ballroom I
Sponsor: Committee on Physics in High Schools
Co-Sponsor: Committee on Professional Concerns
Date: Wednesday, August 1
Time: 1:30–3 p.m.

Presider: Eugenia Etkina

GA01: 1:30-2 p.m. Technologies for Innovative and Efficient Mastery-based Assessment

Invited – Chris D'Amato, Mount Olive High School, Flanders, NJ 07836; cd@chrisdamato.com

High school physics classes using a mastery-based approach to assessment (students can revise their graded work many times) produce excellent results in student learning and help create a classroom in which all participants are stakeholders in shared achievement -- but this produces reams of paperwork and lots of data to manage. This talk shows how common technology skills can create mastery-based assessment instruments that work better for both teacher and students. Using simple technical solutions I can make daily individualized paper quizzes with unique solutions, dynamically generated charts and figures, and pre-printed student information encoded in QR barcode. I scan student work with copier or webcam, record grades, and share the result with the student. The student gets prompt personal feedback; the teacher provides an innovative, responsive, rigorous and yet compassionate grading system while expending less energy than with a traditional assessment and grading system.

GA02: 2-2:30 p.m. Making Fun Out of Educational Physics Games

Invited – Matthew Blackman, Madison High School, Parsippany, NJ 07054-4239; matthewblackman1@gmail.com

Being a high school physics teacher and game designer, I would like to share with you some educational physics games that have helped me engage my students. A new generation of educational physics games and software is evolving, inspired by such unlikely predecessors as Angry Birds. In physics education software, developers are finding increasingly exciting and unique ways to engage students in physics while keeping them excited about learning. By incorporating cutting-edge game design techniques, we can keep the average digital-age student immersed in physics for hours. By building on strong pedagogical content knowledge, as well as incorporating new possibilities afforded by tablets and laptops, educational physics games are becoming a hugely successful and widely-used tool to reinforce physics in the classroom. I believe that games, if designed and used correctly, can become an indispensable tool to reinforce concepts and keep students smiling while they're thinking.

GA03: 2:30-2:40 p.m. Can Standards-based Grading Reduce Dropout Rates in Physics I?

Contributed – Janet Kahn, Marshall High School, Falls Church, VA 22043; jlkahn@fcps.edu

Marshall High School in Falls Church, VA, is a diverse, cosmopolitan school with students from a wide range of economic, racial, and international backgrounds. About 80% of our students take at least one year of physics. Physics I is taught to 11th and 12th graders with very diverse levels of science and math backgrounds as well as motivation levels. Many of these students do not respond well to traditional grading systems. We are currently in our third year of using standards-based grading. Scores on standards are linked to levels of knowledge and ability in each unit. Students are given multiple opportunities to demonstrate competency on each standard. Preliminary results show a much lower rate of students dropping out of physics mid-year, with similar numbers of students receiving D and F grades.

GA05: 2:40-2:50 p.m. Convincing Middle, High School Teachers of the Value of Formative Assessment

Contributed – Gordon J. Aubrecht, Ohio State University at Marion, Marion, OH 43302; aubrecht@mps.ohio-state.edu

Bill Schmitt, Science Center of Inquiry

Jennifer Esswein, Ohio State University

Formative assessments can allow teachers to understand what is and is not working in their classrooms for the purpose of changing how they teach various content. Many school administrators do not understand the difference between summative and formative assessment and actively prevent true formative assessment to occur. The teachers then proceed to "give them what they want" with no useful effect. This study presents a model, as well as its application, for the development of formative assessments in the classroom in a rurally located, city high-needs district in the state of Ohio. Results indicate changes not only in the way teachers view their pedagogical approaches, but also in how teachers consider student personal epistemologies.

Session GB: PER: Investigating Classroom Strategies II

Location: Sheraton - Ben Franklin Ballroom III
Date: Wednesday, August 1
Time: 1:30–3 p.m.

Presider: David Rosengrant

GB01: 1:30-1:40 p.m. Department-Level Instructional Change: Complexity Leadership Theory and Social Networks

Contributed – Charles Henderson, Western Michigan University, Kalamazoo, MI 49008-5252; charles.henderson@wmich.edu

Kathleen Quardokus, Western Michigan University

Efforts to improve teaching in higher education have often focused on individual faculty. However, there is a growing consensus that the academic department is a more productive focus of change initiatives. The difficulty for change agents working with departments is to find ways to allow faculty members to maintain autonomy to develop emergent ideas while simultaneously allowing departmental leaders to maintain control and provide direction. Complexity leadership theory combines ideas from complexity science and social network analysis to help organizations better understand how to manage the emergent and prescribed polarities necessary for successful change. This talk will introduce the ideas of complexity leadership theory and illustrate their utility to department-level instructional change through the use of social network analysis applied to an academic department.

GB02: 1:40-1:50 p.m. Observing Faculty Practice in Workshop-Style Physics Classrooms Through Multiple Lenses

Contributed – Scott V. Franklin, Rochester Institute of Technology, Dept. of Physics/RIT, Rochester, NY 14623; svfsps@rit.edu

Tricia Chapman, Rochester Institute of Technology

While research has established the effectiveness of reform physics curricula, less well-studied is how different faculty, with varying pedagogical content knowledge, use these materials. We characterize the diversity of practice in workshop-style introductory physics courses through two complementary observational protocols: the Reform Teaching Observation Protocol assesses fidelity to reform-teaching philosophies, while the Teaching Dimension Observation Protocol records direct practice. Despite a common environment and core materials, there is significant variance across faculty and course content. Instructors in electricity and magnetism courses not only lecture more frequently, they lecture to prepare student activities ("Tell and Practice"), whereas mechanics instructors use lecture to summarize student findings ("Invent and Tell"). We find no significant difference in practice during weekly sessions when the class meets in a traditional setting (stadium seating, well-defined front, etc); faculty treat both environments as an essentially interactive lecture. I'll also discuss implications for future dissemination efforts.

GB03: 1:50-2 p.m. Investigating the Effect of Lab Section on Lecture Performance

Contributed – Sytil Murphy, Shepherd University, Shepherdstown , WV 25443; smurphy@shepherd.edu

Unlike most schools, the lecture and lab portions of the introductory algebra-based physics courses at Shepherd University are not linked. Material covered in the lab portion is not the same between sections nor is it tied to the lecture portion. It is possible to cover material in lecture and not in lab and vice versa. Students can have one instructor for lecture and another for lab. Student performance on in-class exams and the FCI is investigated as a function of the combination of lecture and lab instructors.

GB04: 2-2:10 p.m. Toward Assessing K-12 Teacher Responsiveness to the Disciplinary Substance of Student Ideas*

Contributed – Amy D. Robertson, Seattle Pacific University, Seattle, WA 98119; robertsona2@spu.edu

Rachel E. Scherr, Sarah B. McKagan, Stamatis Vokos, Seattle Pacific University

Recent science education reforms have called for teachers to be responsive to the student ideas that arise in the midst of instruction and to make in-the-moment pedagogical decisions that rely on what they hear. There has thus been an increased emphasis on noticing, interpreting, and responding to the disciplinary substance of student ideas in K-12 teacher professional development. However, the physics education research community has yet to develop a systematic way of assessing growth in teacher responsiveness as manifested in their classroom practices. The Energy Project is developing a framework for assessing teacher responsiveness that is grounded in the literature and in episodes from practicing teachers' classrooms. A brief overview of the developing framework will be presented.

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

GB05: 2:10-2:20 p.m. What Are Our Goals? TAs' Views About Introductory Laboratories

Contributed – Jacquelyn J. Chini, University of Central Florida, Orlando, FL 32816-2385; jacquelyn.chini@ucf.edu

Ahlam Al-Rawi, University of Central Florida

While teaching assistants may still be developing their beliefs about and skills in teaching and communicating physics, they also may be the most approachable or accessible physics experts for students in large-enrollment introductory courses. For example, the student-teacher ratio in our lecture sections is about 250-1, while the ratio in our lab sections is about 30-1. As we are in the process of reforming our introductory courses and laboratories as well as our TA training program, we began by asking the TAs about their views and experiences on both the teaching and training processes. Our TAs come from diverse cultural, teaching, and research backgrounds. All were teaching the laboratories associated with algebra-based courses. We will discuss trends in the TAs' responses to questions about the purpose of the laboratory component, their roles as TAs, their own strengths and weaknesses, and their efforts to improve their teaching skills.

GB06: 2:20-2:30 p.m. When Classrooms Are Technology-Rich & Pedagogy Poor...

Contributed – Nathaniel Lasry, John Abbott College, Quebec, H3X 3A2, Canada; nlasry@me.com

Elizabeth Charles, Chris Whittaker, Dawson College

There is growing interest in constructing technology-rich classrooms (eg. SCALE_UP & TEAL) to enable student-centered active learning. But what if technology-rich classrooms are used by instructors who have not fully embraced student-centered pedagogies? We studied the effect of different classrooms (conventional vs technology-rich) and of different pedagogies (active learning vs. traditional) on students' conceptual change. We also examined the effect of the instructors' perception of their instructional approach (teacher-centred and student-centred) on students' conceptual learning. Our findings show that technology-rich classrooms work only when implemented with student-centered pedagogies. Students who received an active learning pedagogy in technology-rich classrooms achieved greatest conceptual gains. However, students exposed to traditional pedagogies achieved similar gains in the technology-rich and conventional classrooms. We also found that instructors range on a continuum of student-centredness and that instructors' self-reported student-centredness correlates strongly with their students' conceptual gains.

GB07: 2:30-2:40 p.m. Quasi-Experimental Evaluation of Interventions on At-Risk Students' Introductory Mechanics Performance

Contributed – Sara J. Rose, University of Illinois Urbana-Champaign, Urbana, IL 61801; sararose@illinois.edu

Synthesis and evaluation of research on at-risk student interventions signals the need for more rigorous delineation of the characteristics involved in intervention effectiveness. Systematic links to and manipulation of the major theoretical factors underlying these interventions must also be elaborated and studied in greater detail. Such was the purpose of this study, which was undertaken in the context of two interventional approaches: a pre-course and a course offered concurrent to enrollment in the target introductory mechanics course at a large Midwestern university. Participants were engineering freshmen with the prerequisite calculus credit. The quasi-experimental, post-test only, nonequivalent control group design utilizes propensity score matching to assess the differential impacts of the two approaches on at-risk student performance and persistence in the target course as well as retention rates in the related physics course sequence.

GB08: 2:40-2:50 p.m. Helping Students to Interrogate a Physics Text

Contributed – Elana M. Resnick, Rutgers University, New Brunswick, NJ 08901; resnick.e.m@gmail.com*

Robert C. Zisk, Eugenia Etkina, Rutgers University

Students have difficulties comprehending science texts. The interrogation method, which prompts students to read sentences from the text and answer, "Why is this true?" has been developed to enhance students' ability to read science texts. To enact this method, instructors must choose sentences that are both important conceptually and deeply interrogatable. We explored the use of this method in an introductory physics course for non-physics majors. The teaching assistants (pre-service teachers), learning assistants (undergraduates), and the course instructor chose sentences for each chapter of the text, and the students were asked to interrogate two to four of the sentences in each chapter. We analyzed the conceptual importance of the sentences and their interrogatability, based on underlying epistemologies. We then interviewed the course instructor to determine how he chose the interrogatable sentences. Based on analysis of the chosen sentences and interview responses, we developed a model for choosing productive sentences to interrogate.

*Sponsor: Eugenia Etkina

GB09: 2:50-3 p.m. Modeling Consensus: Understanding How Undergraduate Freshmen Define

Contributed – Gina M. Quan, University of California, Berkeley, Berkeley, CA 94720; ginaquan@berkeley.edu

Angela Little, University of California, Berkeley

In this talk I will analyze how students in a constructive whole-class discussion come to consensus around defining "physics model." This discussion occurred as part of an elective freshman course at the University of California, Berkeley which is taught as part of The Compass Project, a program that supports physical science students. The course had students explore physics models through open-ended research questions around the ray model of light. On the first day of class, students argued around and unpacked important components of physics models in order to define physics models broadly. I will identify and characterize the "consensus building moves" which are statements that participants made in the course of the conversation. Using this coding scheme, I will look for patterns in student argumentation. Finally, I will discuss resonances between ideas that came up in the student discussion and within interviews with physics faculty.

Session GC: Technologies

Location: Sheraton - Ben Franklin Ballroom III
Date: Wednesday, August 1
Time: 1:30–2:40 p.m.

Presider: TBA

GC01: 1:30-1:40 p.m. A Computerized Testing System that Shows Students' Work

Contributed – Michael R. Meyer, Michigan Technological University, Houghton, MI 49931; mrmeyer@mtu.edu

This spring semester I implemented a process for computerized examinations in my introductory physics course. Goals included a more secure and valid testing environment, the ability to give students exams at varying and flexible times, and offering students partial credit for their work with minimal grading time. I'll discuss my progress toward these goals and student reactions to and performance within the system I developed, including ways it could be adapted for use within almost any course using almost any LMS or online homework system.

GC02: 1:40-1:50 p.m. Designing and Using the Next Generation of Active Learning Classrooms

Contributed – Chris Whittaker, Dawson College, West Montreal, QC H3Z 1A4 Canada; cwhittaker@place.dawsoncollege.qc.ca

Elizabeth S. Charles, Dawson College

What might the next generation of active learning classrooms look like? What challenges and benefits might they present? What kinds of technologies and strategies work best in these environments? We report on efforts by a team of researchers and physics instructors at Dawson College who have developed a new generation of technology-rich active learning classrooms. Building on the success of projects such as SCALE-UP, these new rooms feature flexible layouts, elements of universal design, specialized tables that accentuate group work, and most importantly, networked multi-touch interactive white-boards (SMART Boards) for each student group (six students). We will present details of our classroom designs along with some thoughts, experiences and best practices in using these state-of-the-art learning environments and we will outline ongoing research efforts to evaluate them.

GC03: 1:50-2 p.m. Java Applets for Undergraduate Physics Teaching

Contributed – Ramalingam Periasamy, American University of Nigeria, Yola, Ad PMB2250 Nigeria; periasamy.ramalingam@aun.edu.ng

Teaching and the learning is a process of dynamic equilibrium between the instructor and the students, i.e. there is no perfect lecture but with open communications between the students and teacher one can strive to optimize the transfer and retention of physics concepts. Mostly the students lack fundamental mathematics and underprepared or students who pursue the course for the required credit. By conventional methods of teaching undergraduate physics, an instructor will only be able to reach a select group of students in the class. In order to engage the entire set of students for the full length of the lecture and also to keep them motivated, we have tried to adopt a selection of different pedagogical methods such as multimedia, etc. Using commercially available and off-the shelf demonstration equipment has been expensive and time-consuming and moreover ineffective. Herein we intuit students to use available open-source software to design java applets. These along with others available have been used and were evaluated for their effectiveness in our lectures. A model lesson plan for Faraday's law will be exhibited.

GC04: 2-2:10 p.m. PC Tablets and Lecture Clips

Contributed – Harold T. Stokes, Brigham Young University, Provo, UT 84602; stokesh@byu.edu

The PC tablet is a fully functional laptop that has a touch screen, so that a stylus functions like a mouse. This allows us to write on slides in a presentation during class. After class, we use screen-capture software on the tablet to make short videos where we repeat some of the points from class as well as repeat clicker quizzes given during class.

GC05: 2:10-2:20 p.m. Preparation of Screen Casts

Contributed – Paul G. Hewitt, City College of San Francisco, 50 Phelan Ave., San Francisco, CA 94112; Pghewitt@aol.com

Tutoring students is nicely achieved with screen casts. I will show and discuss my most recent screen casts.

GC06: 2:20-2:30 p.m. Using PC Tablets to Record Homework Solutions

Contributed – R. Steven Turley, Brigham Young University, Provo, UT 84604; turley@byu.edu

Screencasts of homework solutions have the advantages of showing students a narrated problem solution process as well as steps to get a correct answer. In particular, they can be used to demonstrate to students how to use tools such as Mathematica and web resources in conjunction with written text and online homework forms. Students appreciate the ability to replay and pause solutions on their own time and to have both audio and visual clues on how to solve problems. With practice, it takes about the same amount of time to publish a screencast solution as a written one. I will give some examples and an assessment of how such a system was used for homework solutions in a modern physics and honors physics of the human body course.

GC07: 2:30-2:40 p.m. Video Is the New Writing: Are You Literate?

Contributed – Matthew T. Vonk, University of Wisconsin-River Falls, 410 South Third St., River Falls, WI 54022; matthew.vonk@uwrf.edu

There is or will soon be a video analog for virtually every genre of writing that exists. There are video obituaries, resumes, novels, instruction manuals, and highway billboards. Even quirky and idiosyncratic genres of writing like recipes and post-it notes are finding their video analogs. Video is everywhere, except in many college classrooms, where most of my colleagues are still requiring only written work. This year in my electronics class I'm trying something new. I've lessened the emphasis on written work, am requiring my students to make short videos about the theoretical and practical aspects of the circuits that they've made. So far I'm really pleased with the results. I have found my students take more ownership, spend more time to get it right, and are more creative with video than they were before I used video.

Session GD: Great Teachers

Location: Sheraton - Ben Franklin Ballroom IV
Sponsor: Committee on History and Philosophy in Physics
Date: Wednesday, August 1
Time: 1:30–1:50 p.m.

Presider: Thomas B. Greenslade, Jr.

GD01: 1:30-1:40 p.m. Franklin Miller at One Hundred

Contributed – Thomas B. Greenslade, Jr., Kenyon College, Gambier, OH 43022; greenslade@kenyon.edu

Franklin Miller, the winner of the 1970 Millikan Award for his development of the Single Concept Film, will turn 100 in September. Many of us have used his physics text, *College Physics*, which went into six editions. I will tell some Miller stories, ranging from his work in saving the original Tacoma Narrows film to his work with the Society for Social Responsibility in Science.

GD02: 1:40-1:50 p.m. Henry H. Barschall: A Teacher to Remember

Contributed – Charles H. Holbrow, Colgate University/MIT, Cambridge, MA 02139; cholbrow@colgate.edu

Heinz Barschall was a physics professor at the University of Wisconsin-Madison from 1946 to 1986. Internationally known and respected for his research with fast neutrons, he was as serious about his teaching as he was about his research. He was my lab instructor in beginning physics; taught me undergraduate modern physics; and supervised my PhD work. He taught me—as he taught all his graduate students—to have high standards, high expectations, and low tolerance for stupidity. German by birth and upbringing, he taught me to write simple, lucid English; he did this by example and by insistence. Some stories will show how Barschall's austere rationality, unemotional but penetrating criticism, and lifelong interest in the careers of his former students made him a teacher with a lasting impact on their careers and characters. He was a distinguished teacher of a kind not in style today.

Session GE: The Third Eye

Location: Sheraton - Ben Franklin Ballroom V
Sponsor: Committee on Apparatus
Co-Sponsor: Committee on International Physics Education
Date: Wednesday, August 1
Time: 1:30–3 p.m.

Presider: Tetyana Antimirova

GE01: 1:30-3 p.m. Promoting Inquiry-based Teaching by Thought-Provoking Activities: The Third Eye's Perspectives

Invited – Xingkai LUO, Guangxi Normal University, No. 15, Yucai Road Guilin, Guangxi 541004, China; xingkailuo@vip.163.com

Weigang LIANG, Guangxi Normal University

Ruoping TIAN, Rise-China Academy of Sci. Edu. Guilin

Janchai Yingprayoon, Suan Sunandha RUIC & Rise-China Academy of Sci. Edu. Guilin

Zengxin HUANG, Xiangming High School of Shanghai

At the 2000 AAPT Summer Meeting, a Chinese physics teachers and educators group, named "The Third Eye" presented a special show, The "Third Eye" Demonstration Show. The show attracted the audience not only with memorable and thought-provoking physics demonstrations but also a very interesting philosophy embodied in each presentation (S. Mellema, *Phy. Edu.*, Vol. **35**, P.375). Now they return to this meeting with more innovations developed in the past 12 years. Their informative, unique and entertaining demonstration show should be again one of the highlights of the meeting.

Session GF: PER: Student Reasoning II

Location: Houston Hall - Class of 49
Date: Wednesday, August 1
Time: 1:30–3 p.m.

Presider: Brian Frank

GF01: 1:30-1:40 p.m. Research on Coherence Seeking Across Disciplinary Boundaries*

Contributed – Chandra Turpen, University of Maryland, College Park, MD 20742; Chandra.Turpen@colorado.edu

Benjamin W. Dreyfus, Benjamin Geller, Vashti Sawtelle, Edward F. Redish, Department of Physics, University of Maryland, College Park

We analyze coherence-seeking in on-going student activity from a video-recorded discussion section. Here, students engage in a task designed to build connections between physics and biology. We present evidence of students 1) spontaneously bringing in unanticipated outside knowledge into their reasoning in this physics course and 2) seeking connections between the course material and other things they know. Throughout this process, we examine both implicit and explicit indexing of the disciplines throughout the reasoning episode to show that often these connections span disciplinary boundaries. Independent of whether reconciliation is achieved, we see coherence-seeking reasoning practices that students are engaged in as essential to scientific practice and as such we claim that those practices should be a focus of our assessment efforts.

*Supported by the NSF Graduate Research Fellowship (DGE 0750616), NSF-TUES DUE 11-22818, and the HHMI NEXUS grant.

GF02: 1:40-1:50 p.m. An Examination of Expert/Novice Positional Identities in the Disciplines *

Contributed – Vashti Sawtelle, University of Maryland, College Park, MD 20742; vashti.sawtelle@gmail.com

Chandra Turpen, Edward F. Redish, Department of Physics, University of Maryland, College Park

We present a qualitative analysis of a group of students working through a task designed to build connections between biology, chemistry, and physics. During the discussion, members of the group explicitly index some of the ideas being presented as coming from "chemistry" and from "physics." While there is evidence that students seek coherence between outside knowledge and in-class knowledge, there is little evidence of reasoning with one another's ideas, resulting in a lack of reconciliation. In this talk we present evidence that the difficulty students face in trying to reconcile each other's ideas can be understood through a positional identity lens. We examine how students position themselves and each other as experts and novices in the disciplines. We argue that this disciplinary positioning contributes to the lack of the reconciliation of ideas for these students.

*Supported by the NSF Graduate Research Fellowship (DGE 0750616), NSF-TUES DUE 11-22818, and the HHMI NEXUS grant.

GF03: 1:50-2 p.m. Coupling Epistemology and Identity in Explaining Student Interest in Science

Contributed – Jennifer Richards, University of Maryland, College Park, MD 20742; jrich@umd.edu*

Luke D. Conlin, Tufts University

Ayush Gupta, Andrew Elby, University of Maryland, College Park

A critical goal in science education is to encourage minority students' continued interest and engagement in science. [1-2] Here, we provide a case study of an eighth-grade student from Honduras,"Estevan," who first caught our attention in class for his dogged pursuit of trying to figure out how seasons occur on Earth. We draw on interview and classroom data to demonstrate that what engages Estevan lies at the intersection of epistemology and identity. Specifically, his epistemological stance toward science as figuring things out for oneself taps into his personal love of challenges, and this love of challenges is tied strongly to his sense of self. We make the case for conceptualizing personal epistemology as deeply intertwined with aspects of identity, at least for some students, and we draw the implications of this perspective for classroom practice.

*Sponsor: Andrew Elby

1. Bang & Medin, *Sci. Ed*., Vol. 98. (2010).

2. Basu & Calabrese Barton *J. Res. Sci. Teach.*, Vol. **44** (3) (2007).

GF04: 2-2:10 p.m. Coupling Identity and Epistemology to Explain Differences in Learning Experiences

Contributed – Ayush Gupta, University of Maryland, College Park, MD 20742; ayush@umd.edu

Andrew Elby, University of Maryland, College Park

Students' personal epistemology—their notions about the nature of knowledge and learning—affect how they approach learning.[1] These personal epistemologies have usually been conceptualized as originating in students' past experiences and recruited in particular learning contexts.[2] Drawing on a case study based on a clinical interview with an electrical engineering major ("Rebecca") in an introductory physics class, we argue that in some instances, students' projected sense of their future profession—an aspect of their developing disciplinary identities—influences their approaches towards learning. Specifically, Rebecca positions herself as an electrical engineer and draws a distinction between her introductory mechanics course, which she sees as irrelevant to her future, and courses on digital logic and introductory electromagnetism, which she sees as relevant. She sees mechanics as less coherent than digital logic. She structures her learning in the two courses differently and reflects on how she draws on more rote-learning in physics, but deep sense-making in digital logic design.

1. D. Hammer, "Two approaches to learning physics," *Phys. Teach.* **27**(9), 664-670 (1989).

2. D. Hammer, & A. Elby, On the Form of a Personal Epistmology (2002).

*This work is sponsored, in part, by NSF EEC-0835880 and NSF MSP-0831970

GF05: 2:10-2:20 p.m. Entangled Identity and Epistemology Meet Electromagnetism: The Case of Michael

Contributed – Andrew Elby, University of Maryland, College Park, MD 20742-1115; elby@umd.edu

Brian Danielak, Ayush Gupta, University of Maryland, College Park

In this contribution to our series of talks about how a student's epistemology (views about what counts as knowledge and learning) can be entangled with his sense of who he is, we discuss how "Michael" approached an apparent paradox he encountered near the beginning of his intermediate-level electromagnetism class. Michael wondered if current is defined as moving charge and the ideal conductor is by definition neutral, how could one calculate the current through it? This question is thornier than it first appears. We will show how Michael's identity as a sense-maker, an identity defined in part by its oppositional relation to many aspects of Michael's engineering program, influences how he approaches this problem, and how his approach reinforces his identity.

GF06: 2:20-2:30 p.m. Teaching Assistant Interventions that Produce Sense Making Activities

Contributed – Paul W. Irving, Kansas State University, Manhattan, KS 66506-2600; paul.w.irving@gmail.com

Eleanor C. Sayre, Kansas State University

A recent area of investigation that has developed in the STEM community is students' sense making and answer making activities in collaborative problem-solving learning environments. In these learning environments, sense making manifests as discussions which are aimed at ascertaining "what is going on" in the problem. Conversely, answer making manifests as a discussion that is aimed toward procedures with the intended goal to find out "what to do." Collaborative problem solving environments typically employ TAs to lead the discussion and encourage students to work together to develop an understanding of the concepts being probed in the problems. In this talk, we examine TA interventions which result in tipping students into sense making activities.

GF07: 2:30-2:40 p.m. Application of Bloom's Taxonomy to Introductory College-Level Physics Courses

Contributed – Nathaniel C. Grosz, North Dakota State University, Department of Chemistry & Biochemistry, Fargo, ND 58108-6050; Nathaniel.C.Grosz@my.ndsu.edu*

Erika Offerdahl, Mila Kryjevskaia North Dakota State University

A team of discipline-based educational researchers at North Dakota State University has been using Bloom's taxonomy as a basis for characterizing the cognitive levels required by students (1) to learn subject matter in college-level science courses and (2) to demonstrate acquired knowledge and skills on exams. Exam problems were used as a data source for both categories. Correlation between student performance and cognitive level was measured. To gain a deeper understanding of student learning, exam problems were further categorized according to the number of reasoning steps required to arrive to an answer; the level of abstraction represented in the problem; and whether or not a solution hinges on visualization and/or spatial reasoning skills. Results relevant to students' learning in introductory physics courses will be presented.

*Sponsor: Mila Kryjevskaia

GF08: 2:40-2:50 p.m. Student Justifications of Correct Responses to Commonly Used PER Tasks

Contributed - Jeffrey M. Hawkins, The University of Maine, Orono, ME 04469; jeffrey.hawkins@maine.edu

Brian W. Frank, Middle Tennessee State University

Michael C. Wittmann, John R. Thompson, The University of Maine

When presented with the correct answer to a commonly used PER question and asked to justify it, students have diverse ways of responding. Surprisingly, many students reject the given answer and do not attempt to explain why it is correct. Other students appear to not accept the answer as correct, but still attempt to justify the answer by reinterpreting the problem or applying a strategy to determine the expected reasoning. This range of unexpected responses provides information about students' knowledge, cognitive processes, and epistemologies. We discuss examples of these responses from interviews and pre-tests where students were asked both canonical tasks and tasks where they were given the correct answer. Our results have implications for research, curriculum design, and instruction.

GF09: 2:50-3 p.m. Differentiated Instruction: An Exploration with Simple DC Circuits

Contributed – Thomas M. Scaife, University of Wisconsin-Platteville, Platteville, WI 53818; scaifet@uwplatt.edu

Andrew F. Heckler, The Ohio State University

Following a lecture-driven introduction to DC circuits, students frequently responded to features about resistors when asked to compare the power dissipation between two circuits -- while ignoring relevant features about the voltage or current sources. Over a series of questions, individual students answered in different manners, with some consistently answering in favor of one particular feature (e.g., the circuit with a greater number of resistors will always dissipate more power). Among 150 students, several such responses were identified. In an attempt to mediate these individual differences and align student performance with the intended outcome of instruction, some students completed additional practice problems that were meant to address a particular response, while others received more generic practice with a wide variety of power-comparison questions.

Session GG: Dollar Store Labs

Location: Sheraton - William Penn Suite
Sponsor: Committee on Physics in Pre-High School Education
Date: Wednesday, August 1
Time: 1:30–3 p.m.

Presider: Vivian O'Brien

GG01: 1:30-2 p.m. Newton on the Cheap

Invited – Gene L. Easter, Brushfire Science Consultants, 540 S. Ridgecliff St., Tallmadge, OH 44278; GLEaster@sbcglobal.net

Lisa Borgerding, Donnelly Kent State University

A guide to teaching Newton's three laws of motion using the cheap and the familiar—with flair. Learn to "teach the laws for less" and leave with effective and captivating activities, interactive demos, labs, and assessment activities. All activities are drawn from Kent State University's Operation Physics, a program for in-service middle school teachers, now in its 29th year. The program includes: How to uncover students' prior knowledge of forces and motion, Using interactive demonstrations and labs that develop the concepts of force and acceleration with bridging techniques (Clement, 1993); Use of fan carts to develop Newton's laws, such as dueling fan carts and fan cart with sail (Morse, 1993); Assessment activities such as interactive demonstrations, lab practicum, and a "performance assessment" by way of a play—*Newton's Laws of Motion* in three acts.

References: J. Clement, "Using bridging analogies and anchoring intuitions to deal with students' preconceptions in physics," *J. of Research in Sci. Teaching* **30**(10),1241-1257 (1993).
Robert. A. Morse, "Constant acceleration: Experiments with a fan-driven dynamics cart," *Phys. Teach.* **31**(6), 347 (1993).

GG02: 2-2:30 p.m. Cheap Physics at the Dollar Store

Invited – Courtney W. Willis, University of Northern Colorado, Greeley, CO 80631; courtney.willis@unco.edu

A century ago C. Riborg Mann talked about the need to engage students with real physics in his book titled *The Teaching of Physics*.[1] Today, we have the "Dollar Store Phenomena" which has become quite popular considering the economic times and offers the opportunity to investigate real physics in action (at inexpensive prices.) From using inexpensive toys to demonstrate such fundamental concepts as force and energy, to foods for the discussion of temperature and heat, to housewares for talks about relationships of pressure and density, the dollar store represents a unique opportunity to study physics. In this paper we will try to demonstrate a number of these activities in an interactive manner.

1. C. Mann, C. Riborg, *The Teaching of Physics for the Purposes of General Education*, New York, The Macmillan Company (1912).

GG03: 2:30-3 p.m. Dollar Store Labs

Invited – Daryl Taylor, Greenwich High School, Naugatuck, CT 06770; DT@DTFizzix.com

Through the use of simple household items — toys, tools, food, you name it—investigate how to get conceptual results without all the expensive proverbial "bells and whistles." Twenty simple demonstrations of various physics topics will be rapid-fired your way along with some group participation. Each demonstration can be easily turned into an entire lab activity. Entirely too much fun to pass up.

Session GH: PER: Teacher Preparation and Development

Location: CCH - Claudia Cohen Terrace
Date: Wednesday, August 1
Time: 1:30–2:40 p.m.

Presider: Hunter Close

GH01: 1:30-1:40 p.m. Preliminary Investigations of Physical Science Teacher Content Knowledge and PCK*

Contributed – Daniel P. Laverty, University of Maine, Orono, ME 04469; daniel.laverty@maine.edu

MacKenzie R. Stetzer, John R. Thompson, University of Maine

There is ongoing discussion of the extent to which specific strands of teacher professional development influence student learning. We describe research efforts exploring the roles of teacher content knowledge and pedagogical content knowledge, particularly teacher knowledge of student ideas (KSI), in the context of the Maine Physical Sciences Partnership (MainePSP). The primary focus of the MainePSP is the professional development of physical science instructors in grades 6-9 via curriculum renewal using common instructional resources across multiple school districts. This particular study looks to assess teacher content knowledge and KSI in order to explore their respective effects on student learning in specific contexts, including density and mechanics. We will describe our methods, present preliminary results, and outline recommendations for further investigation.

*This work is partially supported by NSF grant DUE 0962805.

GH02: 1:40-1:50 p.m. Students' Prediction of Their Exam Performance: Comparison of Two Cohorts

Contributed – N. Sanjay Rebello, Kansas State University, Manhattan, KS 66506-2601; srebello@ksu.edu

At the 2011 Summer AAPT Meeting we reported on the accuracy of students' estimation of their exam score. That study, which was completed with second semester calculus-based students, seemed to suggest that students typically overestimated their exam score. We further found that low scoring students tended to have larger overestimates than high scoring students. We report here on a follow-up study completed with a different population of physics students—future elementary teachers. We asked these students to predict their score before taking the exam and estimate their score after taking the exam. Further, we also asked students to predict and estimate the class mean as well as provide brief explanations of how they arrived at their predictions or estimates in each case. We report on the results of the follow-up study and where relevant compare these with the results of the previous study.

GH03: 1:50-2 p.m. TA Training for Collaborative, Group-Problem-Solving Sections

Contributed – Chaya Nanavati, Stanford University, Stanford, CA 94305; nanavati@stanford.edu

Building on the work of the Physics Education Research community, we have implemented pedagogical changes in the way the introductory physics sequences are taught at Stanford. Instead of the previous instructor-centered approach, we use student-centered, active-learning strategies in discussion sections and laboratories. The change in section style has necessitated a change in our TA training programs. We will compare different TA training approaches that we have used with varying levels of success. These include practicum versus theory-based sessions and day-long boot camps versus weekly training seminars. We will discuss what has worked and not worked with these programs based on feedback from the TAs-in-training and from student feedback once the TAs-in-training became TAs.

GH04: 2-2:10 p.m. Comparing Written and Video Data of Learners' Understanding of Energy

Contributed – Beth A. Lindsey, Penn State Greater Allegheny, McKeesport, PA 15132; bal23@psu.edu

Rachel E. Scherr, Seattle Pacific University

Simple phenomena, such as lifting and lowering a ball vertically a few feet, can offer tremendous insight into learner thinking about energy transfers and transformations. The insights gained depend on the data collected. The first and second authors collaborated to compare undergraduates' written responses to questions on energy in lifting/lowering scenarios to secondary teachers' videotaped discussions of similar questions in professional development courses. Our comparison of these data sets is not a controlled study; the representations in the two data sets are different, the populations are different, and in general comparing written work to video is rather like comparing a tropical jungle to a backyard garden. That said, our findings illuminate the different opportunities presented by our two research modalities.

GH05: 2:10-2:20 p.m. Developing a Conceptual Model for Both Entropy and Energy*

Contributed – Abigail R. Daane, Seattle Pacific University, West Seattle, WA 98119; abigail.daane@gmail.com

Stamatis Vokos, Rachel E. Scherr, Seattle Pacific University

Entropy is typically not a central focus either in introductory university physics textbooks or in national standards for secondary education. However, entropy is a key part of a strong conceptual model of energy, especially for connecting energy conservation to energy degradation and the irreversibility of processes. We are developing a conceptual model of entropy and the second law of thermodynamics as they relate to energy, with the goal of creating models and representations that link energy and entropy in a meaningful way for learners analyzing real-life energy scenarios. We expect this model to help learners better understand how their everyday experiences relate to formal physics analyses. Our goal is to develop tools for use with elementary and secondary teachers and secondary and university students.

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

GH06: 2:20-2:30 p.m. Examining Student Ability to Relate Energy Concepts and Real-World Observations*

Contributed – Brian M. Stephanik, University of Washington, Seattle, WA 98195-1560; bsteph@uw.edu

Peter S. Shaffer, Lillian C. McDermott University of Washington

The concept of energy is becoming an increasingly important topic in the K-12 curriculum. We are in the process of developing a Physics by Inquiry[1] module on energy that is designed to help teachers deepen their understanding of this abstract concept. The curriculum emphasizes how experimental results can motivate the construction of a scientific model for energy. It also provides teachers with direct experience in inquiry-based learning that can be used as a guide for teaching through a process of inquiry in their own classrooms. We discuss results from our preliminary investigation that illustrate the extent to which teachers and students are able to relate energy concepts to real-world observations.

*This work has been supported in part by the National Science Foundation.

1. L.C. McDermott and the Physics Education Group at the University of Washington, *Physics by Inquiry,* Wiley (1996).

GH07: 2:30-2:40 p.m. Validating a Survey of Students' and Teachers' Understanding of Energy

Contributed – Levi Lucy, University of Maine, Orono, ME 04469-5709; Levi_Lucy@umit.maine.edu*

Michael C. Wittmann, University of Maine

In the Maine Physical Sciences Partnership, we are studying middle school teachers' knowledge of their students' thinking about energy. Building a survey from scratch might require extensive original research, but a bank of questions at the appropriate grade-level exists online at the AAAS assessment website (http://assessment.aaas.org/). The website provides both questions and student data of common incorrect answers. We chose from these questions to design a written survey given to both students and teachers. Teachers were asked to answer the questions on their own and also to predict how their students might most commonly answer. We used one-on-one interviews with both students and teachers to validate the original survey. We present data on teacher content knowledge as well as teacher knowledge of student ideas. We observed a ceiling effect for teachers on content understanding, suggesting the survey is too easy. We also found good examples of predictions of student thinking.

*Sponsor: Michael C. Wittmann

Session GI: Physics for All

Location: Irvine Auditorium - Amado Recital Hall
Sponsor: Committee on Physics in Two-Year Colleges
Date: Wednesday, August 1
Time: 1:30–3 p.m.

Presider: Greg Mulder

This session focuses on the diversity of individuals in the physics classroom and the techniques used to engage the wide range of students we encounter.

GI01: 1:30-2 p.m. Physics in Two-Year Colleges: A Closer Look

Invited – Susan White, American Institute of Physics, College Park, MD 20740; swhite@aip.org

As of this submission (late March 2012), the 2012 Survey of Physics in Two-Year Colleges is well under way. In this session, we will present preliminary results looking at physics offerings in two-year colleges. We will examine the results in light of earlier results. Furthermore, from our surveys of physics bachelor's degree recipients, we know that there are differences between physics majors who began their post-secondary education at two-year colleges and those who did not. Please join us as we take a closer look at physics in two-year colleges.

GI02: 2-2:10 p.m. Broadening of University Student Physics Education through Informal Science

Contributed – Kathleen A. Hinko, University of Colorado, Boulder, CO 80304; kathleen.hinko@colorado.edu

Noah Finkelstein, University of Colorado, Boulder

Through the Partnerships for Informal Science Education in the Community (PISEC) program at the University of Colorado, Boulder, many undergraduate and graduate physics students choose to participate in an informal science after-school program, where they coach elementary and middle school students in inquiry-based science activities. Recently, the program has expanded to include university students staging a large-scale science demonstration show. We present findings that indicate these informal experiences improve the communication skills of the university student as well as positively influence their self-efficacy as both scientists and scientific communicators. We also present a model of integrating these activities into the institutional structures of the university system, informal community-based programs, and schools.

GI03: 2:10-2:20 p.m. Making Kinematics a Dynamic Vehicle for Launching Students into Physics*

Contributed – Frederick J. Thomas, Learning with Math Machines, 1014 Merrywood Dr., Englewood, OH 45322; fred.thomas@mathmachines.net

Many students (and some faculty) consider kinematics among the least interesting and least valuable parts of physics. Too often, the topic also serves to intimidate and frighten those students who have been struggling with mathematics. The NSF-funded project, "Math Machines and Algebraic Thinking," has developed hardware and software that empowers students to create, test, compare, and modify free-form mathematical functions that CONTROL motion, rather than simply describing it. Based on a hobby servo motor with 0.1 degree precision, the system lets students control the motion of a laser dot across the front of a classroom whiteboard or a small laboratory screen, the motion of a block of wood as it creates scale-model earthquakes, the motion of gears as they drive other objects, and more. The system's role in motivation, pedagogy, and assessment will be discussed along with opportunities for collaboration.

*Supported in part by NSF's Advanced Technological Education Program through grant DUE-1003381. More information is available at www.mathmachines.net.

GI04: 2:20-2:30 p.m. Excellence in Student Attention from Excellence in Teacher Attention to Detail

Contributed – Saami J. Shaibani, Instruction Methods, Academics & Advanced Scholarship (IMAAS), Lynchburg, VA 24506; shaibani@imaas.org

A lot of students are into sports; but, physics, not so much. Even when the many standard applications of physics to athletic endeavor are presented, there can be a sense that these are contrived and/or limited by too much approximation. The path to success has been found to lie in relevance and accuracy, no more so than when examining one particular play[1] whose broadcast and sensation were remarkable.[2] A simplistic appraisal of this event merely repeats the overly generic approach seen elsewhere far too often; instead, a detailed analysis to describe that athlete in that circumstance provides a level of specificity and engages student interest at a deep level. The high quality of the results reinforces the benefit of eschewing the prevalent one-size-fits-all mindset in favor of adopting the correct methodology. Multiple extensions to other sports increase the enjoyment of the students, which is exceeded only by their learning.

1. Touchdown run after catch (at 02:46 in the second quarter of a regular-season NFL game on Dec. 24, 2011) by Cincinnati Bengals wide receiver, Jerome Simpson (89), who executed a front flip over Arizona Cardinals linebacker Daryl Washington (58) into the end zone after receiving a pass from quarterback Andy Dalton (14)
2. More than 1 million views on a popular video-sharing website within less than 24 hours of when the play took place

GI05: 2:30-2:40 p.m. Continuing the Learning During the Assessment Stage

Contributed – Maureen L. Hintz, Utah Valley University and Brigham Young University, Provo, UT 84604 hintzma@uvu.edu

I have implemented the "Check Your Neighbor" learning activity concept into my conceptual physics course. In addition to having such questions throughout all lecture periods, they have become part of the assessment process where one third of an exam's questions are done with one's neighbors. This permits me to ask questions that may be considered more challenging during this portion of the tests, forces students to defend their answers by vocalizing their reasoning to others, and, as necessary, helps correct understanding of concepts. After getting their exams back, the students continue the learning process by earning partial points back by correcting wrong answers following a prescribed process. I will give details of all the strategies and their influence on a student's grade.

GI06: 2:40-2:50 p.m. A Body Falling Through the Earth: Newton Versus Hooke

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

Christopher M. Graney, Jefferson Community & Technical College

In a 1679 letter to Robert Hooke, Isaac Newton suggested an experiment to detect Earth's rotation. The experiment consisted of dropping an object from a great height and looking for a small eastward deflection (as first predicted by G. B. Riccioli in 1651). Newton included with his letter a diagram of the path the object would take if it were allowed to pass through the Earth. Newton's diagram was criticized by Hooke (and more recent commentators) because his path ends at the center of Earth. Hooke instead argued that the path should be an ellipse with the Earth's center at one focus. We have developed two open-source computer simulations that illustrate the path of a falling object in both an inertial frame and the frame of the rotating Earth, using various models for the gravitational and resistive forces inside the Earth. We show that Newton's sketch accurately depicts the motion of the object in the rotating frame if one assumes a uniform distribution of mass and a linear resistive force within the Earth. This can be viewed as a more accurate depiction than Hooke's diagram, which fits a point mass model with no resistance seen in the inertial frame. The computer simulations, which are suitable for use in the undergraduate classroom, help to emphasize the role of unstated assumptions in scientific arguments.

Session GK: Middle and High School Teaching

Location: Sheraton - Ben Franklin Ballroom IV
Date: Wednesday, August 1
Time: 2–3 p.m.

Presider: Kathleen Falconer

GK01: 2-2:10 p.m. Acoustics Materials: Activity Kit for Teachers

Contributed – Wendy K. Adams, Acoustical Society of America, Greeley, CO 80631; wendy.adams@colorado.edu

The Acoustical Society of America (ASA) has recently been focusing effort on K-14 outreach through a partnership with the Optical Society of America and the American Association of Physics Teachers/Physics Teaching Resource Agents. This year ASA has created a free activity kit for teachers that includes hands on equipment for a classroom of 30 and ~30 lesson plans. The material addresses the science of sound and touches on most of the areas of study and practice within acoustics. A brief overview of the development will be provided, including details on the testing and an expert review that has been completed for these resources.

GK02: 2:10-2:20 p.m. Implementing a Regional Radiation "Loan Pool"

Contributed – Craig C. Wiegert, University of Georgia, Athens, GA 30602-2451; wiegert@physast.uga.edu

Chad Fertig, University of Georgia

Becky Bundy, Madison County School District

Kevin McReynolds, Barrow County School District

Dale Autry, Athens-Clarke County School District

The University of Georgia's physics learning community (a group of university and high school faculty) recently purchased a set of portable radiation-measuring devices, to be loaned out to area high school physics and chemistry classrooms. We report on our first year of working with the radiation "loan pool," in particular on developing interesting activities to teach students about radioactive decay, sources of environmental radiation, and even basic probability and statistics. We also discuss our long-term goal of collecting and organizing radiation datasets from participating area schools. This repository of regional radiation measurements from a variety of environments will serve as an additional teaching resource, and will in effect allow the students to experience being part of a distributed scientific collaboration.

GK03: 2:20-2:30 p.m. Science Learning Through Parental Involvement

Contributed – Gabriela Aguirre, Socorro Independent School District, El Paso, TX 79927; gaguir07@sisd.net

Sergio Flores, University of Texas at El Paso

It is well known that when students have to elaborate on an excellent science project to participate in the School Science fair and continue until the final competition, they face with a lot of questions to make and present it with confidence in which parents sometimes can't help their children at home. Our intent in this issue is to present the importance to work together, parents and students to perform an excellent science project. Science project training for parents is ideal learning for this purpose. In a combo (elementary and middle) school that has a total of 758 students enrolled, just 29 parents and students from different grade levels came to participate in the science learning through parental involvement. The result of this training was that parents were amazing about the science project their children had to do by themselves, about the students they felt more confident to ask their parents about their homework and they were more successful with the science project presentation in the School Science fair. Moreover, three of the students and parents we trained were finalists on the school science fair project being placed to participate on the District Science fair project and obtaining one of these three students to pass to the Sun Country Regional Science Fair. It proves that when parents are involved in their children's education, the student succeeds (Epstein 1996). Finally we are discussing the study to have more students in the first places and engage more parents and students to participate in this beneficial training.

GK04: 2:30-2:40 p.m. Physics First Implementation Action Research

Contributed – Timothy Burgess, McGill-Toolen Catholic High School, Mobile, AL 36606; Tim.Burgess@comcast.net

A high school changed its science sequence to a "Physics First" sequence (physics-chemistry-biology) from a more traditional sequence (integrated science-biology-chemistry). Small studies done over the transition years reveal interesting results. A significant drop in unit test scores were observed during the last three units of the year among seniors (compared with freshmen). Data indicate that freshmen appear to learn more physics than seniors in the same introductory physics course. Sophomores in chemistry (with previous physics) scored higher than juniors (with no previous physics) on the same chemistry final exam items (agreed to by both teachers). Surprisingly juniors from the new sequence showed similar performance on the Advanced Placement Biology Exam as seniors who had more than twice the academic units in biology. Standardized scores (ACT) appear to have been impacted. There has been a significant increase in Advanced Placement Science enrollment but, surprisingly, AP Physics enrollment was not greatly impacted.

GK05: 2:40-2:50 p.m. Physicist/Theorist as a High School Teacher

Contributed – Mikhail Tyntarev, Liceum 239, Kirochnaya 8A St., Petersburg, 190000 Russia; tynt@mail.ru

The special course "Practical theoretical physics" was developed and succesfully approved in our liceum for those pupils who desire to become physicists. The main idea of the course is to show how real physicists work, how the problems given by nature are different with (and more interesting than!) those from the school book. We used very simple examples to illustrate the mathematical methods (for example, mathematical pendulum, nonlinear, of course) and always made experiments to compare results. We especially explained approximative methods in order to make pupils sure that they can solve any problem with more or less precision if they understand the physical meaning.

Session GL: Advanced Physics Topics/ Post Deadline

Location: Houston Hall - Golkin
Date: Wednesday, August 1
Time: 1:30–2:20 p.m.

Presider: Gay Stewart

GL01: 1:30-1:40 p.m. Photon Momentum Principles of Refraction Through a Uniformly Moving Medium

Contributed – J. Ronald Galli, Weber State University, Ogden, UT 84408-2508; jrgalli@weber.edu

Farhang Amiri, Weber State University

The bending of light as it passes from one medium to another and undergoes a speed change is well established. Not so well established or understood is the change in photon momentum and the role that momentum plays in the refraction process. In particular, it is uncertain whether the momentum of a photon increases (P=nPo) or decreases (P=Po/n), as a photon of momentum Po passes from a vacuum to a medium of refraction index n. We propose that the magnitude of the photon momentum is directly proportional to the index of refraction and is given by P=nPo. We further propose that upon refraction, the photons undergo a momentum change such that the momentum change vector is perpendicular to the refracting surface. We justify these two assumptions and show how they can be used as principles to derive the relationships for refraction for media moving at any uniform speed.

*Website: physics.weber.edu\galli

GL02: 1:40-1:50 p.m. Analysis of World Record Sprint Performance to Determine Effects Due to Wind

Contributed – Blane Baker, William Jewell College, Liberty, MO 64068; bakerb@william.jewell.edu

The women's world record for the 100 m dash is currently 10.49 seconds. This mark was set in 1988 on a day in which the wind speed near the track was recorded at 0.0 m/s. More recent studies of the wind that day indicate possible wind speeds as high as 5.0-7.0 m/s. The analysis presented here is a model for how wind affects sprinting events such as the 100 m dash. This model is applied to the 1988 case to determine how much the elapsed time to complete the race could have been affected by wind.

GL03: 1:50-2 p.m. Introductory Physics by Karplus: a Free, Teacher-Editable Web- and E-Book

Contributed – Fernand Brunschwig, Columbia University Teachers College, New York, NY 10025; fb2228@tc.columbia.edu

Ivo Antoniazzi, Lawrence Furnival, Columbia University Teachers College

We will demonstrate the capabilities and potential of an electronic edition of Introductory Physics: A Model Approach by Robert Karplus, based on a database that maps the existing structure of the traditionally published textbook.[1] The entire book will be available for free on the web.Teachers will be able to adapt the book to fit their objectives and to add their own material, such as problems and homework assignments. Individual teacher's "recipes" for deploying the book will be available for other teachers to use and revise. Teachers will also be able to produce a PDF or E-Book version at will using a conversion program. Finally, we will report on our plans to use contributions and feedback from teachers to improve the book, as well as the results of a survey of teachers we conducted to determine feasibility and interest.

1. Peter B. Kahn, "Book Review: *Introductory Physics: A Model Approach* by Robert Karplus," *Phys. Teach.* **42**, 561-562 (Dec, 2004).

GL04: 2-2:10 p.m. Influence of Teacher Reasoning Ability on Student Reasoning and Knowledge

Contributed – Jennifer L. Esswein, The Ohio State University, Columbus, OH 43201; esswein.5@osu.edu

Andrew W. Dougherty, Bruce R. Patton, The Ohio State University

Teachers participating in science professional development completed 120 hours or more of training consisting of inquiry-based pedagogical approaches and content knowledge. This study will relate a teacher's score on a measure of scientific reasoning ability to that of their students using hierarchical linear modeling (HLM). Influences on reasoning ability such as economic status, gender, state test scores and grade level are explored. Preliminary analysis shows a strong predictive relationship between the reasoning ability of a teacher and his/her students' reasoning abilities.

GL05: 2:10-2:20 p.m. Investigation of Instructor Effects on Gender Gap in Introductory Physics

Contributed – Kimberley Kreutzer, North Dakota State University, Newry, SC 29665 United States kreutzk@gmail.com

Andrew Boudreaux, Western Washington University

Gender differences in student learning in the introductory, calculus-based electricity and magnetism course were assessed by administering the Conceptual Survey of Electricity and Magnetism pre- and post-course. As expected, male students outgained females in traditionally taught sections as well as sections that incorporated interactive engagement (IE) techniques. In two of the IE course sections, however, the gains of female students were comparable to those of male students. Classroom observations of the course sections involved were made over an extended period. In this paper, we characterize the observed instructor-student interactions using a framework from educational psychology referred to as Wise Schooling. Results suggest that instructor practices affect differential learning, and that Wise Schooling techniques may constitute an effective strategy for promoting gender equity in the physics classroom.

GL06: 2:20-2:30 p.m. From Energy to Energy Change

Contributed – Yaron Lehavi, The David Yellin Academic College of Education, Jerusalem, 93303 Israel; Yarlehavi@gmail.com

Bat-Sheva Eylon, Weizmann Institute, Israel

Teaching the concept of Energy, a fundamental concept in any science education curricula, presents a great challenge (Goldring & Osborne, 1994; Kaper & Goedhart, 2002; Papadouris et. al. 2008). The observed difficulties may be attributed to the apparent vagueness regarding the meaning of energy, energy forms, energy transformation/conversion/transfer and energy conservation. We will describe an approach to teaching, addressing this challenge by introducing the concept of energy change as a unifying, measurable and concrete property of different kinds of natural processes (change in speed, in height, in chemical constituents etc.). Our approach, following Karplus (1981), rests on an operational definition of energy change, based on Joule's-like experiments, and the first law of thermodynamics as relating energy change of a system to different mechanisms. An appropriate "Energy language" was developed, together with teaching materials (representations, demonstrations and experiments) which were administered to 7th grade students. Preliminary findings from the pilot will be presented.

GL07: 2:30-2:40 p.m. POOLkits: Applying Object-Oriented Principles to Physics Object-Oriented Learning

Contributed – Thomas J. Kassebaum, The Ohio State University, Columbus, OH 43210; kassebaum.1@osu.edu

Gordon J Aubrecht, The Ohio State University -Marion

Object-oriented development depends upon the creation of generic pieces that can be built into more complex parts. The process of teaching of physics concepts often parallels that of object-oriented design. Capitalizing on that parallel, the techniques of object-oriented software engineering are applied to the development of physics learning modules. Each learning object consists of observable quantities, such as the physical properties of an item and operators that act on it, such as force. Additionally, each object can include an assessment operator that evaluates the impact of the learning object on student comprehension. The physics object-oriented learning kits (POOLkits) will be developed to enhance student understanding of physics concepts, as well as, build a framework for developing a software object based on the physics concept. As with software objects, POOLkits can be extended as physics knowledge expands. POOLkits may also enhance the object-oriented programming capabilities of physics students.

GL08: 2-2:10 p.m. AppleTV for Mobile Lectures and Sharing Student-made Videos

Contributed – Kenneth R. DeNisco, Harrisburg Area Community College, Harrisburg, PA 17110; krdenisc@hacc.edu

The third-generation Apple TV with AirPlay and an iPad will be demonstrated as unique tools for wireless presentations in the science classroom. This combination allows freedom of movement for the teacher to circulate in the classroom and to easily switch between presentations, videos, and science applications (apps). These all stream wirelessly to an LCD projector or TV, and allow the instructor to be much more connected to the class. The AppleTV can also be used to show students' work in the situations where they have their own device. An example could be an assignment where the students must make a short video reflecting a particular physics principle. This setup allows the student to stream the content with no additional set up needed. Attendees will be invited to share their own experiences with Apple TV and to discuss the merits of this particular technology.

Session GM: *Panel:* Giving Voice in the Classroom

Location: Sheraton - University Suite
Sponsor: Committee on Women in Physics
Co-Sponsor: Committee on Minorities in Physics
Date: Wednesday, August 1
Time: 1:30–3 p.m.

Presider: Zahra Hazari

GM01: 1:30-3 p.m. Reality Pedagogy and Urban Science Education

Panel – Christopher Emdin, Columbia University Teachers College, New York, NY 10027; ce2165@columbia.edu

Much of the research in urban science education that focuses on the needs of youth of color utilizes the concept of cultural relevance or responsiveness as the primary framework that guides the work. This presentation explores the extent to which this pedagogical approach impacts urban science education, and describes its chief limitations. I also introduce an approach to pedagogy (reality pedagogy) that considers the limitations of existent research, and provides a means to improving physics instruction by focusing on the realities of youth experiences.

GM02: 1:30-3 p.m. Enacting Localized Reform Through the Cogenerative Mediation Process for Learning Environments

Panel – Natan Samuels, Florida International University, Miami, FL 33199; nsamu002@fiu.edu

Eric Brewe, Florida International University

We discuss how using the Cogenerative Mediation Process for Learning Environments (CMPLE) affected physics instructors? awareness of classroom gender, cultural, and language issues. CMPLE is a formative intervention designed to help teachers better engage with students in their shared learning environment. Through giving students meaningful roles in classroom operations via CMPLE, instructors reflected upon and adjusted their teaching methods to better suit their own and their students' learning preferences. Listening to, and working with their students as individuals and as a group helped instructors understand shared classroom issues through the students' voices. The process of actively changing aspects of classroom function opened new possibilities for teaching, learning, communication, and mutual understanding. We highlight this process using data from two courses: a high school honors physics class using the Modeling curriculum, and a university science content and methods course for pre-service elementary teachers using the Physics and Everyday Thinking (PET) curriculum.

Session PERC: PERC Bridging Session

Location: Inn at Penn - Woodlands Ballroom
Sponsor: Committee on Research in Physics Education
Date: Wednesday, August 1
Time: 3–6 p.m.

Presider: Chandra Turpen

David Hammer (Discussant, invited)

Leslie Atkins (Moderator, invited)

PER01: 3-3:30 p.m. Where Do Physics Students Come From and What Do They Become? A Look at Knowledge and Identity Pathways Through and Beyond School Experience

Invited – Reed Stevens, Learning Sciences, SESP, Northwestern University, Evanston, IL 60208; reed-stevens@northwestern.edu

In this talk, I will present a perspective that conceptualizes learning in cultural practice terms. Cultural practices are differently "sized" patterns of interaction among people and things to which people orient and hold each other accountable. Learning then involves coming to participate in these patterns of interaction and undergoing possible changes to body, mind, and identity in the process. Cultural practices are often knotted together to make normative cultural paths, through and around which people traverse specific pathways. Drawing on a conceptual framework for studying young people's learning pathways toward "becoming" engineers (Stevens et al., 2008)[1], this presentation will examine the knowledge and identity formation processes in everyday physics, physics education, and professional physics. I will consider an additional dimension of importance, how people —individually and with cultural support—navigate through sanctioned institutional passage points and rituals. I will use this framework to generate a set of future-looking questions for physics learning and physics education research.

1. R. Stevens, K. O'Connor, L. Garrison, A. Jocuns, and D. Amos, "Becoming an Engineer: Toward a three-dimensional view of engineering learning," *Journal of Engineering Education* **97**, 355–368. (2008).

PER02: 3:30-4 p.m. Practice-Linked Identities, Social Identities, and Mathematics Learning

Invited – Indigo Esmonde, University of Toronto, 252 Bloor St., W. Toronto, ON, M5S 1V6 Canada; indigo.esmonde@utoronto.ca

I will talk about two different ways of thinking about identity as it relates to learning, and discuss the importance of integrating both perspectives. First, I'll talk about practice-linked identity: a sense of self that develops through participation in a set of cultural or collective practices. These identities are shifting and changeable, and are developed in relation to other people in the context. Second, I'll talk about social identity: a sense of self—or a perception of others—based on socially meaningful categories like race or gender. These identities are seen as quite static (although they may not be experienced that way) and are related to broader systems of oppression in society. I will give examples from my research in mathematics education, and discuss how these concepts can be useful in the study of physics education.

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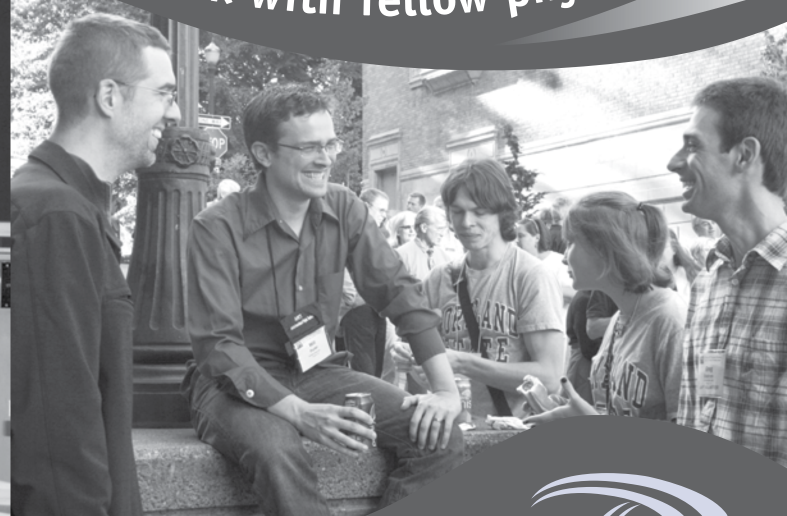

Learn more at the AAPT booth in Houston Hall Reading Room next to meeting registration.

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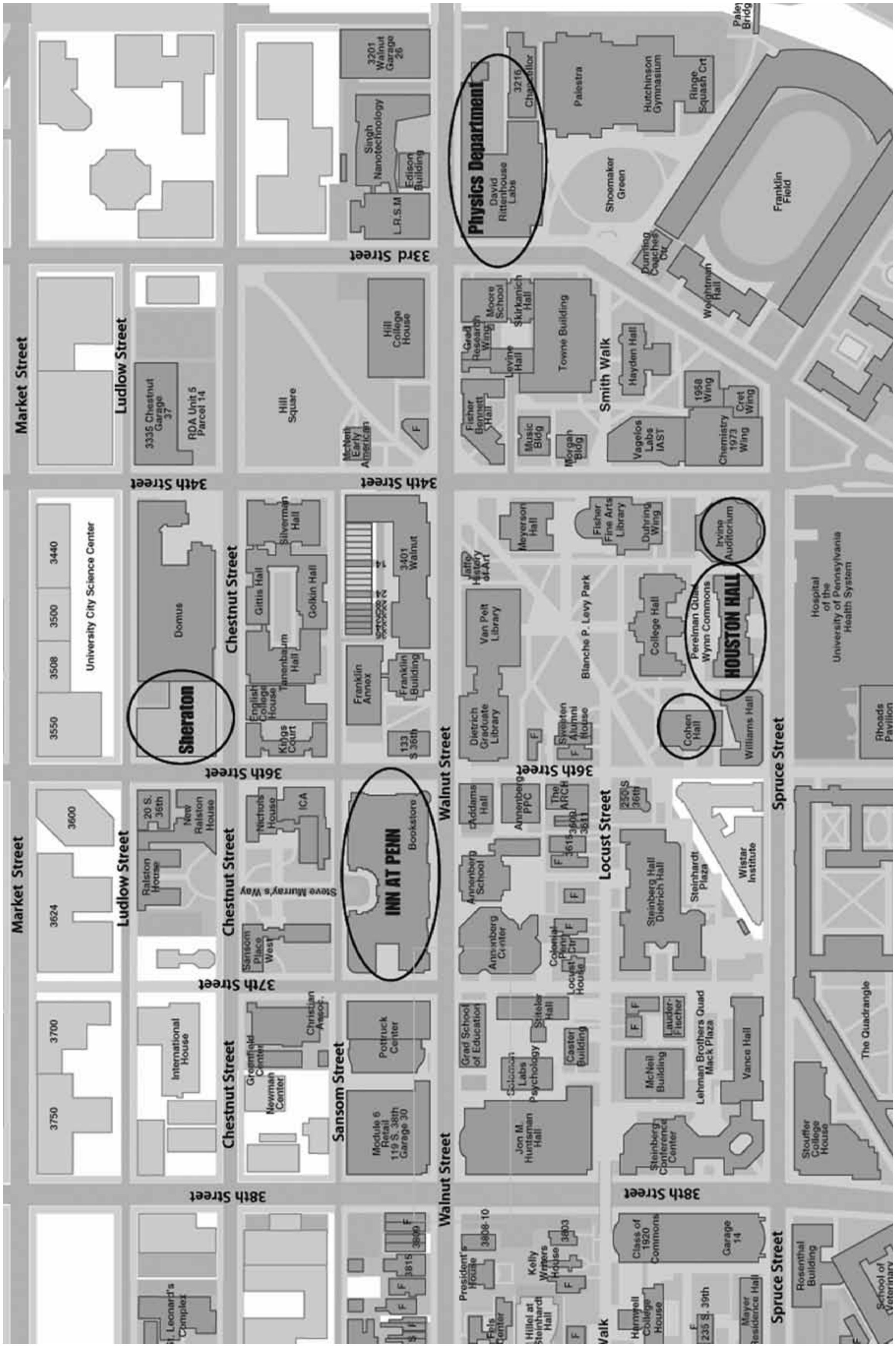

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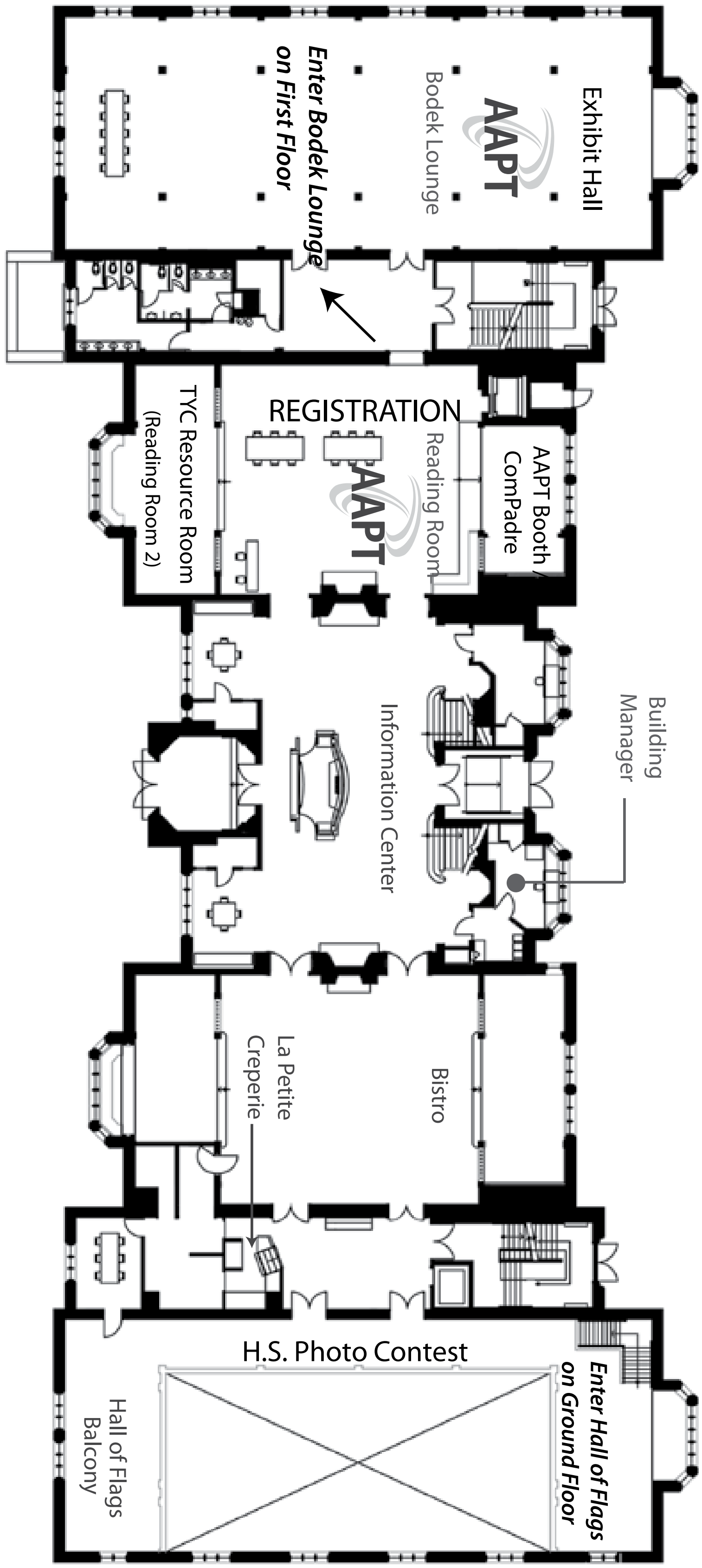

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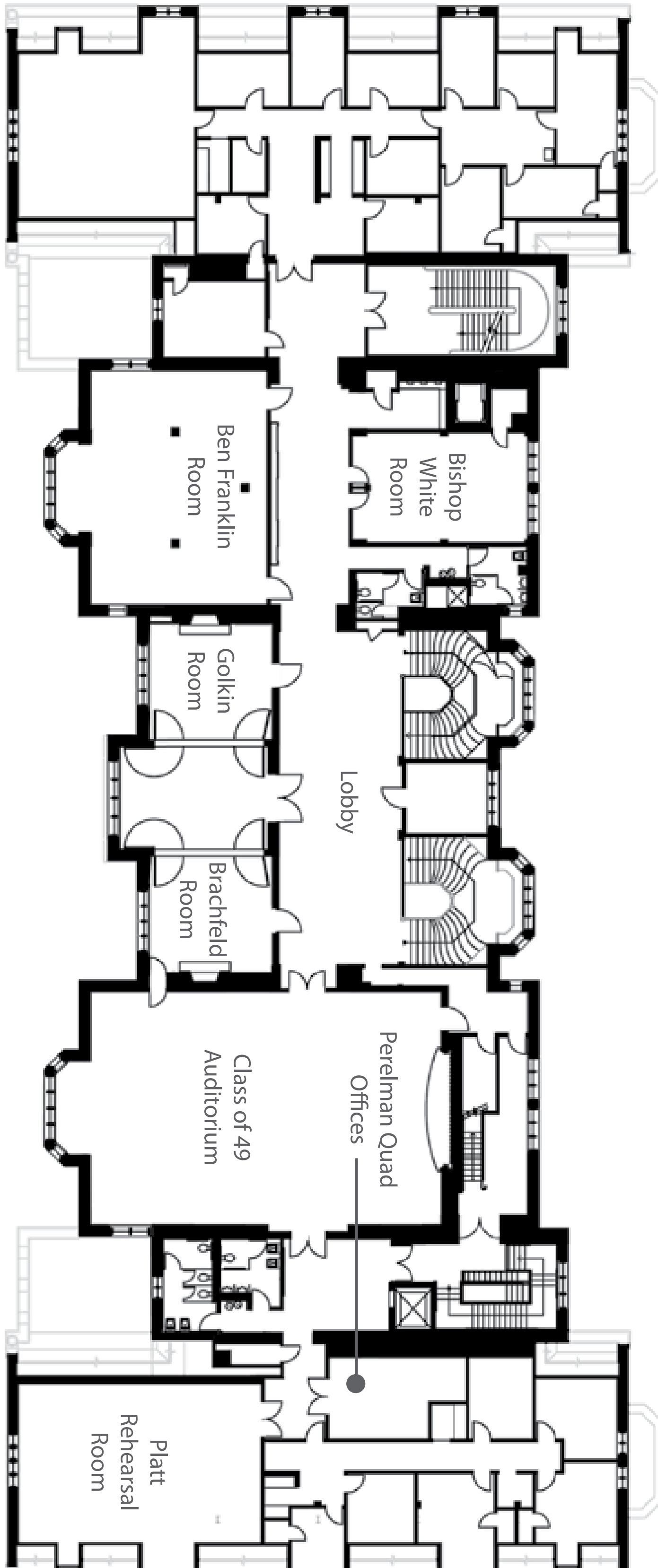

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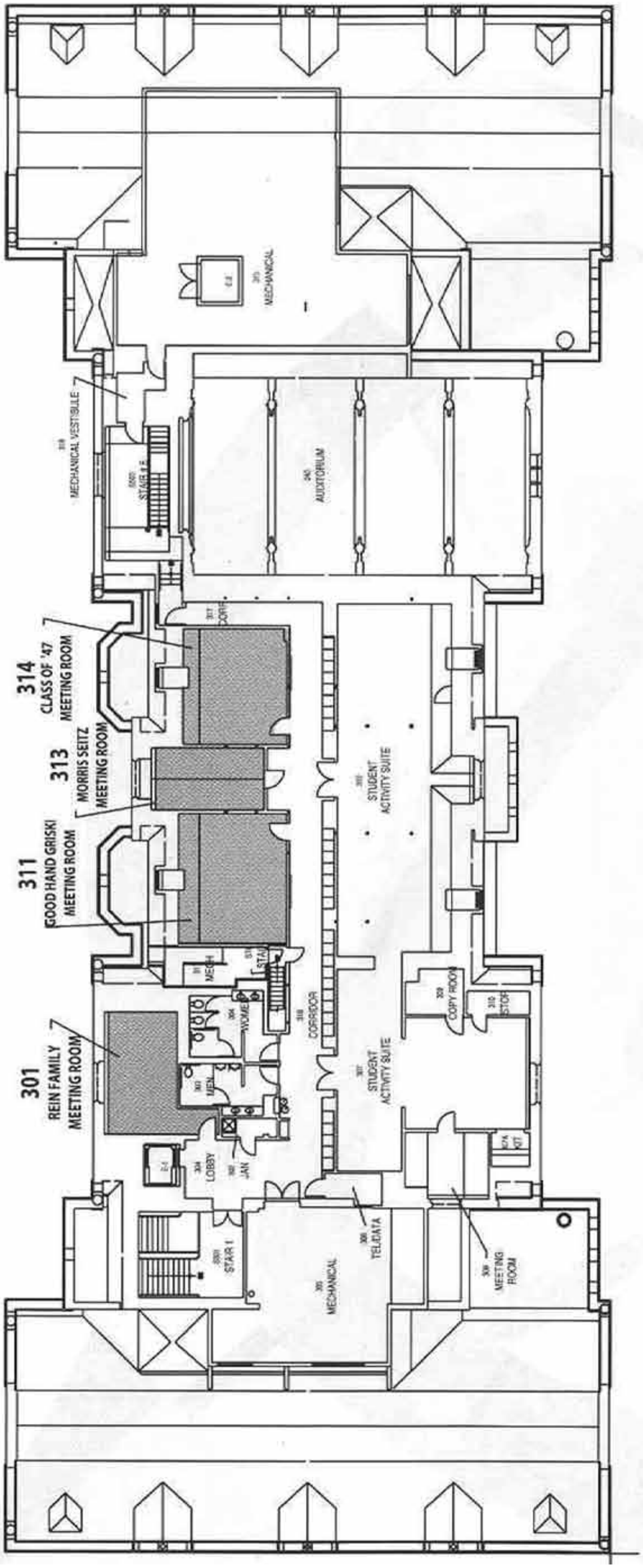

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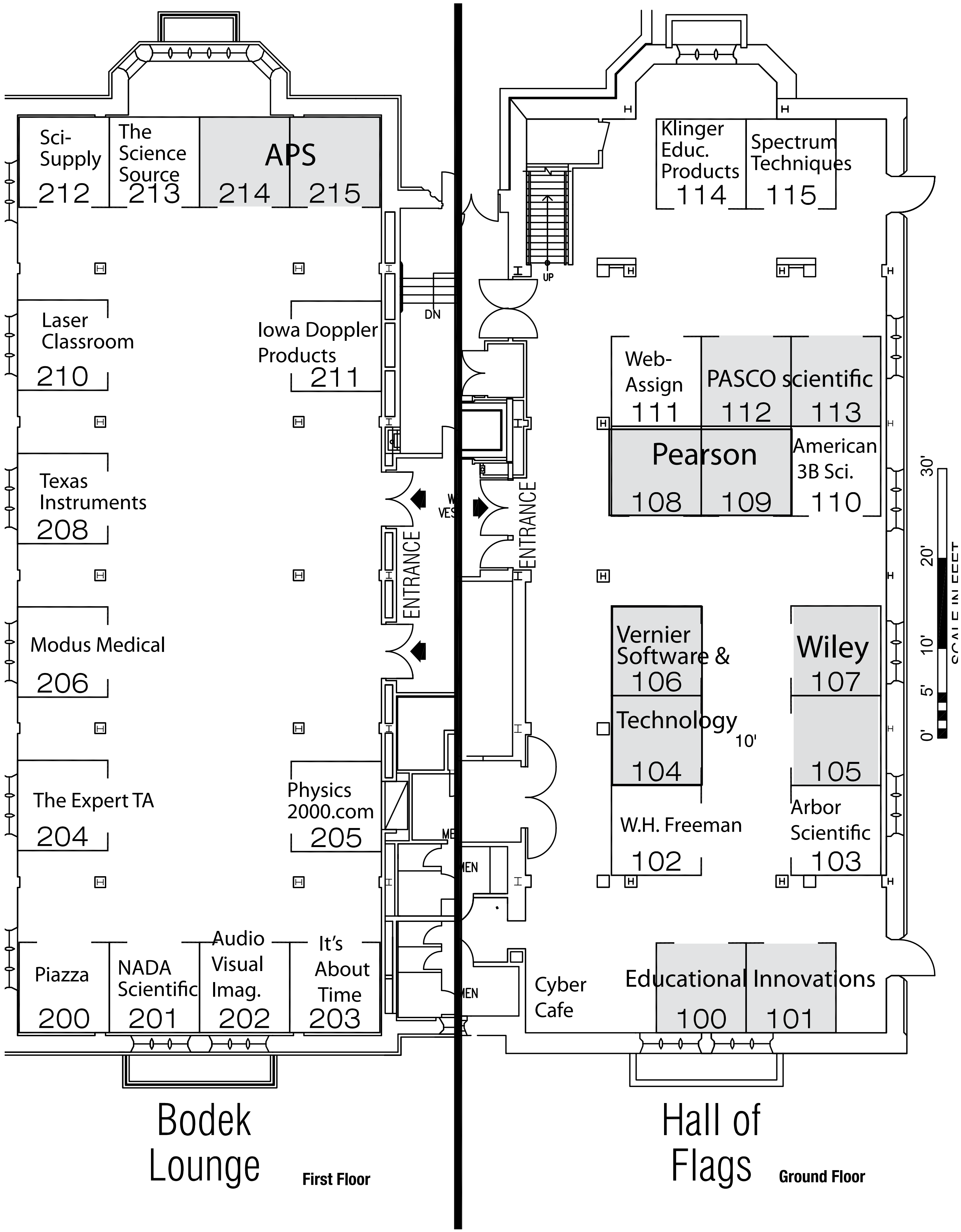

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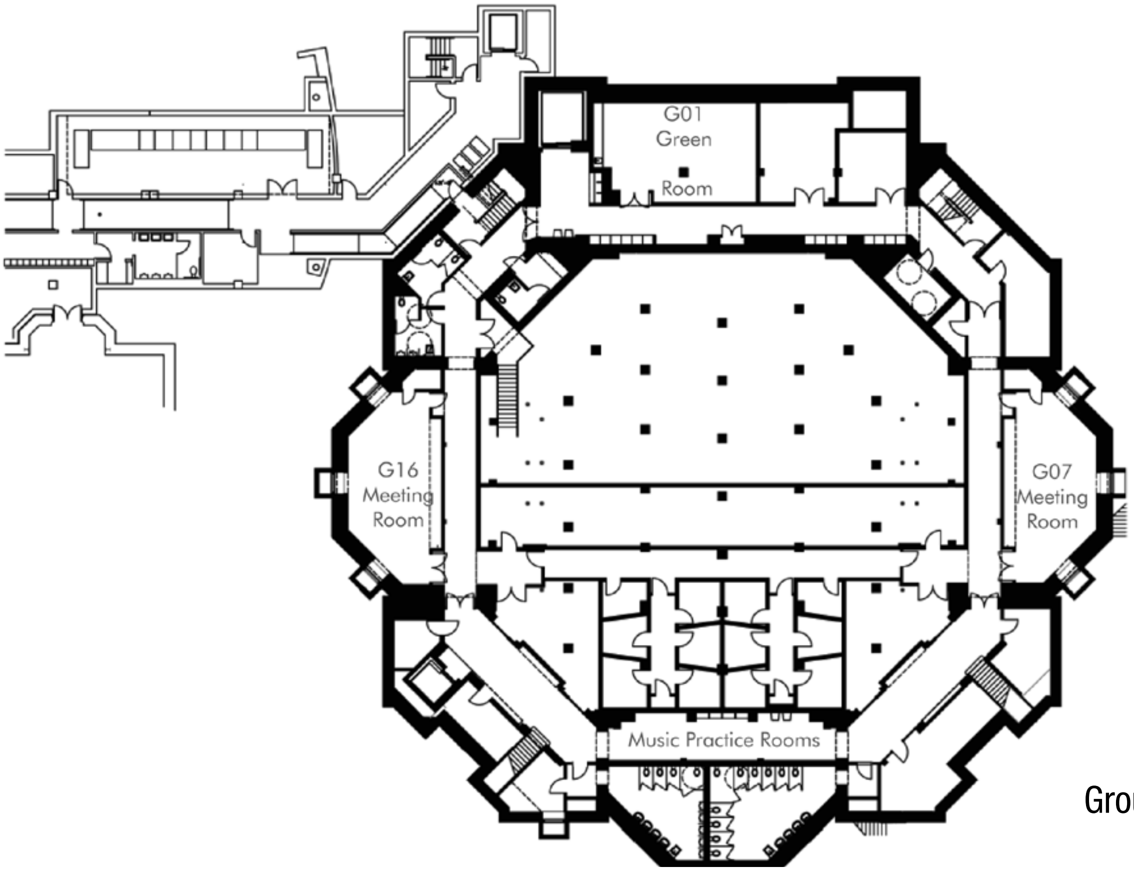

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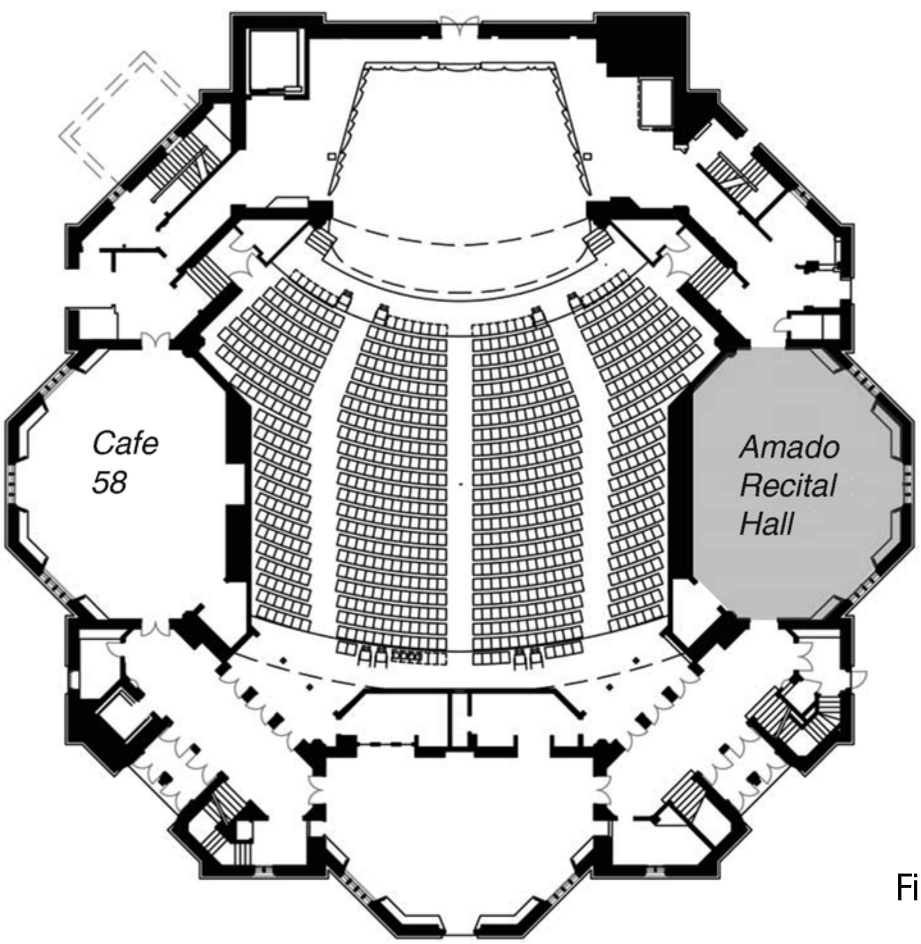

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Local Restaurants

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38th Chestnut St.
Philly style food/cheesesteaks
215-662-0100

Baby Blues
3402 Sansom St.
Barbeque
215-222-4444

Beijing Restaurant
3714 Spruce St.
Chinese and Bubble Tea
215-222-5242

Bobby's Burger Palace
3714 Walnut St.
Bobby Flay's burgers
215-387-0378

Chili's
3801 Chestnut
Mexican grill
215-222-7322

City Tap House
3925 Walnut St.
American Grille and Tap
215-662-0105

Distrito
3945 Chestnut St.
Mexican
215-222-1657

Metropolitan Bakery
4013 Walnut St.
Breakfast and bakery
215-222-1492

Mikey's
32nd and Chestnut St.
American Grill and Sports Bar
215-222-3226

New Deck Tavern
3408 Samson St.
Irish Pub
215-222-0100

Penne
3611 Walnut St.
Italian Cuisine
215-823-6222

Pizza Rustica
3602 Chestnut St.
Pizzeria
215-895-3490

Pod
3636 Sansom St.
Pan Asian Cuisine
215-387-1803

Sabrina's Cafe
227 N. 34th St.
Breakfast and cafe food
215-222-1022

Lemon Grass
3630 Lancaster Ave.
Thai
215-222-8042

Mad Mex
3401 Walnut St.
Casual Mexican
215-382-2221

White Dog Cafe
3420 Sansom St.
Organic/American Cuisin
215-386-9224

Zocalo
3600 Lancaster Ave.
Contemporary Mexican
215-895-0139

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http://www.gourmet.com/restaurants/2009/09/philadelphia-street-food

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with Refreshments

Poster Session 1
8:30–10 p.m.
Monday, July 30
Houston Hall - Bistro
Philly Soft Pretzels and Lemonade!

Poster Session 2
6–7:30 p.m.
Tuesday, July 31
Houston Hall - Bistro
Delicious Dessert Bars and Punch!