Summer Meeting Program

July 30-August 3, 2011

2011AAPT

Omaha

Communicating Physics Outside the Classroom

aapt.org

AAPT American Association of Physics Teachers


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2011 AAPT Summer Meeting

Omaha, NE
July 30–August 3, 2011

Creighton University, Omaha

AAPT PHYSICS EDUCATION

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

Welcome to Omaha!

Our hosts at Creighton University have rolled out the red carpet, opening their campus to us for a tour of their alternative energy installations, part of an NSF-sponsored initiative. They will share ideas for developing curriculum around this critical and timely topic. Metropolitan Community College has also opened its grounds to us, hosting a TYC dinner at their historic Fort Omaha Campus. Guests will experience a sumptuous catered dinner on the deck of the college president's house, overlooking flower gardens and complete with wine and linens, in addition to a campus tour, before returning to Creighton on Olley the Trolley.

We'll also have opportunities for an "insiders" tour of the Omaha Zoo, which has received rave reviews from previous participants, as well as a visit to the Strategic Air & Space Museum.

Thanks to the Bennington High School Future Business Leaders of America, Summer 2011 will feature another bridge run/walk, this time all the way to Iowa over the Missouri River on the gorgeous Kerry Pedestrian Bridge.

Summer 2011 will continue our tradition of workshops to take your career to the next level. Women in Physics will reprise its workshop on negotiating strategies for women, which a previous participant credited with getting her a 6.4% increase in her base pay.

Tuesday will be a special "first-timers" day for high school physics teachers, featuring special sessions on what AAPT has to offer. In his Millikan Award talk Brian Jones will share the wonders of the Little Shop of Physics, toured by thousands of visitors during its most recent open house, and make some of its marvelous demos available for viewing on Tuesday afternoon.

We also have some great sessions planned around the theme of communicating physics with the public. Jim Stith of AIP will begin our discussion with his opening plenary: "Reaching Out to the Public – A Necessary Dialogue." Our Klopsteg winner, Jim Hansen, has been featured on the David Letterman show for his work in engaging citizens as well as elected officials in debate about the science of climate change. A few lucky attendees at the Wednesday plenary will receive autographed copies of his book, *Storms of My Grandchildren*.

The Committee on Science Education for the Public will continue this theme with an invited session on Energy and the Environment. We'll also have opportunities to consider "The Big Bang Effect: Representations of Physicists in Popular Culture," as well as the possibilities for using communication technology to teach physics in "Don't Put That Phone Away: Personal Electronics in the Classroom."

The APS Division of Condensed Matter Physics will engage in communicating cutting-edge physics in a plenary session on Frontiers of Nanoscience, with Barbara Jones and Jeremy Levy. If you attended the Richtmyer Lecture in Jacksonville you already saw some of Barbara Jones' amazing images of a quantum corral, so you know that we are in for a treat.

It's going to be a great meeting and I look forward to hearing from you all about it!

Jill Marshall, University of Texas, Austin

2011 Program Chair

Special Thanks:

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

Paper Sorters: David Sturm, Dyan McBride, Gay B. Stewart, MacKenzie Stetzer, Warren Christensen

Our local organizers:

– Dr. Jack Gabel, Assistant Professor, and Janet Seger, Chair, Department of Physics, Creighton University

AAPT Board of Directors

Facebook/Twitter at Meeting

We will be tweeting and posting updates 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 **#aaptsm11** 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 on the meeting!

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

facebook twitter

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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Contacts:

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

Meeting Registration Desk, Omaha: 402-280-1406

Tiffany Hayes, Director of Programs & Conferences

Cerena Cantrell: Associate Director of Programs & Conferences

Janet Lane, Programs Administrator

Pearl Watson, Meetings Logistics & Registration Coordinator

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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

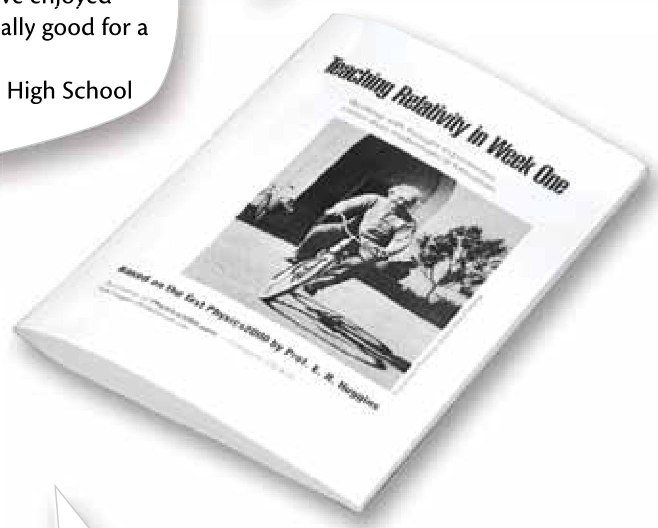
Professor Huggins,
I am truly enjoying reading your textbook. I must admit that this is the first physics text that I have enjoyed reading - most text are really good for a bad case of insomnia.

M.C., Bentonville High School
11 Aug 2005

Monday, Aug. 1

11:30 a.m.–12:45 p.m.

Harper Center 3040



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

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

Professor — good afternoon,
I wish to express my gratitude to you for creating and providing the Physics2000/Calculus2000 CD and printed material.

In the distant past I received a B.S. in mathematics and physics, and I now wish, and need, to study this material again. I find your approach refreshing and extremely approachable, with its conversational writing style and emphasis on physics beyond that developed up until the mid-nineteenth century!

I should mention as well that the price of your material should shame many textbook publishers. I purchased an elementary text on classical mechanics a couple of years ago, and its cost was three times that of the CD and both the Physics2000 and Calculus2000 books. With the depth and breadth of material in your courses, I imagine more than a few college students are breathing sighs of relief.

Thank you very much once more. I greatly appreciate your efforts.

W.P., Celebration, FL 06 Nov 2006

Shuttle Bus Schedule

Shuttle Buses will run every 10 minutes between the Doubletree Hotel and Creighton University during the following hours:

- **Friday, July 29:** *5:30–8:30 p.m.*
- **Saturday, July 30:** *6:30 a.m.–5:30 p.m.*
- **Sunday, July 31**: *6:30 a.m.–10:30 p.m.*
- **Monday, August 1:** *6:30 a.m.–10:30 p.m.*
- **Tuesday, August 2:** *6:30 a.m.–10:30 p.m.*
- **Wednesday, August 3:** *6:30 a.m–5 p.m. & 10 p.m.–10:30 p.m.*
- **Thursday, August 4:** *7:30–8 a.m. & 5–5:30 p.m.*

Pick-up Location/Doubletree Hotel:

Capitol Street entrance on north side of the hotel

Campus Drop Off:

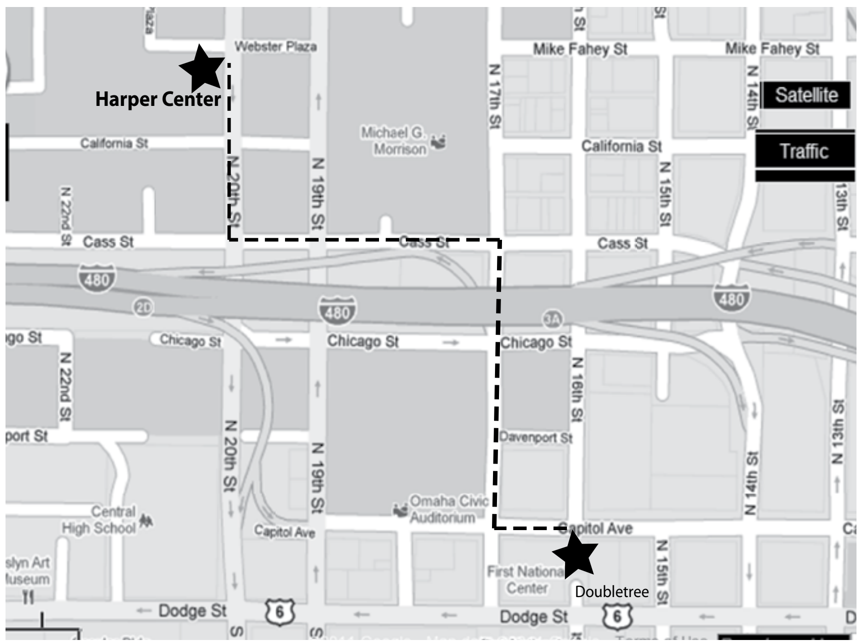
Harper Center, lower level, 20th Street

Walking Directions to Creighton University Harper Center, from Doubletree

1. Head west on Capitol Ave. toward N 17th St.
   (341 ft)
2. Turn right onto N 17th St.
   (0.2 mi)
3. Turn left onto Cass St.
   (0.2 mi)
4. Turn right onto N 20th St.
   (281 ft.)

   Harper Center will be on the left

(about 10–15 minute walk)



Stop by to Visit Our Exhibitors

Exhibit Hall hours

Sunday: 8–10 p.m.
Monday: 10 a.m.–6 p.m.
Tuesday: 10 a.m.–4 p.m.

Harper Center, 4th fl. ballroom

snack breaks: Mon. 10–10:30 a.m. & 3–3:30 p.m.
Tues., 10–10:30 a.m. & 3:15–3:45 p.m.

First time at an AAPT meeting?

Welcome to the 2011 AAPT Summer Meeting in Omaha! 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 7–8 a.m. on Monday in Skutt Student Center 105. It is a wonderful way to learn more about the meeting and about AAPT.
- Awards and other plenary sessions have distinguished speakers and are especially recommended. Invited speakers are experts in their fields and will have half an hour or more to discuss their subjects in some depth. Posters will be up all day and presenters will be available during the times indicated in the schedule. Contributed papers summarize work the presenters have been doing. You are encouraged to talk to presenters at the poster sessions or after the contributed paper sessions to gain more information about topics of interest to you. Informal discussion among those interested in the announced topic typically will follow a panel presentation, and crackerbarrels are entirely devoted to such discussions.
- Be sure to make time to visit the exhibits. This is a great place to learn what textbooks and equipment are available in physics education.

2011AAPT Omaha Communicating Physics Outside the Classroom

Photos courtesy of Creighton University

Photos courtesy of Omaha Convention & Visitors Bureau

About Omaha!

History

Founded in 1854 by land speculators, Omaha was incorporated as a city in 1897. Omaha, named after an American Indian tribe, means "those going against the wind or current."

Historic Sites

–**Fort Omaha** is best known for its role in the 1879 landmark trial of Ponca Chief Standing Bear. Standing Bear was arrested while trying to bury his son near the tribe's homeland along the Niobrara River. At the trial Civil War General George Crook, in his full military regalia, spoke on behalf of the Ponca chief. The court ruled in favor of Standing Bear, which represented the first time the Indian was recognized as a person under the law.

–**Boys Town:** This well-known landmark is a national treasure and historic children's home founded in 1917 by Father Flanagan. Boys Town now assists over 400,000 children each year.

–**The Old Market** is Omaha's historic art, shopping, and dining district. In the 1880s it served as a manufacturing, industrial warehouse and wholesale jobbing area.

–**The Gerald R. Ford Birth Site and Gardens** is a memorial to our country's 38th President.

–**The Malcolm X Birth Site** is a memorial to the civil rights leader and his contributions to our country.

–**The Mormon Trail Center** at Winter Quarters archives the journeys and hardships faced by the Mormon pioneers who stopped in Omaha enroute to Utah.

Education

Omaha's first public school building was built in September 1863. There are now 11 colleges and universities among Omaha's higher education institutions, including the University of Nebraska at Omaha. Omaha's Creighton University was ranked the top non-doctoral regional college in the Midwestern United States by *U.S. News and World Report.* Creighton maintains a 108-acre campus just outside of downtown Omaha in the new North Downtown district, and the Jesuit-run institution has an enrollment of around 6,700 in its undergraduate, graduate, medical, and law schools. There are more than 10 other colleges and universities in the Omaha metro area.

Things to do in Omaha:

➤ **Omaha's Henry Doorly Zoo:** See the largest indoor rainforest. View sharks and other deep sea inhabitants through a glass-enclosed, walk-through tunnel; take a Lozier IMAX Theatre adventure to the top of Mt. Everest; and view hundreds of birds flying freely in a mesh aviary the size of four football fields—all in one afternoon.
Open daily; 3701 S 10th St., Omaha, NE 68107-2299; omahazoo.com

➤ **Strategic Air & Space Museum:** Provides visitors with exciting permanent and traveling exhibits. B-1, SR-71, B-52, B-36, MiG-21, FB-111, B-17, Apollo 009 as well as the history of the Strategic Air Command are part of the collection at the Museum. Includes: 34 aircraft; variety of rockets and missiles; aerospace display; world-class traveling exhibits; guided public tours; flight simulators; museum store.
Open daily; Ashland, NE 68003; SASMuseum.com

➤ **Heartland of America Park & Fountain:** Catch the spectacular Heartland of America Fountain with its 300-ft water jet and light show. Lewis & Clark Interpretive exhibits, WWII and Airborne Memorial Sculptures, and a pedestrian bridge connecting to the Lewis & Clark Landing. Gondola rides by Heartland Gondola. Located across the street from the historic Old Market area. Accessible.
Fountain: Mon-Fri 11 a.m.-1 p.m. & 5-11 p.m., Sat & Sun 10:30 a.m.-11 p.m.; 8th & Douglas Sts, Omaha, NE; ci.omaha.ne.us/parks

➤ **Durham Western Heritage Museum:** The Durham Museum is housed in historic Union Station in downtown Omaha. Union Station was designed by Gilbert Stanley Underwood and built for Union Pacific Railroad in 1931 and is one of the best examples of art deco architecture in the country. Enjoy permanent exhibits that capture the history of the region as well as a broad range of traveling exhibits from across the country covering subjects from history and culture, to science and industry.
Open daily, 801 South 10th St., Omaha, NE 68108; durhammuseum.org

➤ **Joslyn Art Museum:** Masterpieces abound here. The permanent exhibit includes works by El Greco, Degas, Monet, and Renoir. 19th- and 20th-century art receive a special focus. The museum building itself is a striking example of art deco design.
Open Tues.–Sun.; 2200 Dodge St., Omaha, NE 68102-1208; joslyn.org

Photos courtesy of Omaha Convention & Visitors Bureau


Experimenting with
your hiring process?
Finding the right science teaching job or hire shouldn't be left to chance. The American Association of Physics Teachers (AAPT) Career Center is your ideal niche employment site for science teaching opportunities at high schools, two-year, and four-year colleges and universities, targeting over 125,000 top teaching scientists in the highly-specialized disciplines of physics, engineering, and computing. Whether you're looking to hire or be hired, AAPT provides real results by matching hundreds of relevant jobs with this hard-to-reach audience each month.
http://careers.aapt.org
The American Association of Physics Teachers (AAPT) is a partner in the AIP Career Network, a collection of online job sites for scientists, engineers, and computing professionals. Other partners include Physics Today, the American Association of Physicists in Medicine (AAPM), American Physical Society (APS), AVS Science and Technology, IEEE Computer Society, and the Society of Physics Students (SPS) and Sigma Pi Sigma.
AAPT
PHYSICS EDUCATION

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 at Creighton University unless otherwise noted. (HC = Harper Center, SS = Skutt Student Center, HLSB = Hixson Lied Science Bldg, RS = Rigge Science Bldg.)

FRIDAY, July 29

6–8 p.m.		Pre-registration Pickup	**HC South Lounge**

SATURDAY, July 30

7 a.m.–4 p.m.		**REGISTRATION**	**HC South Lounge**
8 a.m.–12 p.m.	W10	Computer Problem Solving Coaches	HLSB 408
8 a.m.–12 p.m.	W11	A Research-based Methodology for Using Clickers	HLSB 244
8 a.m.–5 p.m.	W01	Critical Thinking in Introductory Astronomy	HLSB 361
8 a.m.–5 p.m.	W02	Developing a High-Altitude Balloon Program	HLSB L26
8 a.m.–5 p.m.	W03	Learning Physics While Practicing Science	RS G21
8 a.m.–5 p.m.	W04	Physics by Design	HLSB 188
8 a.m.–5 p.m.	W06	PIRA Lecture Demos 1	HLSB G59
8 a.m.–5 p.m.	W09	The Physics of Energy	RS L22
1–5 p.m.	W15	Introductory Laboratories	RS G19
1–5 p.m.	W16	Laserfest Apparatus and Activities	HLSB 244
1–5 p.m.	W17	Modeling Applied to Problem Solving	HLSB 246
1–5 p.m.	W19	Teaching Critical Thinking: Science and Religion	HLSB 408
3–6 p.m.		Omaha Energy Tour	Offsite
6:30–7:30 p.m.		Review Board	Doubletree Dakota
6:30–7:30 p.m.		PTRA Advisory Board	Doubletree Midlands-Iowa
6:30–9 p.m.		TYC Dinner at Ft. Omaha	Offsite
7:30–9:30 p.m.		Awards Committee	Doubletree Midlands-Missouri

SUNDAY, July 31

7 a.m.–4 p.m.		**REGISTRATION**	**HC South Lounge**
8–10:30 a.m.		Publications Committee	HC 3053
8–10:30 a.m.		Meetings Committee	HC 3048
8 a.m.–12 p.m.	W13	Pre-College Labs: Student Centered Lab Progression for Vertical Alignment	RS L10
8 a.m.–12 p.m.	W26	Activities for Teaching Climate and Climate Change	RS G21
8 a.m.–12 p.m.	W27	Can You Use Inquiry to Teach Radioactivity? Yes!	RS L22
8 a.m.–12 p.m.	W28	Computational Physics Examples to Include in Physics Courses	HLSB 408
8 a.m.–12 p.m.	W29	Blurring the Lines: ILDs (& other activities) in an Integrated Lecture-Lab Environment	HLSB L26
8 a.m.–12 p.m.	W31	LivePhoto Physics: Video-based Motion Analysis for Homework and Class	RS G18
8 a.m.–12 p.m.	W32	NTIPERs: Research-based Reasoning Tasks for Introductory Mechanics	HLSB 522
8 a.m.–12 p.m.	W33	What Every Physics Teacher Should Know About Cognitive Research	HLSB 523
8 a.m.–5 p.m.	W20	Arduino Microcontrollers in the Physics Lab	RS G09
8 a.m.–5 p.m.	W21	Computer Modeling & the Physics Classroom Web Resources	HLSB 244
8 a.m.–5 p.m.	W22	Make, Take, and Do; A PTRA Workshop	RS G16
8 a.m.–5 p.m.	W23	Math Machines: Connecting Physics with Math & Engineering	HLSB 361
8 a.m.–5 p.m.	W25	PIRA Lecture Demos 2	HLSB G59
8 a.m.–10 p.m.		H.S. Photo Contest Viewing and Voting	HC South Lounge
10:30–11:30 a.m.		Nominating Committee	HC 3053
10:30 a.m.–5 p.m.		Executive Board I	HC 3023
1–5 p.m.	W35	Advanced and Intermediate Laboratories	RS G19
1–5 p.m.	W36	Designing and Implementing an Inquiry-based Physics Course	HLSB 428
1–5 p.m.	W38	Free Physics Webtools	HLSB G59
1–5 p.m.	W40	Make Your Own Teacher 2.0 Websites	TBA
1–5 p.m.	W41	Physics and Toys I: Force, Motion, Light, and Sound	HLSB 188
1–5 p.m.	W42	Skepticism in the Classroom	HLSB 523
1–5 p.m.	W43	Strategies to Help Women Succeed in Physics-related Professions	HLSB 522
1–5 p.m.	W44	Teaching Astronomy with Ranking Tasks	HLSB 408
1–5 p.m.		Strategic Air & Space Museum Tour	Offsite

5:30–6:30 p.m.		Programs Committee I	HC 3029
5:30–6:30 p.m.		Section Officers Exchange	SS Ballroom ABC
6–8 p.m.		High School Share-a-Thon	SS Ballroom DE
6–8 p.m.		**Registration**	**HC South Lounge**
6:30–8 p.m.		Section Representatives	SS Ballroom ABC
6:30–8 p.m.		Physics in Two-Year Colleges Committee	HC 3053
6:30–8 p.m.		History & Philosophy of Physics Committee	HC 3048
6:30–8 p.m.		Women in Physics Committee	HC 3027
6:30–8 p.m.		Laboratories Committee	HC 3023B
6:30–8 p.m.		SI Units and Metric Education Committee	HC 3029
8–10 p.m.		**Exhibit Hall Opens/ Welcome Reception**	HC Ballroom, 4th Floor
8–10 p.m.		SPS Undergraduate Research and Outreach Poster Reception	HC Ballroom Galleria

MONDAY, August 1

7 a.m.–5 p.m.		**Registration**	**HC South Lounge**
7–8 a.m.		First Timers' Gathering	SS 105
7–8 a.m.		Retirees Breakfast (ticket required)	HC 3023B
7–8 a.m.		Bauder Endowment Committee	HC 3040
8 a.m.–5 p.m.		Poster Session I Setup	Kiewit Fitness Center
8 a.m.–10 p.m.		PIRA Resource Room	HC 2066
8 a.m.–5 p.m.		TYC Resource Room	HC 3053
8 a.m.–5 p.m.		Apparatus Competition	HC 2060
8 a.m.–10 p.m.		H.S. Photo Contest Viewing and Voting	HC South Lounge
8–9 a.m.	AF	Learning Progressions	SS Ballroom F
8–9:30 a.m.	AD	Reflections on Gordon Conference on Experimental Research and Labs in Physics Ed.	SS 105
8–9:30 a.m.	AG	Methods to Improve Conceptual Learning in Quantum Mechanics I	SS Ballroom ABC
8–9:40 a.m.	AC	Physics Education Research Around the World I	SS Ballroom DE
8–10 a.m.	AA	PIRA: Outreach from the Ground Up	HC 3028
8–10 a.m.	AB	Objectives and Assessment of the Physics Graduate Program	HC 3027
8–10 a.m.	AE	PER: Investigating Classroom Strategies I	HC 3023 & 3023A
8–10 a.m.	AI	Potpourri of Teacher Preparation Programs I	SS 104
8:30–9:40 a.m.	AH	Best Practices in the Use of Educational Technologies I	HC 3029
10–11 a.m.		Spouses' Gathering	HC 3023B
10 a.m.–6 p.m.		**Exhibit Hall Open (coffee break, 10–10:30 a.m.)**	**HC Ballroom, 4th Floor**
10:30–11:30 a.m.	**Plenary**	**"Reaching Out to the Public: A Necessary Dialogue," J. Stith**	**HC Hixson-Lied Aud.**
11:30 a.m.–12:30 p.m.		Young Physicists' Meet and Greet	HC 3023B
11:30 a.m.–12:30 p.m.		PERTG Town Hall Meeting	HC 3023
11:30 a.m.–12:30 p.m.	Ckrbrl-01	Crackerbarrel on Professional Concerns of Faculty in Small Departments	SS Ballroom ABC
11:30 a.m.–12:45 p.m.		Membership and Benefits Committee	HC 3042
11:30 a.m.–12:45 p.m.	CW03	Physic2000.com Commercial Workshop	HC 3040
11:30 a.m.–1 p.m.		Science Education for the Public Committee	HC 3029
11:30 a.m.–1 p.m.		Educational Technologies Committee	HC 3028
11:30 a.m.–1 p.m.		Teacher Preparation Committee	HC 3027
11:30 a.m.–1 p.m.		Minorities in Physics Committee	HC 3048
11:30 a.m.–1 p.m.		International Physics Education Committee	SS Ballroom F
1–1:40 p.m.	BD	Using Literature to Teach Physics	HC 3048
1–1:50 p.m.	BJ	Astronomy Teaching and Learning	SS 105
1–2:30 p.m.	BA	Don't Put that Phone Away: Personal Electronics in the Classroom	HC 3027
1–2:30 p.m.	BC	PER: Problem Solving I	HC 3023 & 3023A
1–2:30 p.m.	BE	Preparing Minority Students for Graduate School	HC 3040
1–2:30 p.m.	BF	Spacetime Physics (Panel)	SS Ballroom ABC
1–2:40 p.m.	BI	Cross Campus Collaboration: What I Learned from Liberal Arts about Teaching Physics	SS 104
1–3 p.m.	BB	Best Practices in the Use of Educational Technologies II	HC 3029
1–3 p.m.	BG	Energy and the Environment	SS Ballroom DE
1–3:10 p.m.	BH	Induction and Mentoring of Physics Teachers	SS Ballroom F
3–3:30 p.m.		**Break in Exhibit Hall**	**HC Ballroom, 4th Floor**
3:30–5 p.m.	**Plenary**	**APS Division of Condensed Matter Physics Session: Frontiers in Nanoscience**	**HC Hixson-Lied Aud.**
5–6 p.m.		SPS Undergraduate Awards Reception	HC 3023B
5–6:30 p.m.		Professional Concerns Committee	HC 3029
5–6:30 p.m.		Physics in Undergraduate Education Committee	HC 3048

5–6:30 p.m.		Physics in High Schools Committee	HC 3028
5–6:30 p.m.		PIRA meeting	HC 3027
6:30–7:30 p.m.	CA	Use and Misuse of Lasers	HC 3027
6:30–7:30 p.m.	CD	Alternative Assessments and Practicums	HC 3048
6:30–7:30 p.m.	CE	Online Courses and Simulated Learning	HC 3040
6:30–7:30 p.m.	CG	Indigenous Astronomy	SS Ballroom DE
6:30–7:30 p.m.	CJ	Potpourri of Teacher Preparation Programs II	SS 104
6:30–7:40 p.m.	CI	Methods to Improve Conceptual Learning in Quantum Mechanics II	HC 3028
6:30–7:50 p.m.	CF	Physics of Sports	SS Ballroom ABC
6:30–7:50 p.m.	CB	PER: Student Reasoning I	HC 3023 & 3023A
6:30–8 p.m.	CC	Best Practices in the Use of Educational Technologies III	HC 3029
6:30–8 p.m.	CH	Science and Society	SS Ballroom F
8–9:30 p.m.	PST1	Poster Session I	Kiewit Fitness Center

TUESDAY, August 2

6:30–7:30 a.m.		AAPT Fun Run/Walk	13th and Douglas Sts.
7 a.m.–4:30 p.m.		**Registration**	**HC South Lounge**
7:30–8:30 a.m.		Physics Bowl Advisory Committee	HC 3040
8 a.m.–5 p.m.		PIRA Resource Room	HC 2066
8 a.m.–5 p.m.		TYC Resource Room	HC 3053
8 a.m.–5 p.m.		Apparatus Competition	HC 2060
8 a.m.–5 p.m.		H.S. Photo Contest Viewing and Voting	HC South Lounge
8 a.m.–5 p.m.		Poster Session II Setup	Kiewit Fitness Center
8:30–9:30 a.m.	DC	Digital Textbooks: Possibilities and Perils	HC 3029
8:30–9:30 a.m.	DG	New AP B Where Are You?	HC 3048
8:30–9:40 a.m.	DA	Interactive Lecture Demonstrations: Physics Suite Materials that Enhance Learning	HC 3027
8:30–9:40 a.m.	DJ	Upper Division Undergraduate	HC 3040
8:30–9:50 a.m.	DH	Research on Learning Assistants and TAs	SS 104
8:30–9:50 a.m.	DI	PER: Student Reasoning II	HC 3023 & 3023A
8:30–10 a.m.	DB	Adjunct Faculty Issues	HC 3028
8:30–10 a.m.	DD	Astronomical Image Processing	SS Ballroom DE
8:30–10 a.m.	DF	Research-based Pedagogy in the High School	SS 105
8:30–10:10 a.m.	DE	The Big Bang Effect: Representation of Physicists in Popular Culture	SS Ballroom ABC
10–10:30 a.m.		National AAPT “What’s in it for High School Teachers?”	HC 3023 & 3023A
10 a.m.–4 p.m.		**Exhibit Hall Open (coffee break 10–10:30 a.m.)**	**HC Ballroom, 4th Floor**
10:30 a.m.–12:15 p.m.	**Awards**	**Millikan Medal and AAPT Teaching Awards**	**HC Hixson-Lied Aud.**
12:15–1:15 p.m.	CW01	WebAssign Commercial Workshop	HC 3042
12:15–1:15 p.m.	Crkrbrl-02	Crackerbarrel on Professional Concerns of PER Solo Faculty	HC 3029
12:15–1:15 p.m.	Crkrbrl-03	Crackerbarrel on Adjunct Issues	HC 3028
12:15–1:15 p.m.	Crkrbrl-04	Crackerbarrel on Using Simulations Interactively in the Classroom	HC 3027
12:15–1:15 p.m.	Crkrbrl-05	Crackerbarrel on New Methods of Teacher Evaluations	HC 3023 & 3023A
12:15–1:15 p.m.		Audit Committee	HC 3048
1:15–2:15 p.m.	EA	Impact of New K-12 Standards on Teachers and Teacher Training (Panel)	SS Ballroom ABC
1:15–2:15 p.m.	EI	Physics Education Research Around the World II	HC 3028
1:15–2:45 p.m.	EE	Upper Division Laboratories: Ideas, Equipment and Techniques	SS 105
1:15–2:45 p.m.	EG	The Art and Science of Teaching	HC 3029
1:15–3:15 p.m.	EB	PER: Topical Understanding and Attitudes	HC 3023 & 3023A
1:15–3:15 p.m.	EC	Educating the Larger Public about Science: Lessons from Public Institutions (Panel)	HC 3027
1:15–3:15 p.m.	EF	Reforming the Introductory Physics Course for Life Science Majors V (Posters)	SS 104
1:15–3:15 p.m.	EH	Research on Student Learning of Energy	SS Ballroom DE
1:15–3:05 p.m.	EJ	Recruiting Students to High School Physics	SS Ballroom F
2:15–3:15 p.m.	ED	What Do We Know About Web 2.0?	HC 3048
3:15–3:45 p.m.		Great Book Giveaway – **Break in Exhibit Hall**	**HC Ballroom, 4th Floor**
3:15–4:15 p.m.		Synergy: High School Physics Teachers Networking Event	Hixson-Lied Sci. Bldg.
3:45–5:15 p.m.		Little Shop of Physics Demos Display	HC 3023B
3:45–5:15 p.m.		Research in Physics Education Committee	HC 3023
3:45–5:15 p.m.		Physics in Pre-High School Education Committee	HC 3027
3:45–5:15 p.m.		Graduate Education in Physics Committee	HC 3028
3:45–5:15 p.m.		Space Science and Astronomy Committee	HC 3048
3:45–5:15 p.m.		Interests of Senior Physicists Committee	HC 3040
3:45–5:15 p.m.		Apparatus Committee	HC 3029

4–6 p.m.	CW02	Vernier Commercial Workshop	HC 3042
4:45–5:15 p.m.		High School Teacher First Timers Gathering	SS 105
5:15–6:45 p.m.		Poster Session II	Kiewit Fitness Center
7:15–8:15 p.m.		Pizza Extravaganza	Doubletree Ballroom
8:30–10 p.m.		Demo Show: An Enchanting Evening of Physics and Magic	Doubletree Ballroom

WEDNESDAY, August 3

7–8:20 a.m.		Programs Committee II	SS Ballroom ABC
7–8:30 a.m.		Governance Structure Committee	HC 3048
7:30–8:30 a.m.		Finance Committee	HC 3040
8 a.m.–3 p.m.		**REGISTRATION**	**HC South Lounge**
8 a.m.–3 p.m.		PIRA Resource Room	HC 2066
8 a.m.–3 p.m.		TYC Resource Room	HC 3053
8 a.m.–12 p.m.		Apparatus Competition	HC 2060
8–9:30 a.m.	FE	Developing Teacher Leaders	SS Ballroom F
8–9:50 a.m.	FA	PER: Investigating Classroom Strategies II	HC 3023A & 3023
8–10 a.m.	FB	Teaching Physics Around the World	HC 3027
8–10 a.m.	FD	Physics and Society Education	HC 3029
8–10 a.m.	FH	Assessment Beyond Conceptual Inventories	SS 104
8–9:30 a.m.	FI	Teacher Recruitment, Training and Enhancement	SS 105
8–10 a.m.	FF	Introductory Courses	SS Ballroom DE
8:30–9:50 a.m.	FC	Innovative Labs for Introductory Courses	HC 3028
8:30–10 a.m.	FG	New Avenues for Collaboration and Mentoring (Panel)	SS Ballroom ABC
10:15–11:30 a.m.	**Awards**	**Klopsteg Memorial Award – James Hansen; DSCs**	**HC Hixson-Lied Audit.**
11:30 a.m.–1 p.m.		Nominating Committee II	HC 3023B
12–1 p.m.		PERLOC	HC 3048
12–1 p.m.	Crkrbrl 06	Crackerbarrel for PER Graduate Students	HC 3027
12–1 p.m.	Crkrbrl 07	Crackerbarrel on Physics and Society Education	HC 3028
12–1 p.m.	Crkrbrl 08	Crackerbarrel on Ideas and Resources for Using History to Teach Physics	HC 3029
12–1 p.m.		ALPhA meeting	HC 3023 & 3023A
1–1:30 p.m.	GD	PER in the High School	HC 3023 & 3023A
1–2:10 p.m.	GA	Post Deadline Session	HC 3040
1–2 p.m.	GB	High Performance Computing	HC 3028
1–2:20 p.m.	GC	Laboratories for Astronomy	HC 3029
1–2:30 p.m.	GH	PER: Problem Solving II	SS Ballroom ABC
1–3 p.m.	GE	Major Consequences of Minor Dishonesty in Physics Classes	HC 3027
1–3 p.m.	GF	Research in Undergraduate Math Education	SS Ballroom DE
1–5 p.m.		Omaha's Henry Doorly Zoo Tour	Offsite
3–4 p.m.		Investment Advisory Committee	HC 3040
3–6 p.m.		Executive Board II	Doubletree Midlands
3:15–4:45 p.m.	HA	PERC Bridging Session	HC Hixson-Lied Audit.
5–7 p.m.		PERC Banquet	HC Ballroom C
7–10 p.m.		PERC Poster Session	HC Ballroom B

Special Events at the Summer Meeting

Saturday, July 30

Omaha Energy Tour

3:00 to 6:00 p.m. No Fee

Innovative educational programs in alternative energy and sustainability currently developed in the Omaha area at Creighton University, Metropolitan Community College, and the University of Nebraska. (meet at Harper Center)

TYC Dinner at Fort Omaha

6:30 p.m. $30

TYC Dinner at the Historic Fort Omaha Campus Metropolitan Community College. The evening includes a campus tour with dinner on the veranda of officers' row overlooking the campus, flower gardens, and parade ground built in the late 1800s. (meet at Harper Center)

Sunday, July 31

Strategic Air & Space Museum Tour

1:00 to 5:00 p.m. $12/$4

Impressive set of exhibits that celebrate the history of aviation and space. During your visit, a John Wayne memorabilia exhibit will be featured.

A cafe is open to purchase food until 4 p.m. (meet at Harper Center)

Exhibit Show/ Welcome Reception

8:00 to 10:00 p.m. No Fee
Harper Center Ballroom 4th Floor

Browse the Exhibit Hall and see what's new in the physics teaching world.

Hall open Monday and Tuesday, beginning at 10 a.m.

Monday, August 1

1st Timers' Gathering

7:00 to 8:00 a.m. No Fee
Room: Skutt Student Center 105

Are you new to an AAPT National Meeting? If so, this is the best time to learn about AAPT and the Summer Meeting, as well as meet fellow attendees.

AAPT leadership will be represented to discuss ways to get more involved with AAPT.

Retired Physicists' Breakfast

7:00 to 8:00 a.m. $25
Room: HC 3023B

Start your day by networking and exchanging ideas with our long-served and deserving supporters of AAPT.

Spouses' Gathering

10:00 to 11:00 a.m. No Fee
Room: HC 3023B

Connect with other spouses and partners of AAPT attendees and plan an Omaha outing.

Learn about local attractions from an Omaha Convention and Visitor's Bureau representative.

Young Physicists' Meet & Greet

11:30 a.m. to 12:30 p.m. No Fee
Room: HC 3023B

Mix and mingle with other young physicists.

Tuesday, August 2

AAPT Fun Run/Walk

6:30 to 7:30 a.m. $20
13th and Douglas Sts.

3rd Annual AAPT Fun Run/ Walk will travel through beautiful downtown Omaha to the new Bob Kerrey bridge that s-curves its way across the Missouri River to Iowa.

Water and an after race breakfast will be provided.

The $20 donation will benefit AAPT's programs.

Pizza Extravaganza/ Demo Show

7:15 to 10:00 p.m. $12/$10
Doubletree Hotel Ballroom

Enjoy a night out with your AAPT friends and family over pizza. A bar will be available to purchase beer. The pizza event will be held at the Doubletree Hotel prior to the demo show, "An Evening of Physics and Magic."

Wednesday, August 3

Henry Doorly Zoo

1:00 to 5:00 p.m. $10

Omaha's Henry Doorly Zoo is nationally renowned for its leadership in animal conservation and research. It includes one of the world's largest indoor rainforests (Lied Jungle), the world's largest indoor desert (Desert Dome), and the largest Cat Complex in North America. (meet at Harper Center)

2011AAPT Omaha Communicating Physics Outside the Classroom

Committee Meetings

Saturday, July 30

PTRA Advisory Board	6:30–7:30 p.m.	Doubletree Midland-Iowa
Review Board	6:30–7:30 p.m.	Doubletree Dakota
Awards	7:30–9:30 p.m.	Doubletree Midland-Missouri

Sunday, July 31

Publications	8–10:30 a.m.	HC 3053
Meetings	8–10:30 a.m.	HC 3048
Nominating	10:30–11:30 a.m.	HC 3053
Programs I	5:30–6:30 p.m.	HC 3029
Section Representatives	6:30–8 p.m.	SS Ball. ABC
History & Philosophy of Physics	6:30–8 p.m.	HC 3048
Physics in Two-Year Colleges	6:30–8 p.m.	HC 3053
Women in Physics	6:30–8 p.m.	HC 3027
Laboratories	6:30–8 p.m.	HC 3023B
SI Units and Metric Education	6:30–8 p.m.	HC 3029

Monday, August 1

Bauder Endowment	7–8 a.m.	HC 3040
PERTG Town Hall	11:30 a.m–12:30 p.m.	HC 3023
Membership & Benefits	11:30 a.m.–12:45 p.m.	HC 3042
Science Education for the Public	11:30 a.m.–1 p.m.	HC 3029
Educational Technologies	11:30 a.m.–1 p.m.	HC 3028
Teacher Preparation	11:30 a.m.–1 p.m.	HC 3027
Minorities in Physics	11:30 a.m.–1 p.m.	HC 3048
International Physics Education	11:30 a.m.–1 p.m.	SS Ball. F
Professional Concerns	5–6:30 p.m.	HC 3029
Physics in Undergraduate Education	5–6:30 p.m.	HC 3048
Physics in High Schools	5–6:30 p.m.	HC 3028
PIRA meeting	5–6:30 p.m.	HC 3027

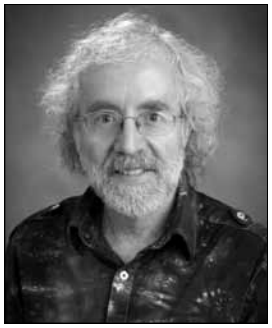
Tuesday, August 2

Physics Bowl Advisory	7:30–8:30 a.m.	HC 3040
Audit	12:15–1:15 p.m.	HC 3048
Research in Phys. Education (RIPE)	3:45–5:15 p.m.	HC 3023
Physics in Pre-High School Educ.	3:45–5:15 p.m.	HC 3027
Graduate Education in Physics	3:45–5:15 p.m.	HC 3028
Space Science and Astronomy	3:45–5:15 p.m.	HC 3048
Interests of Senior Physicists	3:45–5:15 p.m.	HC 3040
Apparatus	3:45–5:15 p.m.	HC 3029

Wednesday, August 3

Programs II	7–8:20 a.m.	SS Ball. ABC
Governance Structure	7–8:30 a.m.	HC 3048
Finance	7:30–8:30 a.m.	HC 3040
Nominating II	11:30 a.m.–1 p.m.	HC 3023B
PERLOC	12–1 p.m.	HC 3048
Investment Advisory	3–4 p.m.	HC 3040

Robert A. Millikan Medal



Brian Jones
Colorado State University
Physics Department
Fort Collins, CO

Tuesday, August 2
10:30 a.m.
Harper Center
Hixson-Lied Auditorium

All I Really Need to Know About Physics Education I Learned in Kindergarten

The Robert A. Millikan Medal for 2011 is presented to **Brian Jones** for his work as the developer and director of the Little Shop of Physics. Mr. Jones holds a BS degree in Physics from Case Western Reserve University and an MS degree in Physics from Cornell University. He teaches at Colorado State University, where he also supervises the undergraduate physics laboratories and from which he has received several teaching awards. He has been involved in AAPT for over two decades, serving as a member of the Committee on Laboratories and the Committee on Science Education for the Public and presenting numerous workshops at AAPT national meetings. He is an active member of the Colorado-Wyoming section and served a term as its president. Mr. Jones has been recognized in a *People* magazine profile; was selected as one of 75 physics educators profiled in AAPT's 75th anniversary booklet "Celebrating 75 Years of Excellence in Enhancing the Understanding and Appreciation of Physics Through Teaching"; is co-author of *College Physics: A Strategic Approach*; and has co-developed hands-on science activity kits on electricity, pressure, energy, and motion.

The heart of the Little Shop of Physics is its hands-on traveling program, which is based at CSU. Each year, the Little Shop crew visits over 40 different schools and makes presentations to approximately 20,000 K-12 students. In addition, the Little Shop of Physics presents teacher workshops, hosts an annual open house, and produces the television show Everyday Science in cooperation with the local Poudre School District. The Little Shop of Physics website features simple physics experiments, interactive experiments, and resources for K-12 teachers and has more than 200 visitors daily.

In describing Mr. Jones to the AAPT Awards Committee, former AAPT President Chris Chiaverina said, "His life-long passion for communicating both the content and beauty of physics to diverse audiences is exemplary; his impact on his students, his colleagues, the local, national and international physics teaching community, and the public is extraordinary. Simply stated, Brian Jones is an evangelist for physics."

Established in 1962, the Robert A. Millikan Medal recognizes those who have made notable and intellectually creative contributions to the teaching of physics.

Klopsteg Memorial Lecture Award

James E. Hansen
NASA Goddard Institute for Space Studies
New York City

Wednesday, August 3
10:15 a.m.
Harper Center
Hixson-Lied Auditorium

Halting Human-Made Climate Change: The Case for Young People and Nature

The Klopsteg Memorial Lecture Award for 2011 is presented to **James E. Hansen** for his skill in communicating his work on global climate change to the general public. Dr. Hansen received all of his degrees (BA in Physics and Mathematics, MS in Astronomy, PhD in Physics) from the University of Iowa in the space science program of James Van Allen. He participated in the NASA graduate traineeship from 1962 to 1966 and, in 1965 and 1966, he was also a visiting student at the Institute of Astrophysics at the University of Kyoto and in the Department of Astronomy at the University of Tokyo. Dr. Hansen began work at the NASA Goddard Institute for Space Studies in New York City in 1967 and currently heads that Institute. He is also an adjunct professor in the Department of Earth and Environmental Sciences at Columbia University.

Dr. Hansen is a well-known authority on climate change. His testimony on that topic to congressional committees in 1988 helped raise broad awareness of the threats of climate change. In 1996, he was elected to the National Academy of Sciences for his "development of pioneering radiative transfer models and studies of planetary atmospheres; development of simplified and three-dimensional global climate models; explication of climate forcing mechanisms; analysis of current climate trends from observational data; and projections of anthropogenic impacts on the global climate system." In 2006, *Time* magazine listed him as one of the 100 Most Influential People. A year later, he shared the Dan David Prize for "achievements having an outstanding scientific, technological, cultural or social impact on our world." In 2008, he was named by EarthSky Communications as the Scientist Communicator of the Year. He was the 2010 winner of the Sophie Prize for his "key role for the development of our understanding of human-induced climate change."

Established in 1990 and named in memory of Paul Klopsteg, an American physicist and past AAPT President, the Klopsteg Memorial Lecture Award recognizes outstanding communication of the excitement of contemporary physics to the general public.

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

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

Edward E. Prather
University of Arizona
Dept. of Astronomy
Tucson, AZ

Tuesday, August 2
10:30 a.m.
Harper Center
Hixson-Lied Auditorium

Teaching Space Science: A STEM Transformation Vehicle that Really Works

The 2011 David Halliday and Robert Resnick Award for Excellence in Undergraduate Physics Teaching is presented to **Edward E. Prather** for his role as a driving force in the creation of both research-validated curricula and tools for assessment for introductory astronomy and for his conduct of research programs to investigate students' conceptual and reasoning difficulties in astronomy, astrobiology, physics, and planetary science, programs leading to the development of innovative instructional strategies that engage learners and significantly improve their understanding of fundamental Earth and space science concepts. Dr. Prather received a BS degree in Physics and Astronomy from the University of Washington and a PhD in Physics from the University of Maine. He is Associate Professor in the Department of Astronomy–Steward Observatory at the University of Arizona. In 2004, he was appointed Executive Director of the NSF, NASA, and JPL funded Center for Astronomy Education.

Dr. Prather's primary responsibility is to teach large-enrollment general education introductory college astronomy courses but he has also taught in-person and online graduate courses in astronomy and astronomy education, calculus-based introductory physics courses, and physics courses for non-majors and for pre and in-service teachers. His work in Astronomy Education Research has been published in the *American Journal of Physics,* in *Physics Today*, and in *Astronomy Education Review.* In 2006, his work was recognized with the University of Arizona Provost's General Education Teaching Award and, in 2009, he received the 2009 University of Arizona College of Science Innovation in Teaching Award. Dr. Prather's interactive classroom environment challenges his students to step out of their comfort zones, to take chances on being wrong, and to take charge of their learning.

Established in 1993 but now named for the authors of a very successful college-level textbook in introductory physics and funded since 2010 primarily by a generous endowment from John Wiley and Sons, the publisher of that textbook, the David Halliday and Robert Resnick Award for Excellence in Undergraduate Physics Teaching recognizes outstanding achievement in teaching undergraduate physics, which may include the use of innovative teaching methods.

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

Stacy McCormack
Penn High School
Mishawaka, IN

Tuesday, August 2
10:30 a.m.
Harper Center
Hixson-Lied Auditorium

Blond Girls Can't Learn Physics

The Paul W. Zitzewitz Award for Excellence in Pre-College Physics Teaching for 2011 is presented to **Stacy McCormack** for her outstanding teaching of physics at Penn High School in Mishawaka, IN. In recommending her for this award, Steve Hope, principal of Penn High School, said, "Stacy is nothing short of a master teacher. She maintains high standards, teaches to every modality through a wide variety of creative assignments, differentiates her instruction to meet individual needs, personalizes instruction, incorporates current technology, and uses current research to guide her teaching. Stacy creates an atmosphere of support, healthy risk taking, and camaraderie in her classes. She has taken technology and integrated that with her best practices to further motivate and engage students." Ms. McCormack holds a BS degree in Secondary Education from Indiana University and an MA degree in Physics Education from Ball State University. She has received numerous awards, including Indiana State Teacher of the Year 2011, Penn-Harris-Madison 2010 Teacher of the year, and the Martha Lee and Bill Armstrong Teacher Educator award. She has been involved in the Quarknet Research Experience for Teachers program at the University of Notre Dame, and she was selected as one of five teachers in the United States to attend a three-week conference at CERN during the summer of 2006.

A teacher of First Year Physics, Integrated Chemistry/Physics, and online adjunct instructor of astronomy, physics, and physical science classes for Ivy Tech Community College, Ms. McCormack is also the author of *Teacher Friendly Physics*, a book designed to help science teachers plan affordable lab projects.

Established in 1993 and funded since 2010 by a generous gift to AAPT from Paul W. and Barbara S. Zitzewitz and named for Paul W. Zitzewitz, the principal author of the highly acclaimed and widely adopted high school physics text *Physics: Principles and Problems* and a long-time member and supporter of AAPT, the Paul W. Zitzewitz Award for Excellence in Pre-College Physics Teaching recognizes outstanding achievement in teaching pre-college physics.

Wednesday, August 3, 10:15 a.m. • Harper Center Hixson-Lied Auditorium

Andrew C. Isola (Drew)

Drew Isola
Allegan H.S.
Allegan, MI

Drew Isola is presented with a 2011 Distinguished Service Citation in recognition of several roles he has played in support of AAPT's mission. He has been a member of the Committee on Teacher Preparation, President of the Michigan Section, and program chair for a number of Michigan section meetings. He is the only high school teacher on the National Task Force on Teacher Education in Physics. He has been actively involved in the PhysTEC Project as the 2005-07 Teacher-in-Residence at Western Michigan University and as part of the Project Leadership Team at the national level. He has served for many years as a consultant and presenter of professional development workshops for science teachers both locally and at the state level through the Michigan Math and Science Centers Network. He also served as a member of the writing team for the current version of Michigan's High School Science Content Expectations and as a coach for several teams that competed in the Michigan Science Olympiad.

Dr. Isola holds a BS degree in Mathematics from Michigan Technological University and MS and PhD degrees in Science Education from the Mallinson Institute for Science Education. Since 1994, he has taught physics and mathematics at Allegan High School in Allegan, MI. He has also taught mathematics and science in middle school level courses for honors, grade-level, and below grade-level students.

Todd Leif

Todd Leif
Cloud County C.C.
Concordia, KS

Todd Leif is presented with a 2011 Distinguished Service Citation in recognition of his service to AAPT as the Arkansas, Oklahoma, Kansas Section Representative, and as a member of the Membership and Benefits, Educational Technologies, Nominating, and Physics in Two-Year Colleges Committees. Earlier in his career he worked with The Physics Enhancement Project for Two Year Colleges and TYC21. He is currently the Co-PI on the AAPT/NSF Grant for Two-Year College New Faculty Experience. After a successful pilot project, the grant team is developing and conducting workshops for new faculty. These workshops bring current physics education research into the classrooms of the most recent physics teaching hires among two-year colleges. Dr. Leif is a well known author and presenter, especially in the Two-Year College Physics Education area and has been published in *The Physics Teacher.*

Dr. Leif holds a BS degree in Physics and Mathematics and an MAT degree in Physics Education from Hastings College, Hastings, NE, and a PhD degree in Science Education from Kansas State University. He is currently Chair of the Department of Physical and Biological Sciences at Cloud County Community College in Concordia, KS. He also serves as an academic advisor and as a head coach for the Academic Excellence program.

John L. Roeder

John L. Roeder
The Calhoun School
New York, NY

John L. Roeder is presented with a 2011 Distinguished Service Citation in recognition of his service to AAPT and the physics education community. Dr. Roeder has served as a Physics Teaching Resource Agent (PTRA) since 1985 and is the author of the PTRA resource book, *Teaching About Energy,* published by AAPT in 2009. He was elected to the Executive Board in 2005 as a Member-at-Large representing the high school community. Over the years, his contributions have benefitted many committees, including Publications, History and Philosophy of Physics, Bauder Endowment, Venture Fund, Lotze Scholarship, Physics in High Schools, Review Board, Audit, Awards, and Science Education for the Public. Additionally, Dr. Roeder has served as Secretary/Treasurer for The Physics Club of New York since 1986. Most recently he volunteered to serve as an AAPT eMentor.

A science teacher at The Calhoun School in New York City since 1973, Dr. Roeder holds an AB degree in Physics from Washington University and MA and PhD degrees in Physics from Princeton University.

R. Steven Turley

R. Steven Turley
Brigham Young University
Provo, UT

R. Steven Turley is presented with a 2011 Distinguished Service Citation in recognition of his service to AAPT in many contexts. Dr. Turley is an active member of the Idaho/Utah Section of AAPT. He served on the Committee on Physics in Undergraduate Education (2003-06), the Committee on Graduate Education in Physics (2007-09), and on the AAPT Nominating Committee (2008-10), chairing that Committee for the 2010 election. Beyond AAPT, he serves science education—and indirectly AAPT's mission—as a member of the Utah Academy of Sciences, Arts and Letters (and as President of that Academy in 2007-2009) and currently is Associate Affiliate Director of the Rocky Mountain Space Grant Consortium and Director of NSF-sponsored Research Experiences for Undergraduates in Physics.

Dr. Turley holds a BS degree from Brigham Young University and a PhD degree from MIT. He is currently a member of the faculty of the Department of Physics and Astronomy at BYU, where he was department chair from 2000-2003 and was Associate Dean of Undergraduate Education from 2003-2008. Prior to 1995, he worked as Senior Research Staff Physicist at Hughes Aircraft Company Research Laboratories.

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.

AIP Science Writing Award – Children's Category

Wednesday, August 3, 10:15 a.m. • Harper Center Hixon Lied Auditorium

The 2010 winner of the American Institute of Physics Children's Writing Award is Canadian author Gillian Richardson for her book *Kaboom! Explosions of All Kinds*. From the Big Bang to the pop of a seedpod, from solar flares to the explosive gasses inside a car engine, Richardson enables readers to learn about the science behind explosions of all kinds.

Gillian Richardson

Reaching Out to the Public – A Necessary Dialogue

Monday, August 1, 10:30–11:30 a.m. • Harper Center Hixson-Lied Auditorium

Jill Marshall, presider

James H. Stith is former vice president of the Physics Resources Center for the American Institute of Physics. His Doctorate in Physics was earned from The Pennsylvania State University, and his Masters and Bachelors in Physics were received from Virginia State University. A physics education researcher, his primary interests are in Program Evaluation and Teacher Preparation and Enhancement. He was formerly a Professor of Physics at The Ohio State University and spent 21 years on the faculty of the United States Military Academy at West Point.

He is a past president of AAPT, past president of the National Society of Black Physicists, a fellow of the American Association for the Advancement of Science, a fellow of the American Physical Society, a chartered fellow of the National Society of Black Physicists, and a member of the Ohio Academy of Science. Additionally, he serves on a number of national and international advisory boards.

James H. Stith

APS Division of Condensed Matter Physics Session: Frontiers in Nanoscience

Monday, August 1, 3:30–5 p.m. • Harper Center Hixson-Lied Auditorium

Dick Peterson, presider

– A Perspective on the Future of Nanotechnology (3:30–4:15 p.m.)

Barbara Jones leads the theoretical and computational physics project at IBM's Almaden Research Center in San Jose, CA. She received an AB degree in Physics from Harvard University in 1982, and MS and PhD degrees in Physics from Cornell University. Currently she leads research to calculate the effects of magnetic atoms, in clusters or nanolattices, on metallic/insulating surfaces, as engineered and measured by STM. Jones is a fellow of the American Physical Society, and is the 2001 recipient of a TWIN Award (Tribute to Women in Industry). She is currently Chair-Elect of the Division of Condensed Matter Physics of the APS, Chair in 2012. Chair and Founder of the APS/IBM Research Internship for Undergraduate Women, member and past Chair of the American Physical Society (APS)'s Committee on the Status of Women in Physics (1999-2002), and past chair of the IBM Almaden Diversity Council, she is strongly interested in promoting opportunities in science and math for all students.

Barbara Jones

– Etch-a-Sketch Nanoelectronics (4:15–5 p.m.)

Jeremy Levy is a professor at the University of Pittsburgh in the Department of Physics and Astronomy. He received an AB degree in Physics from Harvard University in 1988, and a PhD in Physics from UC Santa Barbara in 1993. After a post-doctoral position at UC Santa Barbara, he joined the University of Pittsburgh in 1996. His research interests center around the emerging field of oxide nanoelectronics, experimental and theoretical realizations for quantum computation, semiconductor and oxide spintronics, quantum transport and nanoscale optics, and dynamical phenomena in oxide materials and films. He is a Fellow of the American Physical Society, and is the recipient of the 2008 Nano50 Innovator Award, and the NSF Career Award. He has received the University of Pittsburgh's Chancellor's Distinguished awards for research (2004, 2011) and teaching (2007). He is Director of the Center for Oxide-Semiconductor Materials for Quantum Computation, and leads a Multidisciplinary University Research Initiative (MURI) on Quantum Preservation, Simulation and Transfer in Oxide Nanostructures.

Jeremy Levy

Free Commercial Workshops

CW01: WebAssign: Using WebAssign to Manage your Lab Sequence!

Location: Harper Center 3042
Date: Tuesday, August 2
Time: 12:15–1:15 p.m.
Sponsor: WebAssign

Leader: John Risley

Since 1997, WebAssign has been the online homework system of choice for the introductory physics lecture courses. Through our partnerships with every major publisher, WebAssign supports over 100 introductory physics textbooks with precoded, assignable questions and advanced learning tools. WebAssign For Your Labs is a simple solution to deliver WebAssign's same powerful course tools already in use at more than 1700 schools, but with your own original lab experiments as the source material. We don't expect to replace the traditional lab sequence with virtual lab experiments, and you don't need computer stations in your laboratory. WebAssign For Your Labs works with your existing experiments and lab materials to let you collect and instantly grade students lab results; provide immediate guidance and feedback for students; and standardize grading across all lab sessions. Learn how WebAssign can help you increase student preparedness and decrease student cost in the introductory lab sequence.

CW02: Vernier Software: New Data Collection Tools for Physics

Location: Harper Center 3042
Date: Tuesday, August 2
Time: 4–6 p.m.
Sponsor: Vernier Software & Technology

Leaders: David Vernier, John Gastineau

Attend this hands-on, drop-in workshop to learn about 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:

- Give the new Centripetal Force Apparatus a spin. Collect data either with LabQuest or Logger Pro, and see how easy it is to do this otherwise difficult experiment.
- Check out the activities in the new Advanced Physics with Vernier–Mechanics book.
- Use our Rotary Motion Sensor with its Accessory Kit to look at rotational dynamics.
- Explore the Audio Function Generator on Vernier LabQuest.
- Use our new Power Amplifier to study electrical circuits or to investigate resonance.
- Experiment with our Optics Expansion Kit, including the new Color Mixer Kit.
- Use the Vernier Spectrometer to collect emission spectra of our new Spectrum Tube Systems.
- Use the LabQuest Mini interface with Logger Pro.
- Use our Bumper and Launcher kit with the Vernier Dynamics System, including the new 2.2 meter track.
- Try out some of the engineering/physics projects in our two great new books: *Hands on Introduction to NI LabVIEW with Vernier* and *Engineering Projects with Vernier*.

CW03: Physics2000.com Commercial Workshop

Location: Harper Center 3040
Date: Monday, August 1
Time: 11:30 a.m.–12:45 p.m
Sponsor: Physic2000.com

Leader: Elisha Huggins

Come to the popular Physics2000 workshop where we show you how to teach special relativity in the first week of an introductory physics course, and then how to fit 20th and 21st century physics into your course. We also show you how to introduce Fourier analysis using the free MacScope audio oscilloscope program (which works on Macs and Windows), ending up with an intuitive explanation of the time-energy form of the uncertainty principle. This approach is followed in the new non-calculus version of the Physics2000 text, as well as the calculus version which we introduced in January 2000.

Session Sponsors Listing by AAPT Committee

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Exhibitor Information

American Assoc. of Physics Teachers

Booths 403, 405, 407, 409
One Physics Ellipse
College Park, MD 20740
Melissa Lapps
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– If you are interested in a partnership with the **AAPT/PTRA Program** to develop a precollege physics and physical science teacher professional development grant, visit the PTRA display and leaders at the AAPT booth. The AAPT/PTRA leadership has experience, application templates and will assist with the development of grant proposals.

ComPADRE

Booth 409; **compadre.org**

The ComPADRE Digital Library is a network of free online resource collections supporting faculty, students, and teachers in Physics and Astronomy Education. Each of our collections contain materials designed for a specific community. Stop by our booth to browse the many resources available!

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Monday, August 1, 2011 – Session Schedule

Rooms are at Creighton University – Poster Session I is in Kiewit Fitness Center Courts, 8 to 9:30 p.m.

	Harper Center 3028	Harper Center 3027	Skutt Student Center Ballroom DE	Skutt Student Center 105	Harper Center 3023 & 3023A	Skutt Student Center Ballroom F	Skutt Student Center Ballroom ABC	Harper Center 3029	Skutt Student Center 104	Harper Center 3048	Harper Center 3040	Harper Center Hixson-Lied Audit.
8:00 a.m.	**AA** PIRA: Outreach from the Ground Up	**AB** Objectives and Assessment of the Physics Graduate Program	**AC** Physics Education Research Around the World I	**AD** Reflections on Gordon Conference on Experimental Research	**AE** PER: Investigating Classroom Strategies I	**AF** Learning Progressions	**AG** Methods to Improve Conceptual Learning in Quantum Mechanics I	**AH** Best Practices in the Use of Educational Technologies I	**AI** Potpourri of Teacher Preparation Programs I			
10:30 a.m.												**Plenary:** Reaching Out to the Public
11:30 a.m.							**Crkrbrl 1** Faculty in Small Departments					
1:00 p.m.		**BA** Don't Put that Phone Away: Personal Electronics in Classroom	**BG** Energy and the Environment	**BJ** Astronomy Teaching and Learning	**BC** PER: Problem Solving I	**BH** Induction and Mentoring of Physics Teachers	**BF** ***Panel:*** Spacetime Physics	**BB** Best Practices in the Use of Educational Technologies II	**BI** Cross Campus Collaboration: What I Learned From Liberal Arts	**BD** Literature in Teaching Physics	**BE** Preparing Minority Students for Graduate School	
3:30 p.m.												**Plenary:** APS Division: Frontiers in Nanoseconds
6:30 p.m.	**CI** Conceptual Learning in Quantum Mechanics II	**CA** Use and Misuse of Lasers	**CG** Indigenous Astronomy		**CB** PER: Student Reasoning I	**CH** Science and Society	**CF** Physics of Sports	**CC** Best Practices in the Use of Educational Technologies III	**CJ** Potpourri of Teacher Preparation Programs II	**CD** Alternative Assessments and Practicums	**CE** Online Courses and Simulated Learning	

AAPT PHYSICS EDUCATION

Tuesday, August 2, 2011 – Session Schedule

Rooms are at Creighton University – Poster Session II is in Kiewit Fitness Center Courts, 5:15 to 6:45 p.m.

	Harper Center 3028	Harper Center 3027	Skutt Student Center Ballroom DE	Skutt Student Center 105	Harper Center 3023 & 3023A	Skutt Student Center Ballroom F	Skutt Student Center Ballroom ABC	Harper Center 3029	Skutt Student Center 104	Harper Center 3048	Harper Center 3040	Harper Center Hixson-Lied Audit.
8:30 a.m.	**DB** Adjunct Faculty Issues	**DA** Interactive Lecture Dem-onstrations: Physics Suite Materials	**DD** Astronomical Image Processing	**DF** Research-based Pedagogy in the High School	**DI** PER: Student Reasoning II		**DE** The Big Bang Effect: Representation of Physicists in Popular Culture	**DC** Digital Textbooks: Possibilities and Perils	**DH** Research on Learning Assistants and TA's	**DG** New AP B Where Are You?	**DJ** Upper Division Undergraduate	
8:45 a.m.												
9:00 a.m.												
9:30 a.m.												
10:00 a.m.					*AAPT & H.S. Teachers*							
10:30 a.m.												**Awards:** Millikan & Teaching Awards
11:00 a.m.												
11:30 a.m.												
12:15 p.m.	**Crkrbrl 3** Crackerbarrel on Adjunct Issues	**Crkrbrl 4** Using Simula-tions Interactively in the Classroom			**Crkrbrl 5** New Methods of Teacher Evaluations			**Crkrbrl 2** Professional Concerns of PER Solo Faculty				
12:30 p.m.												
1:00 p.m.												
1:15 p.m.	**EI** PER Around the World II	**EC** ***Panel:*** Educating the Larger Public about Science: Lessons from Public Institu-tions	**EH** Research on Student Learning of Energy	**EE** Upper Division Laboratories: Ideas, Equip-ment and Techniques	**EB** PER: Topical Understand-ing and Attitudes	**EJ** Recruiting Students to High School Physics	**EA *Panel:*** Impact of New K-12 Standards	**EG** The Art and Science of Teaching	**EF** Reforming the Introduc-tory Physics Course for Life Science Majors V			
2:00 p.m.												
2:15 p.m.										**ED** What Do We Know about Web 2.0?		
2:30 p.m.												
3:00 p.m.												
3:15 p.m.												
3:30 p.m.					*Little Shop of Physics Demos Display*							
4:00 p.m.												
4:30 p.m.				*H.S. Teachers First Timers Gathering*								
5:00 p.m.												
5:15 p.m.												
5:30 p.m.												

AAPT PHYSICS EDUCATION

Wednesday, August 3, 2011 – Session Schedule

Rooms are at Creighton University

	Harper Center 3028	Harper Center 3027	Skutt Student Center Ballroom DE	Skutt Student Center 105	Harper Center 3023 & 3023A	Skutt Student Center Ballroom F	Skutt Student Center Ballroom ABC	Harper Center 3029	Skutt Student Center 104	Harper Center 3048	Harper Center 3040	Harper Center Hixson-Lied Audit.
8:00 a.m.		**FB** Teaching Physics Around the World	**FF** Introductory Courses	**FI** Teacher Recruitment, Training, and Enhancement	**FA** PER: Investigating Classroom Strategies II	**FE** Developing Teacher Leaders		**FD** Physics and Society Education	**FH** Assessment Beyond Conceptual Inventories			
8:30 a.m.	**FC** Innovative Labs for Introductory Courses						**FG** ***Panel:*** New Avenues for Collaboration and Mentoring					
9:00 a.m.												
9:30 a.m.												
10:00 a.m.												
10:15 a.m.												**Awards:** Klopsteg & DSCs
10:30 a.m.												
11:00 a.m.												
11:30 p.m.												
12:00 p.m.	**Crkrbrl 7** Physics and Society Education	**Crkrbrl 6** PER Graduate Students						**Crkrbrl 8** Ideas and Resources for Using History to Teach Physics				
12:15 p.m.												
12:30 p.m.												
1:00 p.m.	**GB** High Performance Computing	**GE** Major Consequences of Minor Dishonesty in Physics Classes	**GF** Research in Undergraduate Math Education		**GD** PER in the High School		**GH** PER: Problem Solving II	**GC** Laboratories for Astronomy			**GA** Post Deadline I	
1:15 p.m.												
1:30 p.m.												
2:00 p.m.												
2:30 p.m.												
3:00 p.m.												
3:30 p.m.												**HA** PERC Bridging Session
3:45 p.m.												
4:00 p.m.												
4:30 p.m.												
4:45 p.m.												

Workshops – Saturday, July 30

All workshops held at Creighton University in the Hixson Lied Science Building, or Rigge. Shuttle buses will be available from the Doubletree Hotel—see page 6.

W10: Computer Problem Solving Coaches

Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Educational Technologies
Time: 8 a.m.–12 p.m. Saturday
Member Price: $70 **Non-Member Price:** $95
Location: Hixson Lied Science Building 408

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

This workshop will introduce participants to three types of computer coaches that can be used to help students with problem solving in introductory physics. The workshop will include the motivation and use of the computer coaches and the process used to build and test them. Please bring your laptop to access the computer coaches. This work is supported by the National Science Foundation.

W11: A Research-based Methodology for Using Clickers

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on Professional Concerns
Time: 8 a.m.–12 p.m. Saturday
Member Price: $77 Non-Member Price: $102
Location: Hixson Lied Science Building 244

Lin Ding, School of Teaching and Learning, The Ohio State University,1945 N. High St., Columbus, OH 43210-1172; lding@ehe.osu.edu

We invite high school and college teachers as well as research professionals to experience with us a new question sequence clicker methodology that is proven to help students enjoy lectures and experience significant learning gains. Discussion leaders have created, validated, and evaluated for learning gains 167 conceptual clicker sequences containing 500 individual questions. The workshop will start with brief discussions of the new methodology, how sequences were created and validated, results of student surveys and evaluations of learning gains. Participants will have hands-on use of clickers while answering questions and observing presentation techniques. With workshop leaders as a resource, teams of participants will then create and present their own two-question sequences. At the workshop's conclusion, participants will receive CDs containing all 167 sequences, relevant published papers, and workshop slides.

W01: Critical Thinking in Introductory Astronomy

Sponsor: Committee on Space Science and Astronomy
Time: 8 a.m.–5 p.m. Saturday
Member Price: $90 **Non-Member Price:** $115
Location: Hixson Lied Science Building 361

Joe Heafner, Catawba Valley Community College, 2550 Highway 70 SE, Hickory, NC 28602; heafnerj@sticksandshadows.com

In this workshop, participants will engage in inquiry activities designed to emphasize critical thinking and scientific reasoning within the context of introductory astronomy. Content may include activities applicable to all science (e.g. logical fallacies, terminology, etc.) and activities specific to astronomy (e.g. shadows, lunar illumination, etc.) These activities are part of the Learning Critical Thinking Through Astronomy Project and its associated textbook (in development). Participants should bring notebook computers with wifi capability.

W02: Developing a High-Altitude Balloon Program: Sending a Hands-On STEM Project to the Edge of Space

Sponsor: Committee on Space Science and Astronomy
Time: 8 a.m.–5 p.m. Saturday
Member Price: $180 **Non-Member Price:** $205
Location: Hixson Lied Science Building L26

Kendra Sibbernsen, 287 Concord Circle, Papillion, NE 68046; ksibb@cox.net

You can participate in a Near-Space mission using a high-altitude balloon taking your experiments to 20 miles above the Earth where you can see the blackness of space in the middle of the day. High-altitude ballooning can be geared toward all levels of students (K-12 and college) in many different science and math courses through a fun and exciting hands-on activity they will remember for a lifetime. At this workshop, we will present information on how you can start your own ballooning program and you will have the same challenges and excitement that the students experience. Our attendees will participate in developing scientific experiments, planning a flight, conducting a launch, tracking the payloads, collecting data in real-time, and recovering the equipment.

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: $115 **Non-Member Price:** $140
Location: Rigge Science Building G21

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

Alan van Heuvelen, Bill Hogan

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: (a) *The Physics Active Learning Guide* with 30 or more activities per 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.

W04: Physics by Design

Sponsor: Committee on Physics in Pre-High School Education
Time: 8 a.m.–5 p.m. Saturday
Member Price: $125 **Non-Member Price:** $150
Location: Hixson Lied Science Building 188

Julia Olsen, The University of Arizona, College of Education, 1430 E. Second St.; jkolsen@u.arizona.edu

What is understanding? What is the relationship between knowledge and understanding? What does "teaching for understanding" look like? Why is deeper understanding important in the current educational climate which emphasizes standardized assessments? 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, but a limited number of computers may be available. Contact the organizer (jkolsen@u.arizona.edu) if you will need one.

W06: PIRA Lecture Demos 1

Sponsor: Committee on Apparatus
Time: 8 a.m.–5 p.m. Saturday
Member Price: $125 Non-Member Price: $150
Location: Hixson Lied Science Building G59

Dale Stille, Van Allen Hall, Dept. of Physics and Astronomy, Univ. of Iowa, Iowa City, IA, 52242; dale-stille@uiowa.edu

Sam Sampere

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 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 either during or after the workshop.

W09: The Physics of Energy

Sponsor: Committee on Science Education for the Public
Co-sponsor: Committee on Physics in High Schools
Time: 8 a.m.–5 p.m. Saturday
Member Price: $115 **Non-Member Price:** $140
Location: Rigge Science Building L22

Abigail R. Mechtenberg, 32727 Hampshire, Ann Arbor; amechten@umich.edu

Regina Barrera

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. This workshop will open the eyes of practitioners to the vast array of teaching and learning possibilities for classroom application of Physics of Energy as well as illustrate how this curriculum and research has been implemented in the U.S. and Uganda. During the workshop 10 laboratories will be executed in groups as well as a final energy competition. All participants will leave with a CD of resources. Together the workshop will weave a coherent common thread of Physics of Energy from mechanical to electrical energy —four devices, thermal to electrical—three devices, solar to electrical—one device, and chemical to electrical energy—two devices.

W15: Introductory Laboratories

Sponsor: Committee on Laboratories
Time: 1–5 p.m. Saturday
Member Price: $90 **Non-Member Price:** $115
Location: Rigge Science Building G19

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

At six stations, presenters will demonstrate an approach to an introductory laboratory exercise, discussing the apparatus and techniques used. The experiments and presenters are from colleges and universities across the United States. Attendees will cycle through the stations and have an opportunity to use 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: Laserfest Apparatus and Activities

Sponsor: Committee on Science Education for the Public
Co-sponsor: Committee on Apparatus
Time: 1–5 p.m. Saturday
Member Price: $80 **Non-Member Price:** $105
Location: Hixson Lied Science Building 244

Patricia Sievert, DSTEM Outreach Coordinator, Northern Illinois University, DeKalb, IL 60115; psievert@niu.edu

David Sturm, Dale Stille

LaserFest 2010 (www.laserfest.org/) included many physics outreach programs around the world with programming styled "LaserFest On The Road." We have invited leaders from many of these programs to share activity ideas both from LaserFest and from related laser-based physics demonstration shows and exhibits. The "focus" is on items you can use in both outreach and the classroom. We'll look (with our one remaining good eye!) at a top 20 laser demo list. We share some of our favorite exhibits and construction techniques. We'll build a few take-home pieces. Safety discussions about how to use lasers with (not on!) students and the public will of course be included. And don't forget, we'll network, share, and develop plenty of new ideas for laserific road show gear. For more information, check for updates. [LaserFest programming originally supported by a consortium led by APS and the Optical Society.]

W17: Modeling Applied to Problem-Solving

Sponsor: Committee on Physics in Undergraduate Education
Co-sponsor: Committee on Physics in High Schools
Time: 1–5 p.m. Saturday
Member Price: $70 **Non-Member Price:** $95
Location: Hixson Lied Science Building 246

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

Analia Barrantes, Carie Cardamone, Andrew Paul, Saif Rayyan, and Raluca Teodorescu

This workshop will introduce participants to a modeling-based approach to problem solving, a pedagogy that enables students to attain significant expert-like improvement of their problem solving. Students develop more expert-like attitudes toward science, particularly in problem-solving self confidence, and the skills they learn transfer to a subsequent E&M course. The workshop goal is to enable participants to introduce some or all of this pedagogy into their courses with the help of our Integrated Learning Environment for Mechanics (ILEM). Hosted in LON-CAPA, an open- source online learning environment, ILEM incorporates our modeling pedagogy into a standard introductory mechanics syllabus and combines multi-level research-based homework sets with a WIKI-text. Workshop participants will sample the various teaching materials for in-class use and will participate in some innovative activities (participants are encouraged to bring their laptops for a hands-on introduction to ILEM). We seek users/collaborators for our materials, which can be freely modified.

W19: Teaching Critical Thinking: Science and Religion

Sponsor: Committee on Science Education for the Public
Co-Sponsor: Committee on Professional Concerns
Time: 1–5 p.m. Saturday
Member Price: $80 **Non-Member Price:** $105
Location: Hixson Lied Science Building 408

Paul J. Nienaber, Dept. of Physics, St. Mary's University of Minnesota, Winona, MN 55987; pnienabe@smumn.edu

Matthew Koss

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.

Workshops – Sunday, July 31

All workshops held at Creighton University. Shuttle buses will be available from the Doubletree Hotel—see page 6.

W13: Pre-College Labs: Student Centered Lab Progression for Vertical Alignment

Sponsor: Committee on Laboratories
Co-sponsor: Committee on Physics in High Schools
Time: 8 a.m.–12 p.m. Sunday
Member Price: $80 **Non-Member Price:** $105
Location: Rigge Science Building L10

Steve A. Lindaas, Dept. of Physics and Astronomy, Minnesota State University Moorhead, Moorhead, MN 56563; lindaas@mnstate.edu

Marsha Hobbs

Experience real and virtual lab activities covering basic electricity and magnetism from simple circuits to motors and speakers. We will discuss ways to engage as well as challenge each student so that they learn no matter their age or ability level. We will also explore how activities can be vertically aligned, connecting content across grades. You will leave with materials and activities, energized and ready to spark the joy of discovery in your students. Share ideas, experiences, and aspirations as we explore ways to enhance the excitement of learning. No prior knowledge of electricity and magnetism is assumed. These activities have been used successfully in elementary classrooms to college engineering courses.

W26: Activities for Teaching Climate and Climate Change

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: $70 **Non-Member Price:** $95
Location: Rigge Science Building G21

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

Paul Williams

During the day, the Earth is warmed by sunlight. This is something that your students can see, something that they can feel. But, over the course of a day and night, 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.

W27: Can You Use Inquiry to Teach Radioactivity? Yes!

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on Educational Technologies
Time: 8 a.m.–12 p.m. Sunday
Member Price: $70 **Non-Member Price:** $95
Location: Rigge Science Building L22

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

Michael Grams

Can high school or beginning college students develop meaningful understandings of radioactivity via inquiry? They can now! The Inquiry-Based Radiation project is supported by a CCLI grant (DUE 0942699). Roughly 30 hours of inquiry materials are currently available. Content includes basic properties of ionizing radiation, interaction of radiation with matter (including health effects), the origins of radiation and nuclear waste. These research-based materials resolve numerous student difficulties and problematic conceptions that we have identified through repeated classroom trials, observations, and interviews with students. Notable examples include recognizing the quantized character of radiation, EM vs. ionizing radiation, the behavior and structure of atoms, the ionization process, and the meaning of half life. Participants will get a flavor of the materials, learn about learning issues and receive a CD containing the current version including fun and effective simulators.

W28: Computational Physics Examples to Include in Physics Courses

Sponsor: Committee on Educational Technologies
Time: 8 a.m.–12 p.m. Sunday
Member Price: $70 **Non-Member Price:** $95
Location: Hixson Lied Science Building 408

Rubin H. Landau, Physics Dept., Oregon State University, Corvallis, OR 97331; rubin@science.oregonstate.edu

Although physics faculties are incorporating computers to enhance physics education, computation is often viewed as a "black box" whose inner workings need not be understood. We propose to open up the computational black box by providing Computational Physics (CP) curricula materials based on a problem-solving paradigm that can be incorporated into existing physics classes, or used in stand-alone CP classes. The curricula materials assume a computational science point of view, where understanding of the applied math and the CS is also important, and usually involve a compiled language in order for the students to get closer to the algorithms. The materials derive from a new CP eTextbook available from Compadre that includes video-based lectures, programs, applets, visualizations and animations.

W29: Blurring the Lines: ILD's (and Other Activities) in an Integrated Lecture-Lab Environment

Sponsor: Committee on Physics in Two-Year Colleges
Time: 8 a.m.–12 p.m. Sunday
Member Price: $84 **Non-Member Price:** $109
Location: Hixson Lied Science Building L26

Robert Hobbs, Science Division L200, 3000 Landerholm Circle SE, Bellevue, WA 98007; rhobbs@bellevuecollege.edu

The small classrooms common in two-year colleges and smaller universities offer unique opportunities for blending Physics Education Research (PER) based pedagogies with other lab and classroom activities. This workshop will present diverse examples where Interactive Lecture Demonstrations (ILDs) and other technologies are combined in this environment. Examples include demonstrations that use computers, demonstrations that become guided inquiry activities for part or all of the class period, and demonstrations with clicker stimulated discussion. Additional activities will be presented that integrate familiar uses of computers (e.g. simulating concepts or environments not easily created in the lab, rapidly analyzing or presenting data in uniquely accessible forms, and capturing phenomena not easily observed) with other curricular elements in ways that are suggested by insights from PER. The workshop will prepare participants for a closing discussion identifying competing factors that they must weigh in making appropriate choices in their local departments or individual classes.

W31: LivePhoto Physics: Video-based Motion Analysis for Homework and Classroom

Sponsor: Committee on Educational Technologies
Co-Sponsor: Committee on Physics in High Schools
Time: 8 a.m.–12 p.m. Sunday
Member Price: $75 **Non-Member Price:** $100
Location: Rigge Science Building G18

Robert B.Teese, Physics Dept., Rochester Institute of Technology, Rochester, NY 14623; rbtsps@rit.edu

Patrick J. Cooney

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

W32: NTIPERs: Research-based Reasoning Tasks for Introductory Mechanics

Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Physics in Two-Year Colleges
Time: 8 a.m.–12 p.m. Sunday
Member Price: $70 **Non-Member Price:** $95
Location: Hixson Lied Science Building 522

David P. Maloney, Physics Dept., Indiana University Purdue University Fort Wayne, Fort Wayne, IN 46805; maloney@ipfw.edu

Curt Hieggelke, Steve Kanim

A common question instructors wrestle with is: How do I get my students to develop a strong understanding of physics? In this workshop you will explore some new materials designed to get students to think about fundamental concepts in alternative and multiple ways to promote robust learning. Participants will work with a variety of tasks and task formats that require students to think about the basic physics in the domains of kinematics and dynamics, including rotational dynamics, in nonstandard ways. Participants will be given a CD with more than 400 tasks, and other materials.

W33: What Every Physics Teacher Should Know About Cognitive Research

Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Physics in Undergraduate Educations
Time: 8 a.m.–12 p.m. Sunday
Member Price: $70 **Non-Member Price:** $95
Location: Hixson Lied Science Building 523

Chandralekha Singh, 3941 Ohara St., Dept. of Physics, University of Pittsburgh, Pittsburgh, PA 15260; clsingh@pitt.edu

In the past few decades, cognitive research has made significant progress in understanding how people learn. The understanding of cognition that has emerged from this research can be particularly useful for physics instruction. We will discuss and explore, in a language accessible to everybody, how the main findings of cognitive research can be applied to physics teaching and assessment materials.

W20: Arduino Microcontrollers in the Physics Lab

Sponsor: Committee on Educational Technologies
Time: 8 a.m.–5 p.m. Sunday
Member Price: $175 **Non-Member Price:** $200
Location: Rigge Science Building G09

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

The Arduino is an open-source microcontroller system that is relatively easy to use in a broad range of situations. In this workshop we will be building and programming a small self-contained Arduino "datalogger" that can record time-stamped analog data and then report that data to a separate computer for analysis at a later time.

W21: Computer Modeling & the Physics Classroom Web Resources

Sponsor: Committee on Educational Technologies
Co-Sponsor: Committee on Physics in Undergraduate Education
Time: 8 a.m.–5 p.m. Sunday
Member Price: $90 **Non-Member Price:** $115
Location: Hixson Lied Science Building 244

Wolfgang Christian, PO Box 6926, Davidson College, Davidson NC 28035-6926; wochristian@davidson.edu

Bruce Mason, Mario Belloni

Did you know you can put together your own customized collection to integrate computer-based modeling and interactive tutorials into your classroom? This workshop shows you how. Participants will build their own personal resource collection that combines ready-to-run simulations from the Open Source Physics Collection with material from other ComPADRE collections such as The Physics Classroom. Once created, instructors can directly share their resource collection with colleagues and students with a dedicated URL provided by ComPADRE. Integrating computer models and tutorials into a traditional curriculum can make difficult concepts much more accessible to students. Afternoon breakout sessions provide opportunities for guided in-depth study of ComPADRE community tools, such as shared filing cabinets, and OSP applications, such as the Easy Java Simulations modeling tool and the Tracker video modeling tool. All materials are free and are provided on CD and on the OSP ComPADRE website: www.compadre.org.

W22: Make, Take, and Do; A PTRA Workshop

Sponsor: Committee on Apparatus
Co-Sponsor: Committee on Physics in Undergraduate Education
Time: 8 a.m.–5 p.m. Sunday
Member Price: $105 **Non-Member Price:** $130
Location: Rigge Science Building G16

Thomas J. Senior, 355 Dell Lane, Highland Park, IL 60035; tomseniorphysics@yahoo.com

Pat Callahan, George Amann, Al Gibson

Participants will build a selection of our favorite Make/Take/Do activities from our years with the PTRA program. The apparatus produced will span many topics in introductory physics. Not only will participants make the apparatus, but will gather suggestions on how and when to use it.

W23: Math Machines: Connecting Physics with Math & Engineering

Sponsor: Committee on Physics in Undergraduate Education
Co-Sponsor: Committee on Physics in Two-Year Colleges
Time: 8 a.m.–5 p.m. Sunday
Member Price: $110 **Non-Member Price:** $135
Location: Hixson Lied Science Building 361

Fred Thomas, 1014 Merrywood Dr., Englewood, OH 45322; fred.thomas@mathmachines.net

Robert Chaney

Each participant will make-and-take 2 "math machines" (an automated servo motor and an RGB color mixer) that their students can control using free-form algebraic or trigonometric functions. They will also receive a SensorDAQ interface with two probes and a CD with all necessary control software along with classroom activities in Word format. Math machine activities engage students in designing and testing mathematical functions that control engineering-style physical systems and display immediate, physical and dynamic results. This workshop builds on an 11-year series of summer workshops for high school and college teachers conducted by math and physics faculty from Sinclair Community College. Participants will learn about opportunities for conducting similar summer workshops at their institutions. Please bring your own Windows laptop computer on which you can install the control software. Supported in part by the National Science Foundation's Advanced Technological Education Program through grant DUE-1003381. More information is available at www.mathmachines.net.

W25: PIRA Lecture Demos 2

Sponsor: Committee on Apparatus
Time: 8 a.m.–5 p.m. Sunday
Member Price: $125 **Non-Member Price:** $150
Location: Hixson Lied Science Building G59

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

Sam Sampere

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 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.

W35: Advanced and Intermediate Laboratories

Sponsor: Committee on Laboratories
Time: 1–5 p.m. Sunday
Member Price: $140 **Non-Member Price:** $165
Location: Rigge Science Building G19

Van D. Bistrow, Dept. of Physics, University of Chicago, 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.

W36: Designing and Implementing an Inquiry-based Physics Course for K-12 Teachers*

Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on Research in Physics Education
Time: 1–5 p.m. Sunday
Member Price: $95 **Non-Member Price:** $120
Location: Hixson Lied Science Building 428

Lillian McDermott, University of Washington, Dept. of Physics, Seattle, WA 98195; peg@phys.washington.edu

Donna Messina

The Physics Education Group at the University of Washington is developing a set of inquiry-oriented materials for the preparation of high school teachers. Tutorials for Teachers of Physics covers more advanced topics than Physics by Inquiry (Wiley, 1996) and goes into greater depth than Tutorials in Introductory Physics (Pearson, 2002). These materials are intended to help teachers strengthen their understanding of important concepts, gain familiarity with common student difficulties, reflect on research-validated instructional strategies, and practice assessing student learning. This workshop is primarily intended for faculty and others responsible for the preparation and professional development of teachers. Participants will gain hands-on experience with Tutorials for Teachers of Physics, which have been tested in courses and institutes for pre-service and in-service teachers. Requirements for effective implementation will be discussed.

*Supported in part by the NSF.

W38: Free Physics Webtools

Sponsor: Committee on Physics in High Schools
Co-Sponsor: Committee on Educational Technologies
Time: 1–5 p.m. Sunday
Member Price: $70 **Non-Member Price:** $95
Location: Hixson Lied Science Building G59

Cathy Ezrailson, University of South Dakota, Vermillion, SD 57069; cathy.ezrailson@usd.edu

Steve Henning

Web 2.0 teaching tools, easily learned, free and immediately available, could markedly enhance and augment physics learning in novel and unforeseen ways. Using web tech tools such as Google Docs to organize, design, access, and assess lessons seamlessly is integral to teaching in the 21st century classroom. This workshop illustrates examples of best teaching practices that incorporate these tools for high school and college instruction.

W40: Make Your Own Teacher 2.0 Websites

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

Lee Trampleasure, 1740 Walnut St. #9, Berkeley, CA 94709; lee@trampleasure.net

Steve Peroni

You will leave this workshop with a fully functional "Web 2.0" site ready to use in the fall. We will start by presenting features of PBWorks and Moodle as possible Make Your Own Teacher 2.0 Websites platforms, then participants will select their choice and begin creating their website. Web 2.0 sites are interactive and allow communication between students and instructor, as well as student to student, using bulletin boards, wikis, databases, etc. Advanced features include online quizzes, surveys, chat, embedding YouTube videos, Google apps, and docs. Both platforms are free for teachers and students. Participants may bring their own laptops or use computers provided at the workshop. If you have questions, please email us at lee@trampleasure.net (Moodle) or peronis@northshoreschools.org (PBWorks).

W41: Physics and Toys I: Force, Motion, Light, and Sound

Sponsor: Committee on Science Education for the Public
Co-Sponsor: Committee on Physics in Pre-High School Education
Time: 1–5 p.m. Sunday
Member Price: $80 **Non-Member Price:** $105
Location: Hixson Lied Science Building 188

Beverley A.P. Taylor, Miami University Hamilton, 1601 University Blvd., Hamilton, OH 45042; 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 75 toys will be demonstrated, and the physical principles related to these toys will be discussed. This workshop will concentrate on toys that illustrate the concepts of force, equilibrium, linear and rotational motion, optics and light, sound and waves. You will have the opportunity to participate in both qualitative and quantitative investigations using some of these toys. The workshop leaders have found that toys can be utilized at all grade levels from kindergarten thought college by varying the sophistication of the analysis. These same toys can also be used for informal presentations to public groups of all ages, whether children or adults. Participants will be given a small assortment of toys to help start their own toy collection.

W42: Skepticism in the Classroom

Sponsor: Committee on Physics in High Schools
Time: 1–5 p.m. Sunday
Member Price: $80 **Non-Member Price:** $105
Location: Hixson Lied Science Building 523

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

Matt Lowry

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 leave with ready-to-use lessons (video clips and student worksheets) and resources designed to bring healthy, scientific skepticism to their classrooms. Topics will include firewalking, ghosts and angels, balance bracelets, the credulity of local media, and more.

W43: Strategies to Help Women Succeed In Physics Related Professions

Sponsor: Committee on Women in Physics
Co-Sponsor: Committee on Graduate Education in Physics
Time: 1–5 p.m. Sunday
Member Price: $70 **Non-Member Price:** $95
Location: Hixson Lied Science Building 522

Chandralekha Singh, Dept. of Physics, University of Pittsburgh, Pittsburgh, PA 15260; clsingh@pitt.edu

Matt Lowry

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

W44: Teaching Astronomy with Ranking Tasks

Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Undergraduate Education
Time: 1–5 p.m. Sunday
Member Price: $35 **Non-Member Price:** $60
Location: Hixson Lied Science Building 408

Kevin M. Lee, 244D Jorgensen Hall, University of Nebraska, Lincoln, NE 68588-0299; klee6@unl.edu

Ed Prather

Ranking tasks are a powerful example of curricular materials for promoting active engagement in the classroom and they have a long history of usage in physics. A ranking task typically provides the learner with a series of pictures or diagrams that describe several slightly different variations of a basic physical situation. The student is then asked to make a comparative judgment and order or rank the various situations based on some physical outcome or result. These novel and intellectually challenging tasks effectively probe student understanding at a deep conceptual level. This workshop will expose participants to two libraries of ranking tasks for use in introductory astronomy at either the college or high school level: 1) pencil-and-paper versions appropriate for group work in the classroom or assigned as homework, and 2) computerized versions that contain extensive randomization, background material, and feedback. Participants will work through several sequences of ranking tasks in both formats and then discuss implementation of ranking tasks in their classroom. All materials will be made available to participants via the web before the workshop and participants are expected to preload them on a laptop that they bring to the workshop. This material is based upon work supported by the National Science Foundation under Grants #0737376 and #0715517, a CCLI Phase III Grant for the Collaboration of Astronomy Teaching Scholars (CATS).


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Physics Teachers
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Are you a high school teacher?

Tuesday, August 2 is your day at the AAPT Summer Meeting!

Special Events for High School Teachers, Aug. 2:

National AAPT: What's in it for H.S. Teachers?
10–10:30 a.m., Harper Center 3023 and 3023A

Little Shop of Physics Demos
3:45–5:15 p.m., Harper Center 3023B

High School Teacher First Timers Gathering
4:45–5:15 p.m., Skutt Student Center 105

Pizza Extravaganza and Demo Show
7:15–10 p.m., the Doubletree Hotel Grand Ballroom

American Association of Physics Teachers

PHYSICSBOWL 2012

Enter your outstanding students in PHYSICSBOWL 2012 and receive recognition for your students, your school, and your teaching excellence.

To register and learn more visit us at
www.aapt.org/Contests/physicsbowl.cfm

Here's how it works: Your students take a 40-question, 45-minute, multiple-choice test in March 2012 under your school's supervision. Exam questions are based on topics and concepts covered in a typical high school physics course. Winners will be announced and awarded prizes the first week of May.

Sunday, July 31

Section Officers Exchange
5:30–6:30 p.m. SS Ballroom ABC

High School Share-a-thon
6–8 p.m. SS Ballroom DE

Exhibit Hall Opens/ Welcome Reception
8–10 p.m. HC Ballroom 4th Floor

Session SPS: SPS Undergraduate Research and Outreach (Posters)

Location: Harper Center Ballroom Galleria, 4th Floor
Sponsor: Physics in Undergraduate Education Committee
Date: Sunday, July 31
Time: 8–10 p.m.

Presider: Gary White

SPS01: 8–10 p.m. Open-source Electronic Education Tools Using Tablet PCs

Poster - Zachary T. Boerner, Colorado School of Mines, Golden, CO 80401; zboerner@mines.edu*

Charley A. Parker, Vincent H. Kuo, Susan E. Kowalski, and Frank V. Kowalski, Colorado School of Mines

The Technology in the Classroom Committee (TICC) at the Colorado School of Mines provides and manages a number of electronic education tools available for anyone to access. These include the InkSurvey tool, a wiki for information on the software used by TICC, and a forum for users to discuss Tablet PCs and the classes in which they are enrolled. InkSurvey, in a manner similar to clickers, provides instructors with the means to pose open-format questions. Combined with the use of Tablet PCs, this allows the instructor to perform a real-time formative assessment of students' problem solving abilities. This poster will explore the utility of each of these tools and suggest how institutions outside of the Colorado School of Mines may use them to further their own educational programs.
* Sponsor: Vincent H. Kuo

SPS02: 8–10 p.m. Symmetry and Asymmetry in Physics

Poster - Yu-Chen Ding, Chieng-Shiung Wu College, Southeast University, Jiangsu, 211189, China; 213101726@seu.edu.cn*

Peng Zhang and Hui-Yu Miao, Southeast University

The investigation of symmetry and asymmetry runs through the history of the development of physics. Inspired by the course Bilingual Physics with Multimedia, we had a strong curiosity and interest on the topic Symmetry and Asymmetry in Physics, and conducted a research study on it. Our paper is divided into four parts. The first part introduces some typical examples of symmetry. Next, we focus on a significant example of asymmetry. The third part is mainly a brief analysis of the relationship between symmetry and asymmetry. Finally, we will present our personal thoughts on this subject.
*Sponsor: Lei Bao

SPS03: 8–10 p.m. Unveil the Mist of Magic Based on Physical Principles

Poster - Zhi-Qiang Hao, Chieng-Shiung, Wu College, Southeast University, Jiangsu, 211189, China; memorizesoff@gmail.com*

Like two sides of a coin, physics and magic are born to be together. As an artistic form, while magic has gained a high popularity and attracts more and more people's attention, it has been prospering under the influence of the development of physics. Inspired by the concepts of education in Introduction to Bilingual Physics, we conducted simple research on the nature of some fascinating magic phenomena and completed this course paper. Lots of interesting or even unbelievable magic tricks will be revealed and then we will illustrate the relation between those "seem-to-be-impossible" phenomena and physical principles.
*Sponsor: Lei Bao.

SPS04: 8–10 p.m. An Explanation of the Origin of the Universe – Superstring Theory

Poster - De-Yu Jiao, Chien-Shiung Wu College, Southeast University, Jiangsu, 211189, China; 213100594@seu.edu.cn*

Peng-Peng Sun and Shu-Ya Tan, Southeast University

After Einstein advanced the theory of relativity, because the Quantum Field Theory and General Relativity are not consistent with each other, people have been committed to finding a unified theory to explain all the interactions, which means Quantum Field Theory and General Relativity should be unified in a larger theoretical framework. This larger theoretical framework for the emerging trends is Superstring Theory. As a theory of quantum gravity, Superstring Theory has experienced a series of difficulties and changes. After learning Bilingual Physics with Multimedia founded by Professor Yun, we were encouraged and conducted a simple study on this topic. This paper briefly describes the history of Superstring Theory, including two revolutions, the development and discusses the relevant physical model, theoretical framework and the physical concepts, and investigates the relevant issues according to their validity and significance of future development.
*Sponsor: Lei Bao

SPS05: 8–10 p.m. Dark Energy

Poster - Tian-Chen Jin, Chieng-Shiung Wu College, Southeast University, Jiangsu, 211189, China; tianchenjin@gmail.com*

Shao-Ran Li and Xi-Chao She, Southeast University

Dark energy, a hypothetical concept, is one of the hottest topics in cosmology at the moment. Its negative pressure gives us the element we need to explain the accelerated expansion of our universe. But how does dark energy really work? Are there other things that may also have similar property? How will dark energy affect our universe if it really exists? Our team became really interested in this subject through studying the course of Introduction to Bilingual Physics. This poster will give you our thoughts and understanding of dark energy and how it could affect the ultimate fate of our universe.
*Sponsor: Lei Bao

SPS06: 8–10 p.m. Skylight Polarization from a Balloon Flight

Poster - Jeffrey R. Lind, University of Minnesota, Morris, MN 56267; lind1419@umn.edu

Gordon C. McIntosh, University of Minnesota, Morris

This research project attempted to measure the polarization of skylight as a function of altitude using a balloon-based polarimeter. The hypothesis was that as altitude increases the model of a Rayleigh sky (single scatters from very small particles) improves because the likelihood of multiple scatters and the aerosol density decrease. The polarimeter utilized eight LED light detectors with seven detectors filtered by linear polarizers at increments of ~26 degrees and one unfiltered detector. The filtered detectors were calibrated by the unfiltered detector. Directional measurements were made using an accelerometer and compass. With directional information, the measured degree of polarization can be compared directly to the Rayleigh sky model. This experiment was sponsored by a University of Minnesota Undergraduate Research Opportunity Program grant.

SPS07: 8–10 p.m. Student Use and Perception of Tablet PCs; Are They Helpful?

Poster - Charles A. Parker, Colorado School of Mines, Golden, CO 80401; cparker@mines.edu*

Zachary T. Boerner, Vincent H. Kuo, Susan E. Kowalksi, and Frank V. Kowalski, Colorado School of Mines

Research shows that learning is more effective when students are actively interacting with the professor and each other. To facilitate these interactions, the Technology in the Classroom Committee (TICC) at the Colorado School of Mines provides Tablet PCs to physics students in selected courses each semester. These Tablet PCs are used in conjunction with the InkSurvey tool, which allows for real-time feedback in the classroom. The Tablet PCs also allow for sophisticated student collaboration using notetaking software, providing a means for note sharing. In our poster, we explore how the Tablet PCs have been used in the physics classrooms at CSM and present preliminary data on student perceptions of having the Tablet PCs.
*Sponsor: Vincent H. Kuo

SPS08: 8–10 p.m. Addressing Students' Math Deficiencies in Introductory Physics with Online Tutorials

Poster - Cameron Zahedi, University of Georgia, Athens, GA 30602-2451, cszahedi@uga.edu*

Craig C. Wiegert, University of Georgia
Daniel Seaton, MIT

Introductory physics courses are mathematically demanding, even those for non-physics science majors. Students must become adept at solving a wide variety of quantitative problems. However, even students with calculus experience often lack facility with basic pre-calculus skills. A large contributing factor to the problem is the students' generally poor retention of working math skills, but they may also be struggling to transfer their math knowledge to unfamiliar problem domains. In either case, these students should benefit from early intervention that continues to scaffold throughout the term. We report on our efforts to create math-related, online formative assessment modules for first-semester introductory physics. These online tutorials target specific mathematical skills that are essential to success in physics, and are designed to progress from a purely math-centered review of each basic skill, to problems of increasing generality and complexity, and ultimately toward a transfer of these skills to physics problem domains.
*Sponsor: Craig Wiegert

SPS09: 8–10 p.m. Alternative Energy Is Everywhere

Poster - Yi-Qi Zhao, Chien-Shiung Wu College, Southeast University, Jiangsu, 211189, China; ddzhaoyiqi@163.com*

Yun-Hao Zhang and Zhi-Heng Shen, Southeast University

With the modernization of the world economy, fossil fuel is going to dry up. The status of energy is so austere that exploitation and utilization of alternative energy is becoming a major issue of concern for countries all around the world, especially for the Asian countries that have enormous populations. As Chinese students, we also take Bilingual Physics as an opportunity to do some research on alternative energy. In our opinion, besides the energy provided by nature—in various daily activities like walking, driving, or even making a call—humans are providing energy all the time. In this paper, we will mainly elaborate on the theories of generating power with these energies, which can be seen everywhere but are easy to neglect. On this basis, we will show some relevant applications as well as our guesses and expectations.
*Sponsor: Lei Bao

SPS10: 8–10 p.m. Quantum Entanglement and its Application

Poster - Ying-Hong Zhao, Chieng-Shiung Wu College, Southeast University, Jiangsu, 211189, China; 213102517@seu.edu.cn*

Xiao-Jiao Yuan and Jin Guo, Chieng-Shiung Wu College

Nowadays, the discussion about the inharmony between the local effect of relativity and the non-local effect of quantum mechanics raised by quantum entanglement has become one of the most difficult problems in physics. By taking a course called Bilingual Physics with Multimedia last semester, we have some new ideas about independent and explorative study. Inspired by the concept of education, we decided to study quantum entanglement and its application from a freshman's view. This essay mainly talks about exploring the history of quantum entanglement, the basic principles and the experimental facilities of quantum teleportation, as well as the latest scientific development on it. At last, we conclude that the exploration of science is endless and we also come up with some deep thoughts about the coming era of quantum information.
*Sponsor: Lei Bao

SPS11: 8–10 p.m. Field-line to Build the Formal Thinking in Induction Law

Poster - Marisa Michelini, Research Unit in Physics Education of the University of Udine, UD 33100 Italy; marisa.michelini@uniud.it

Lorenzo Santi, Alberto Stefanel, and Stefano Vercellati, University of Udine

Electromagnetism has its own cognitive basis in phenomenology whose presentation, often fragmentary to highlight the variables involved, has its own interpretation in complex formal expressions. This is the case of electromagnetic induction, when it's proposed as fruitful exploration of variables (field, surface, relative orientation during time) while the conditions in which one experiences an induced current in a coil are identified. Some conceptual knots, such as the meaning of the sign of the induced electromotive force, remain unresolved. Waiver is also to the building of the angle of formal reading which gives meaning to the properties of the phenomena. The magnetic field flux, its constancy in a flow pipe, and the physical meaning of its variation take in the most deep differences between the magnetic and electric case, establishing the inseparability of the poles and the nature of the closed lines for zero divergence field. The experimentation of an educational proposal based on the representation of field lines as interpretative reference, shows that it's possible to produce learning outcomes that are held strongly related the descriptive and interpretive plans.

SPS12: 8–10 p.m. Partners in Physics with Colorado School of Mines' Society of Physics Students

Poster - Shirley J. Moore, Colorado School of Mines, Golden, CO 80401; shmoore@mymail.mines.edu*

Levi Miller, Matthew D. Stilwell, Chuck Stone, Colorado School of Mines

The Colorado School of Mines (CSM) Society of Physics Students (SPS) revitalized in 2008 and has since blown up with outreach activity, incorporating all age levels into our programs. In spring 2010, CSM SPS launched a new program called Partners in Physics. Students from Golden High School came to CSM where they had a college-level lesson on standing waves and their applications. These students then joined volunteers from CSM in teaching local elementary school students about standing waves beginning with a science show. The CSM and high school students then helped the children to build make-and-take demonstrations incorporating waves. This year, rockets are the theme for Partners in Physics and we began with demonstrations with local middle school students. In spring 2011, CSM SPS will be teaching elementary school students about projectile motion and model rockets along with these middle school students.
* Sponsor: Chuck Stone

Monday, August 1

First Timers' Gathering	7–8 a.m.	SS 105
Spouses' Gathering	10–11 a.m.	HC 3023B
Exhibit Hall	10 a.m.–6 p.m.	HC Ballroom
Plenary: Reaching Out to the Public	10:30–11:30 a.m.	HC Auditorium

Session AA: PIRA: Outreach from the Ground Up

Location: Harper Center 3028
Sponsor: Apparatus Committee
Date: Monday, August 1
Time: 8–10 a.m.

Presider: Ramesh Sathappan

AA01: 8–8:30 a.m. Outreach from Higher Ed to K-12: Collaboration and Engagement*

Invited - Lisa L. Grable, NC State University, Raleigh, NC 27606; grable@ncsu.edu

University departments in the STEM fields often work to develop partnerships and collaboration with K-12 school districts and other community partners. What are the issues with building a bridge from current research and practice in physics and other science and engineering to inquiry-based activities for the K-12 classroom? What are challenges to be addressed when working with teachers or students? How can one go from one-shot, feel-good demonstrations to sustained support and student achievement? What are the possible sources of funding for developing programs? How can university faculty and students be engaged in outreach work? Examples from The Science House at NC State University and other programs will be presented. See http://www.science-house.org/ for information and resources.

*Sponsored in part by NSF Award #0812121, Division of Engineering Education and Centers. See http://www.science-house.org/ for information and resources.

AA02: 8:30–9 a.m. Physics Phenomena as a Catalyst and Context for Cultivating Community and Camaraderie

Invited - Erik A. Herman, Cornell Laboratory for Accelerator based Sciences and Education, Ithaca, NY 14853; eah229@cornell.edu

Lora K. Hine, Cornell Laboratory for Accelerator based Sciences and Education

Over the past year, Cornell's Laboratory for Accelerator Based Sciences and Education has been field-developing its science outreach mobile programming. An iterative process based on existing models, our expansion includes a theatrical kid-powered physics demonstration show, the use of informal venues for science experiences, and bringing science into family conversations with make-and-take exploration. Each component is driven by core motivations: illuminating the simple intrinsic beauty of physical phenomena, making physics familiar and accessible, and bringing people together in the context of science. Practical considerations include: the use of cheap and available resources, establishing a brand, building and maintaining a enthusiastic team of volunteers, and building a following. There are also challenges: how to teach without being didactic, how to provide problem-solving experiences that aren't frustrating, and how to measure success.

AA03: 9–9:30 a.m. Gravitational Waves from the Ground Up

Invited - Kathy D. Holt, LIGO LLO Science Education Center, Livingston, LA 70754; kholt@ligo-la.caltech.edu

Amber Stuver, LIGO LLO Lab

The LIGO Lab in Livingston, LA, searches for gravitational waves or ripples in space-time caused by massive objects undergoing incredible accelerations—such as colliding neutron stars. LIGO Science Education Center seeks to connect this active scientific research to the public through simple science activities and demonstrations. At LIGO-SEC students of all ages learn about gravity waves by developing their understanding of mechanical waves, sound waves, light waves, and general wave properties. Kathy Holt, LIGO Science Educator, will provide an overview of several low-cost demonstrations and activities that LIGO-SEC uses to explain wave properties and how an interferometer works. Demonstrations will bridge the gap from interference in a hanging wave machine to lissajous patterns from a membranophone. Material will be provided for participants to build at least one demonstration.

AA04: 9:30–10 a.m. Taking Physics to the Next Level: Physics in Multimedia

Invited - Angella Johnson, University of Southern California, Los Angeles, CA 90089; angellaj@usc.edu

Opportunities are expanding for physicists and physics technicians to be involved in outreach efforts in the media. There is a growing interest amongst the general public to truly understand physics concepts and to see it presented in an interesting way. Improving the public's understanding of physics can lead to a greater appreciation for science. This will be illustrated with snippets from recent projects and other colleagues' involvement at USC.

Session AB: Objectives and Assessment of the Physics Graduate Program

Location: Harper Center 3027
Sponsor: Graduate Education in Physics Committee
Co-Sponsor: Research in Physics Education Committee
Date: Monday, August 1
Time: 8–10 a.m.

Presider: Juan Burciaga

Our invited speakers will help frame the discussion: What are the objectives of a graduate education in physics? What experiences (both curricular and non-curricular) best meet these objectives? How can we assess if our program is preparing our students to meet the challenges expected of a physicist?

AB01: 8–8:20 a.m. Changes and Challenges in Physics Graduate Programs

Invited - Michael Thoennessen, Michigan State University, East Lansing, MI 48824; thoennessen@nscl.msu.edu

Many physics departments have made significant changes to their graduate programs in the last few years. These changes were partly driven by the increasing specialization of the field and the increasing number of interdisciplinary programs. Changes included modifications of the core curriculum and the comprehensive exams. Are these changes effective? Are the students better prepared for non-academic/industry careers? Are these changes improving the traditionally high drop-out rates? It is still too early to answer these questions, but the departments are encouraged to document and analyze the results of the implemented changes carefully so that the "best practices" can be implemented in other departments.

AB02: 8:20–8:40 a.m. Defining and Assessing Goals of a Graduate Physics Program

Invited - Chandralekha Singh, University of Pittsburgh, Pittsburgh, PA 15260; clsingh@pitt.edu

In this talk, I will discuss and encourage participants to consider how success should be defined for a graduate physics program and how departments can assess it. A particular focus will be on the inclusion of under-represented students in the physics graduate programs.

AB03: 8:40–9 a.m. The Challenge of Setting Objectives in Physics PhD Programs

Invited - Thomas D. Cohen, University of Maryland, College Park, MD 20742; cohen@physics.umd.edu*

It is particularly challenging in the context of physics PhD programs to construct objectives and schemes to systematically assess whether these objectives are met. This is for two reasons. The first is that these programs focus on research. It is probably true that there is broad agreement the purpose of these programs is to train students to become independent and highly competent researchers. The challenge is to articulate in a precise and measurable way precisely what skills and/or knowledge an independent and competent researcher needs to acquire. The second challenge is related to the great diversity of research subfields that exist in Physics PhD programs. Students who work on experimental "big science" such as an LHC experiment need to learn a radically different set of skills than students working in say biophysics or computational plasma physics. Given the disparate needs of these subfields, it is particularly difficult to construct meaningful objectives that apply to all of these.

*Sponsor: Juan Burciaga

AB04: 9–9:20 a.m. Graduate Education as Vocational School: Industrial and Entrepreneurial Physics

Invited - Robert W. Brown, Case Western Reserve University, Cleveland, OH 44106-7079; rwb@case.edu

Three decades of my industrial partnerships with more than 10 companies have led to significant publications, patents, start-ups, and jobs. My 20 graduated PhD students have upwards of 150 patents and 200 publications and abstracts, and have worked in remarkably diverse areas, from radiation, imaging, and heat transfer physics, to magnetic particle ferrofluids, and sensor development for contaminated industrial fluids. I am connected to three new manufacturing companies with more than 100 employees, 20% of whom have been trained in my computational laboratory. This is aligned with a national award-winning master's program in physics entrepreneurship, where I've been co-advisor for 25 graduates. As an outgrowth of a unique imaging course, my former students and I have co-authored a 900-page textbook referred to as the "daily companion of the MRI scientist." I discuss the relevance of all of this to general physics graduate education, especially in today's funding climate.

Session AC: Physics Education Research Around the World I

Location: Skutt Student Center Ballroom DE
Sponsor: International Physics Education Committee
Co-Sponsor: Research in Physics Education Committee
Date: Monday, August 1
Time: 8–9:40 a.m.

Presider: Genaro Zavala

This is an invited and contributed session designed for reports from groups around the world working on Physics Education Research. Included are 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.

AC01: 8–8:30 a.m. Diagnosing Student Understanding of Data Analysis Techniques

Invited - Ross K. Galloway, University of Edinburgh, School of Physics and Astronomy, Edinburgh, EH9 3JZ UK; ross.galloway@ed.ac.uk

Simon P. Bates, Helen E. Maynard-Casely, Katherine A. Slaughter, and Hilary Singer, University of Edinburgh

Physicists acquire data from a multitude of sources, ranging from their own experimental equipment or numerical simulations to the outputs of large experimental collaborations. However, the mere acquisition of this data is not enough: it is essential to know how to analyze and interpret it once it has been gathered. We expect that physics degrees will equip our students with the necessary analysis skills, but do they? We have formulated a diagnostic test of data-handling skills, and have deployed it in a number of universities across the UK and Ireland. Our findings suggest that student abilities in data handling are not being strongly developed by typical laboratory instruction, and that explicit tuition of the required techniques is needed. Furthermore, we find that part of the problem may be that the graduate teaching assistants we rely on may themselves not possess fully developed skills in this area.

AC02: 8:30–9 a.m. Can Student Generated Content Enhance Engagement and Learning in Physics?

Invited - Simon P. Bates, The University of Edinburgh, School of Physics and Astronomy, Edinburgh, EH9 3JZ UK; s.p.bates@ed.ac.uk

Ross K. Galloway and Karon McBride, University of Edinburgh

We describe a pilot study undertaken in a first-year physics class at the University of Edinburgh, in which students were tasked with creating their own assessment content in the form of multiple- choice questions. Using the PeerWise online system, a regular homework assignment was substituted for one in which students were required to author at least one original question, answer five others contributed by their peers, and rate and comment on a further three. The question repository was not moderated during the assignment, with tutors merely observing. The talk will discuss the scaffolding we provided for students in order to help them create questions and illustrate examples of engagement with the task and the exceptionally high quality of questions and comments provided by the student community. We also present correlations of degree of engagement with the task with end-of-course assessment performance.

AC03: 9–9:10 a.m. Perceptions and Beliefs of Undergraduate Physics Majors Toward Physics in Saudi Arabia

Hisham A. Alhadlaq, The Excellence Research Center of Science and Mathematics Education, King Saud University, Riyadh, 11451 Saudi Arabia; hhadlaq@ksu.edu.sa

Katherine K. Perkins, University of Colorado–Boulder
Wendy K. Adams, University of Northern Colorado
Omar M. Al-Dossary, King Saud University

In the last decade, physics researchers around the world have studied student perceptions and beliefs on physics and learning physics. Several instruments have been used to measure these perceptions and to identify how close they are to perceptions of experts. Recently, we have administered a newly developed Arabic version of the Colorado Learning Attitudes about Science Survey (CLASS) to a sample of senior physics-major students at King Saud University (KSU) in Riyadh, Saudi Arabia. The survey was distributed to about 100 male and female students over a three-year period (2009-2011). We will present our findings of perceptions and beliefs of undergraduate physics majors about physics and learning physics at KSU. We will take a closer look at how their perceptions compare to those of experts. An analysis of how these perceptions compare to the perceptions of a sample of freshmen students will also be presented.

AC04: 9:10–9:20 a.m. The Effect of Formative Assessment in Brazilian University Physics Courses

Emerson F. Cruz, Michigan State University, East Lansing, MI 48825; efcruz@msu.edu

Gerd Kortemeyer, Michigan State University

Most post-secondary physics courses in Brazil offer no meaningful formative assessment opportunities. We implemented online homework with immediate feedback in two courses, one with traditional learners at a public university, and one with nontraditional learners at a private university. In addition, at the public university, clickers were used in lecture. While surveys showed broad acceptance of these techniques by the students and the belief that they helped in learning, grades did not significantly improve - instead, we observed a narrowing of the grade distribution toward mid-range grades at the public university, and no difference at the private university. Our study also identifies a number of logistical and organizational hurdles that need to be overcome before a hopefully more successful implementation of these techniques should be attempted.

AC05: 9:20–9:30 a.m. Mathematics in Cameroon: From Text to Talk in the Classroom

Anne E. Emerson, University of California, Santa Barbara, Santa Barbara, CA 93106; aemerson@education.ucsb.edu*

Danielle B. Harlow, University of California, Santa Barbara

Mathematics is a gateway for learning science and thus limits the number of students choosing physics as a discipline of study. In Cameroon, this limitation is exacerbated by the introduction of algebra and early math and science tracking in secondary school. Textbooks prescribe classroom practices and relationships between content, teachers, and students, especially in Cameroon where they have strong foundations in European pedagogy and are often the sole resource in the classroom (Fonkeng, 2007).[1] In this study, we examined how a mathematics textbook served to mediate the structure and interactions for two classes at a secondary school in Yaoundé, Cameroon. This research provides insight into how a textbook informs algebra instruction in an effort to better understand its role in supporting or constraining access to the fields of math and science.

1. Fonkeng, George Epah, *The History of Education in Cameroon, 1844-2004,* The Edwin Mellen Press, Ltd., (Lewiston, New York, 2007).

*Sponsor: Danielle B. Harlow

AC06: 9:30–9:40 a.m. Contextual Elements in Translation of Force Concept Inventory into Japanese

Michi Ishimoto, Kochi University of Technology, Kami-shi, Kochi 782-8502, Japan; ishimoto.michi@kochi-tech.ac.jp

We create a new Japanese version of the Force Concept Inventory (FCI) by combining three existing versions administered at three universities in Japan. The new version is for distribution to high schools and universities to assess students' preconceptions. The three existing versions are quite dissimilar because of differences in the interlingual translation stemming from large variation of expression in the translator's personal sense of language. We identify three elements of the interlingual translation that can alter the context of the questionnaire. The first element is the coining of scientific terms, such as velocity and acceleration, for school use so as to differentiate from everyday language. The second element is the use of gender expression, which is not necessary to describe in questionnaires in Japanese. The third element concerns lifestyle and cultural differences. For example, a car pushing a truck at cruising speed does not occur in Japan.

Session AD: Reflections on the Gordon Conference on Experimental Research and Labs in Physics Education

Location: Skutt Student Center 105
Sponsor: Laboratories Committee
Co-Sponsor: Physics in Undergraduate Education Committee
Date: Monday, August 1
Time: 8–9:30 a.m.

Presider: Kiko Galvez

AD01: 8–8:30 a.m. Using Experiments to Foster Conceptual Understanding: Insights from PER*

Invited - MacKenzie R. Stetzer, University of Washington, Seattle, WA 98195-1560; stetzer@phys.washington.edu

The Physics Education Group at the University of Washington has been investigating student learning in an upper-division laboratory course in analog electronics. Our findings indicate a need for research-based instructional materials that are expressly designed to help deepen student understanding and to address specific difficulties identified through research. As we begin this curriculum-development effort, we plan to draw on our extensive experience designing research-based and research-validated materials for use in special laboratory-based, inquiry-oriented courses for K-12 teachers.[1] In this talk, I will highlight the role of experiments in instructional strategies that have been shown to strengthen the conceptual understanding of K-12 teachers. I will also reflect on how such approaches may be implemented in upper-division laboratory courses.

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

1. L.C. McDermott and the Physics Education Group at the University of Washington, *Physics by Inquiry* (Wiley, 1996).

AD02: 8:30–9 a.m. Dynamic Interferometric Measurements: Acoustical/Mechanical Resonators and Changing Magnetic Fields*

Invited - Richard Peterson, Bethel University, Bethel, MN 55112; petric@bethel.edu

Keith Stein, Bethel University

Physical optics combines with computational physics to make three experimental project areas especially rich in experimental breadth (optics, electronics, acoustics, fluid dynamics, along with structural and magnetic properties of materials), in addition to facilitating year-to-year student/faculty creativity. Stroboscopic holography techniques with a high (130-160) dB gas resonator allow real-time imaging of sound patterns at resonance as gas density variations impact the index of refraction and produce quantifiable fringe motions at pressure antinodes. A steel tuning fork is rich in torsional and transverse modes that yield to spectral analysis and computational FFT work with COMSOL. Stroboscopic holography produces quantifiable video images of these modes that may be compared to spectral and COMSOL predictions. Rapidly changing magnetic fields in a material produce Faraday-effect induced interferometric phase shifts between circularly polarized beams, and real-time fringe readouts can measure rapidly changing fields at the level of a few gauss in TGG.

*Supported in part by the MN NASA Space Grant and the Carlsen-Lewis Endowment at Bethel University.

AD03: 9–9:10 a.m. Quantum Mechanics with a Lab

Enrique J. Galvez, Colgate University, Hamilton, NY 13346; egalvez@colgate.edu

I report on an undergraduate course on quantum mechanics with a lab component. The lab consists of five experiments with correlated photons for students to learn applications of quantum mechanics. Optical components are represented by matrix operators. Hilbert spaces can be momentum modes (propagation along *x* or *y* directions), polarization modes (horizontal or vertical), or combinations of these for one or two photons, forming two or four-dimensional spaces. The experiments explore basic quantum mechanical operations such as basis projection, basis rotation, superposition and measurement. Experiments also touch modern themes such as the concepts of qubits and entanglement. We use two optical layouts, each set up on a 2 ft x 5 ft optical breadboard.

AD04: 9:10–9:20 a.m. Fundamental Instructional Labs in Quantum Mechanics for Undergraduate Physics Majors

Gabriel C. Spalding, Illinois Wesleyan University, Bloomington, IL 61701; gspaldin@iwu.edu

Many students have a difficult time grasping quantum mechanical models and, particularly given that the most popular undergraduate text on quantum (Griffiths) forgoes references to real experiments, a new generation of instructional experiments is deemed to provide the absolutely critical visualization and tangible proof that are needed to convince students of key elements of quantum theory. Such instructional labs have been featured highlights of the 2009 Advanced Lab Topical Conference in Ann Arbor and of the 2010 Gordon Conference on Physics Research and Education, and have also been incorporated into the ALPhA Immersion Program, which provides hands-on training for lab instructors (e.g., in demonstrating the existence of photons, single-photon interference, indistinguishability and the quantum eraser, entanglement and tests of Bell's inequalities, etc.). This led us to establish a group focused on furthering efforts to make these sorts of labs more affordable.

AD05: 9:20–9:30 a.m. What Is the Relevance of Physics Education Research to the Advanced Lab?

Benjamin M. Zwickl, University of Colorado–Boulder, Boulder, CO 80309; benjamin.zwickl@colorado.edu

Noah D. Finkelstein and Heather J. Lewandowski, University of Colorado

The University of Colorado–Boulder is in the early stages of a 2.5-year research-based redesign of our upper-division physics lab courses. There has been a nationwide resurgence of interest in advanced physics labs among instructors and faculty, but the PER community to date has focused on introductory and lecture-format classes. Little research has been conducted on these uniquely sophisticated and resource-rich learning environments in terms of goals, measurements of learning, and outcomes of modification. We are applying the existing research-base and methods of PER as a tool to make our labs better with the dual purpose of finding generalizable lessons about effective instruction in advanced lab courses. We will report preliminary outcomes that include our process of modification, learning goals, assessment frameworks, and a revised lab example.

Session AE: PER: Investigating Classroom Strategies I

Location: Harper Center 3023 & 3023A
Sponsor: Research in Physics Education Committee
Date: Monday, August 1
Time: 8–10 a.m.

Presider: Tom Carter

AE01: 8–8:10 a.m. Understanding the Variable Effect of Course Innovations on Student Learning

Heidi Iverson, University of Colorado–Boulder, Boulder, CO 80302; heidi.iverson@colorado.edu

Over the last several decades, research has challenged the efficacy of the traditional lecture-based instructional model of undergraduate physics education. As a result, a large number of reform-oriented instructional innovations have been developed, enacted, and studied in undergraduate physics courses. While previous work has shown that the impact of course innovations on student learning has been overwhelmingly positive, it has also been highly variable. The purpose of this analysis is to investigate this variability. For this analysis 170 published studies on undergraduate physics course innovations were coded with respect to the characteristics of the innovations as well as the methodological characteristics of the study designs. The findings of this analysis have indicated that nearly half of the variability can be accounted for by study design characteristics rather than by characteristics of the innovations used. However, a subsequent analysis has highlighted some of the critical characteristics of more effective innovations.

AE02: 8:10–8:20 a.m. Teaching Creativity and Innovation to Physicists Using Tablet PCs

Patrick B. Kohl, Colorado School of Mines, Golden, CO 80401; pkohl@mines.edu

Vincent H. Kuo, Frank Kowalski, and Susan Kowalksi, University of Colorado

As the rest of the world catches up to the U.S. in industrial output and technological sophistication, our continued economic prosperity will depend on strengthening our historical success in generating new ideas. While there are limited efforts to foster creativity and innovation through formal and informal instruction in the business world, few efforts exist in science or engineering education. To address this, the Colorado School of Mines has recently created a dedicated Tablet PC classroom where we hold an elective physics course for the purpose of improving creativity in our students. In this talk, we report on the structure of the course and the technologies used. The latter include pedagogical implementations of Ink-Survey, a free web-based software package that enables detailed, real-time interactions with the instructor. We assess student progress via the Torrance Test of Creative Thinking, and discuss early work towards developing a physics-specific instrument for measuring creativity.

AE03: 8:20–8:30 a.m. Clickers 2.0: Managing Classroom Interactions

Brian Lukoff, Harvard University, Cambridge, MA 02138; blukoff@seas.harvard.edu

Eric Mazur, Harvard University

Clickers are widely used for formative assessment in physics classrooms, but current clicker systems have numerous limitations. In particular, most clicker systems have limited question formats beyond multiple-choice, and provide only limited ways for instructors to use data to improve instruction. We will introduce a new web-based system we have developed that allows students to use laptops and smartphones to answer many different kinds of questions (e.g., indicating the direction of a vector, or entering an algebraic expression) and allows instructors to use the data in real time to automatically group students for peer instruction based on their responses and their reported geographical locations in the classroom. Based on an initial deployment of this system in an introductory electricity and magnetism course, we will show some examples of what can be learned about student understanding from non-multiple-choice items and what can be learned about peer instruction from automatic grouping.

AE04: 8:30–8:40 a.m. Assessing Course-Integrated Problem Comparisons Activities Using Similarity Ratings Surveys

Frances A. Mateycik, Penn State Altoona, Altoona, PA 16601; fam13@psu.edu

Kendra E. Sheaffer, Penn State Altoona

Students in an algebra-based physics course were required to complete a compare and contrast activity each week. The treatment was used to examine whether direct problem comparisons are useful for facilitating student awareness of physical, deep-structure problem characteristics. Students were expected to write detailed arguments as to how two problems of their own selection from the weekly homework assignment were similar and different from one another. Handwritten feedback was offered after each assignment, and students were deducted points if their responses were considered too vague. Pre- and post-treatment similarity ratings surveys were used to evaluate the emphasis students placed on deep-structure. The survey required students to rate the similarities between eight pairs of problems of varying similarity, and write a description that supported their numerical rating. This talk will summarize student survey responses before and after treatment, and compare any trends with previous semesters where no immediate feedback was offered.

AE05: 8:40–8:50 a.m. Adapting PER Strategies for Middle School Science Classes

David E. Meltzer, Arizona State University, Mesa, AZ 85212; david.meltzer@asu.edu

There is great potential in adapting, for the middle-school classroom, instructional strategies and curricular materials developed and validated for use with college students. Substantial modifications in content, format, and instructional design are needed and must conform to a variety of constraints such as time availability for instruction and grading, equipment and administrative resources, etc. I will describe my experiences in adapting PER-based materials and methods for weekly science classes taught to grades 5, 6, 7, and 8 during the 2010-2011 academic year. The context was a one-hour class taught each week to five different classes, all in the setting of a university instructional laboratory.

* Supported by a grant from Mary Lou Fulton Teachers College

AE06: 8:50–9 a.m. Examining Correlations Between Lecture Conceptual Question Responses and Course Performance

Jeffrey T. Morgan, University of Northern Iowa, Cedar Falls, IA 50614-0150; jeff.morgan@uni.edu

Cynthia Wakefield, University of Northern Iowa

We have implemented peer instruction in an introductory level conceptual physics course for non-science majors, based on the success that others report with this method.[1] We expected to see that learning from peer conversation, as evidenced by answering conceptual questions correctly following discussion, would correlate with course grade, but did not observe any link. We did, however, note moderate correlation between answering a conceptual question correctly prior to peer conversation and course grade, indicating that while peer conversation improves the interactivity of a lecture course, interaction may be more important than arriving at the correct answer to student success.

1. Crouch, C. H. and Mazur, E., “Peer Instruction: Ten years of experience and results.” *Am. J. Phys.* **69** (9), 970-977 (Sept. 2001).

AE07: 9–9:10 a.m. Scaffolding Students’ Development of Mental Models for Pulleys Systems*

Amy Rouinfar, Kansas State University, Manhattan, KS 66506-2601; rouinfar@phys.ksu.edu

Adrian M. Madsen and N. Sanjay Rebello, Kansas State University
Tram Do Ngoc Hoang, Ho Chi Minh City University of Pedagogy
Sadhana Puntambekar, University of Wisconsin, Madison

Research has shown that students have several misconceptions about pulleys. To construct a mental model of how pulley systems work, students must elicit and confront these misconceptions. We report on a study with students in a conceptual physics laboratory investigating pulley systems using physical or virtual manipulatives. Written materials guided students through a sequence of activities designed to scaffold their model construction process. The activity sequences facilitated students’ sense making by requiring them to make predictions about different pulley systems and testing these predictions by building and comparing different systems. At the end of each of the two weeks of the activity, students were given the task of designing the best pulley system for lifting a piano. We investigate the ways in which students use the manipulatives while navigating scaffolding activities and how the students’ mental model development of pulley systems compares between the physical and virtual treatments.

* This work is supported in part by U.S. Dept. of Education IES grant award R305A080507.

AE08: 9:10–9:20 a.m. Peer Instruction Self-Efficacy

Julie A. Schell, Harvard University, Cambridge, MA 02138; schell@seas.harvard.edu

Brian Lukoff, Jason Dowd, Laura Tucker, and Eric Mazur, Harvard University

Physics education research suggests that students’ beliefs in their ability to complete physics tasks successfully—that is, their physics self-efficacy—may play an important role in explaining their learning and success in undergraduate physics classrooms (Fencl & Scheel, 2005; Kost, Pollock, Finkelstein 2005).[1] Following this line of research, we introduce a new self-efficacy construct, Peer Instruction Self-Efficacy (PISE), which describes students’ beliefs in their abilities to engage in specific Peer Instruction activities. For example, PISE includes physics students’ beliefs that they can successfully convince their neighbors of the validity of their responses to conceptually based questions during Peer Instruction. In this talk, we will introduce our instrument for measuring PISE, as well as data on how students’ PISE changes over the course of one semester of an introductory undergraduate electricity and magnetism course at one major research university. We will also report initial findings about the relationship between students’ PISE and their eventual learning outcomes in the course.

1. H. Fencl & K. Scheel, *J. Col. Sci. Teach.* 35, 20 (2005).
L. E. Kost, S. J. Pollock, N.D. Finkelstein. Physics Education Research Conference, (2009).

AE09: 9:20–9:30 a.m. Is this Good Teaching? Assessment Challenges for Both Faculty and Institutions

Chandra A. Turpen, Western Michigan University, Kalamazoo MI 49008-5200; Chandra.Turpen@colorado.edu

Charles Henderson, Western Michigan University
Melissa Dancy, University of Colorado–Boulder

As part of a larger research study, we focus on the investigation of barriers to instructional change. One significant barrier that has emerged is that neither faculty nor their institutions know how to evaluate student learning (or teaching effectiveness) in introductory physics courses. In this talk, we will present results from telephone interviews with 70 physics faculty related to how faculty and their institutions evaluate teaching effectiveness. We will focus on the following research questions: 1) What information is gathered about instructors? teaching and students? learning? 2) How is this information used? 3) How are different sources of information perceived or valued by faculty? Helping faculty (and possibly institutions) make judgments about whether their instruction is working may be an integral part of supporting efforts to improve undergraduate physics instruction.

*Supported, in part, by NSF Award No. 0715698

AE10: 9:30–9:40 a.m. Teaching Assistant Impact on Student Understanding of Electrostatic Concepts*

*Keith West,** Texas Tech University, Lubbock, TX 79409; keith.h.west@ttu.edu*

Beth Thacker, Texas Tech University

Teaching assistants were given a ranking problem in electrostatics to teach during recitation sections. The same problem was given on an in-class exam two weeks later. Student performance on the exam question is examined as a function of TA teaching style, which is ranked using the RTOP assessment.

* This project is supported by the NIH grant 5RC1GM090897-02.
** Sponsor: Beth Thacker

AE11: 9:40–9:50 a.m. Comparison of an Inquiry-based Algebra-based Course to Traditional Teaching

Mahmoud Yaqoub, Texas Tech University, Lubbock, TX 79409; m.yaqoub@ttu.edu*

Beth Thacker, Keith West, Mark Ellermann, and Jake Schwierking, Texas Tech

We present data comparing an inquiry-based, algebra-based introductory physics course to courses taught traditionally and by interactive engagement. The inquiry-based course was taught in a hands-on, laboratory-based classroom. It was taught without a text, using materials developed explicitly for the algebra-based population, supported by two NSF grants.[1] We present data both from conceptual inventories and written pre- and post-tests administered to all of the classes.

1. arXiv:physics/0702247v1 supported by CCLI #9981031 and CCLI-EMD #0088780. This project is supported by the NIH grant 5RC1GM090897-02.

*Sponsor: by Beth Thacker.

AE12: 9:50–10 a.m. High School Teachers' Implementation of 'Troubleshooting-Tasks' Presented in an In-Service Program

Edit Yerushalmi, Weizmann Institute of Science, Rehovot, Israel; edit.yerushalmi@weizmann.ac.il

Sawsan Ailabouni and Rafi Safadi, Weizmann Institute of Science

"Troubleshooting Tasks" require students to detect an error in a statement describing a situation, explain it, and correct it. Such tasks can serve as a context for refining interpretations of scientific concepts if designed appropriately. In particular, statements should include mistaken reasoning reflecting alternative conceptions known from the research literature, and feedback should highlight how a mistaken interpretation differs from the scientific one. "Troubleshooting Tasks" were presented in an in-service program for high school teachers from the Arab sector in Israel. We report how these tasks were implemented in the classrooms. Data sources consist of statements and sample solutions composed by the teachers, teachers' assessment of students' performance, and their reflections regarding their experience. In particular, we answer: To what extent did actual implementation confirm with the aforementioned guidelines? What challenges did teachers face when implementing these tasks? The results can inform the design of in-service programs presenting teachers with similar tasks.

Session AF: Learning Progressions

Location: Skutt Student Center Ballroom F
Sponsor: Physics in Pre-High School Education Committee
Date: Monday, August 1
Time: 8–9 a.m.

Presider: Vivian O'Brien

This session will focus on the use of learning progressions for planning teaching and the assessment of student learning.

AF01: 8–8:30 a.m. Linking Research with Practice: How Learning Progressions Guide Instructional Decisions

Invited - Karin Hess, National Center for the Improvement of Educational Assessment, Underhill, VT 05489; Khess@nciea.org

This session will address the question: What are learning progressions (LPs) and how can they be used in the classroom to determine the "next steps" for instruction? Several hands-on activities will illustrate how classroom teachers can use science LPs to: (1) evaluate the scope of current assessments across the year; (2) plan curriculum sequences using research-based learning continua; and (3) use ongoing assessment data to monitor student progress. Examples of how teachers in several states are designing assessments to determine where students are along the continuum of learning using LPS will be shared.

AF02: 8:30–9 a.m. Learning Progressions as a Path to Understanding Student Thinking

Invited - Michael Jabot, SUNY Fredonia, Fredonia, NY 14063; jabot@fredonia.edu

This session will introduce the concept of learning progressions as a path to understanding student thinking. Learning progressions allow for the systematic planning of instruction and assessment. This very useful concept will be presented using an example from foundational understandings in physical science. The example will highlight both the components of instructional design as well as assessment models for the evaluation of student thinking and progress toward understanding.

Session AG: Methods to Improve Conceptual Learning in Quantum Mechanics I

Location: Skutt Student Center Ballroom ABC
Sponsor: Physics in Undergraduate Education Committee
Date: Monday, August 1
Time: 8–9:30 a.m.

Presider: Mario Belloni

AG01: 8–8:30 a.m. Teaching Quantum Mechanics in the Paradigms in Physics Curriculum

Invited - David H. McIntyre, Oregon State University, Corvallis, OR 97331; mcintyre@ucs.orst.edu

To improve conceptual learning, the Paradigms in Physics program has reordered material from the subdisciplines and incorporated modern pedagogical strategies. In the quantum part of our curriculum, we adopt a "spins-first" approach by introducing quantum mechanics through the analysis of sequential Stern-Gerlach spin measurements. The aims of the spins-first approach are: (1) To immerse students in the inherently quantum mechanical aspects of physics, and (2) To give students experience with the mechanics of quantum mechanics in the forms of Dirac and matrix notation. To facilitate our spins-first approach, we use Stern-Gerlach simulation software to study measurements, interferometers, spin precession in a magnetic field, and "which-path" detection. We build upon the spins-first approach by using the spin-1/2 example to introduce perturbation theory, the addition of angular momentum, and identical particles. We use Dirac notation and matrix notation throughout our five quantum courses, emphasizing the importance of fluency in multiple representations.

* This material is based on work supported by the National Science Foundation under Grant Nos. 9653250, 0231194, and 0618877. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.

AG02: 8:30–9 a.m. Ask, and It Shall be Given You

Invited - Daniel F. Styer, Oberlin College, Oberlin, OH 44074; Dan.Styer@oberlin.edu

Conceptual learning in a quantum mechanics course can be promoted by a balanced, interwoven treatment of concepts, formalism, and applications so that each thread reinforces the other. In particular, it is important that most problems, no matter how technical, contain conceptual elements as well.

AG03: 9–9:30 a.m. Turning Quantum Mechanics Course Notes into Tutorials

Invited - Todd K. Timberlake, Berry College, Mount Berry, GA; 30149-5004; ttimberlake@berry.edu

Efforts have been under way for many years to introduce active engagement strategies in the teaching of introductory physics. More recently there have been attempts to expand the use of active engagement into upper-division physics courses. In this talk I will discuss my efforts to employ active engagement in an upper-level quantum mechanics course, using a series of tutorial activities covering many of the standard topics in quantum mechanics. I will discuss some of the challenges of using active engagement to teach quantum mechanics, as well as my process for creating the tutorials, most of which were simply adapted from the derivations and sample problems that I had previously presented in lecture format. In addition, I will comment on the overall success of this approach, mention some topics for which I still make use of traditional lecture, and share the reactions of my students to the tutorials and the class as a whole. The tutorials (in pdf and LaTeX format) can be found at http://facultyweb.berr.edu/ttimberlake/active_quantum/.

Session AH: Best Practices in the Use of Educational Technologies I

Location: Harper Center 3029
Sponsor: Educational Technologies Committee
Date: Monday, August 1
Time: 8:30–9:40 a.m.

Presider: Andrew Garvin

This session is a contributed session to encourage physics teachers at all levels to share their best practices in unique ways of using technologies, on the web and in the lab.

AH01: 8:30–8:40 a.m. Minds-On Audio-Guided Activities in Introductory College Physics Courses

James Brian Hancock, II, Central Michigan University, Mt. Pleasant, MI 48859; hanco1jb@cmich.edu

Marco Fornari, Central Michigan University

Minds-On Audio Guided Activities (MAGA) are Podcast-delivered instruction designed to engage students in all-body experiments and foster long-term conceptual learning. These Podcasts guide students through experimentation, prompt group discussion, and lead students toward connecting daily experiences with the activity. Instruction by MAGA has undergone preliminary testing in an introductory physics course at Central Michigan University. The experiment is designed according to the standard protocol of learning assessment and involves pre- and post-tests and student interviews. Topics are currently focused on mechanics and range from discovering the differences between distance and displacement to momentum to the Coriolis effect. The session will include details of the approach and a discussion of preliminary results.

AH02: 8:40–8:50 a.m. The Monty Hall Problem Using Clickers

Stephen H. Irons, Yale University, New Haven, CT 06520; stephen.irons@yale.edu

C. Meg Urry, Yale University

In the lecture setting, clickers make the collection of student-generated input quick and easy. Though traditionally employed in conjunction with conceptual questions and peer instruction, clickers can also be used to perform statistical experiments in real time. We describe an activity that combines clickers and a simple paper prop to conduct rapid and multiple statistical experiments. The eponymously named Monty Hall problem is an excellent exercise in conditional probability for students as it has a counter-intuitive solution, but the actual outcomes can be dramatically demonstrated. Here we describe the problem and its solution and then discuss the results of an in-class implementation conducted during a lecture on probability. In addition to expanding the activity to include variations on the initial problem statement, instructors can also model radioactive decay using students, clickers, and a random number generator.

AH03: 8:50–9 a.m. Tweetment of Twitter in the Classroom

John T. Miller, Thornapple Kellogg High School, Middleville, MI 49333; johnthomasmiller@hotmail.com

How do I better connect with and appropriately communicate with my students? Twitter should be considered as part of the solution. This presentation is about unleashing the power of Twitter to better educate, inform, and connect your students to your classroom and curriculum. This talk will be focused on how Twitter is being used in a high school setting and strategies to make it successful.* Educators of all levels will find this talk informative.

* www.tinyurl.com/tweetment

AH04: 9–9:10 a.m. Using Simulations to Help Prepare Students for the Lab

Mark J. Paetkau, Thompson Rivers University, Kamloops, BC V2C 2Z3, Canada; mpaetkau@tru.ca

Dan Bissonnette and Colin Taylor, Thompson Rivers University

For the past few years we have been using online simulations to help students prepare for their Introductory Physics labs. We have written online animations allowing students to simulate the lab before arriving, which, ideally, more effectively prepares students for the lab. To test whether the simulations are more effective than traditional pen-and-paper questions as pre-lab exercises, we attempted to measure the "level-of-preparedness" of our students. Using our preparedness measure, we compare the preparedness for the two forms of pre-lab exercises. A statistically significant change in "preparedness" is found with the use of online simulations over the pen-and-paper pre-labs.

AH05: 9:10–9:20 a.m. Using Web-based Multimedia Prelectures in Introductory Physics

Homeyra R. Sadaghiani, Cal Poly Pomona, Pomona, CA 91768; hrsadaghiani@csupomona.edu

For the last two years, I have been using Multimedia Learning Modules (MLM)* developed by University of Illinois at Urbana Champagne as online Pre-lecture assignments in introductory physics courses at Cal Poly Pomona. By exposing students to the key ideas of lecture prior to class, MLMs allow instructors to focus on more in-depth application of the physics concepts during class. I will discuss the impact MLMs had on student preparation for class discussion and exam performance.

* https://online-s.physics.uiuc.edu/courses/phys211/gtm/No_Login/page.html

AH06: 9:20–9:30 a.m. Math Machines: Connecting Physics with Math and Engineering*

Fred Thomas, Sinclair Community College, Englewood, OH 45322; fred.thomas@mathmachines.net

Robert Chaney, Sinclair Community College

Math Machines is a unique technology that establishes explicit links to mathematics and engineering within physics labs and student-focused classrooms. Students design and test free-form mathematical functions to control engineering-style physical systems and complete immediate, physical and dynamic tasks. Examples include programming a light to follow an accelerating object, programming an astronomical clock to replicate the motions of the Moon, programming motions of a platform to simulate earthquakes of arbitrary magnitude, and programming red, green, and blue lights to display oscillating colors in various combinations. Equipment is inexpensive, consisting primarily of such things as a hobby servo motor and a 3-color LED in combination with a SensoDAQ or NI myDAQ computer interface. Schools are encouraged to build similar equipment and share it with math, science, engineering and technology teachers in their region.

*Supported in part by NSF's Advanced Technological Education Program through grant DUE-1003381. More information is available at www.mathmachines.net.

AH07: 9:30–9:40 a.m. Teaching with a TabletPC in Introductory Physics

Krista E. Wood, University of Cincinnati, Cincinnati, OH 45236; Krista.Wood@uc.edu

Students in introductory physics often need significant support to develop the thought processes to be successful in physics. A TabletPC, similar to a SMART Board, can be used to create screencasts (videos) of worked out problems or even complete problem-solving sessions. If the instructor records the audio with the writing, students can watch the videos or replay parts they don't understand. The TabletPC can also be used to record Interactive Lecture Demonstration (ILD) results using the screen capture function or screencasts of complete video analysis demonstrations. Since ILDs particularly focus on helping students develop concepts, these videos are effective reinforcements for what occurs during the ILD in class.

Session AI: Potpourri of Teacher Preparation Programs I

Location: Skutt Student Center 104
Sponsor: Teacher Preparation Committee
Co-Sponsor: Minorities in Physics Committee
Date: Monday, August 1
Time: 8–10 a.m.

Presider: Taha Mzoughi

As more of us attempt to start or enhance physics teacher programs, we can benefit from learning about other programs. Speakers will describe their programs and highlight successes and challenges. Talks may address curriculum issues and how you balance physics content with education standards. Another issue is how you attract students from traditionally under-represented groups in the teaching profession.

AI01: 8–8:30 a.m. A Teacher Preparation Model that Cultivates Student Success and Diversity*

Invited - Laird Kramer, Florida International University, Miami, FL 33199; Laird.Kramer@fiu.edu

We present the rationale and results driving Florida International University's (FIU's) new physics teacher preparation program, a program designed to cultivate success for all students. FIU implemented the University of Colorado's Learning Assistant (LA) model in 2008 through a PhysTEC Grant. The LA model is an experiential teaching program for undergraduates that recruits and prepares future teachers while driving departmental reform, as LAs must experience research-validated curricula in order to make informed decisions about their future in teaching. The program now supports 45 LAs, impacts over 2,000 introductory physics students per year, and is now fully sustained by department funding. The LA program's success has prompted a spread to chemistry, earth science, mathematics, and biology. The impact is most compelling as FIU is a minority-serving urban public research institution in Miami, serving over 42,000 students, of which 64% are Hispanic, 13% are black, and 56% are women.

* Work supported by PhysTEC and NSF PHY-0802184.

AI02: 8:30–9 a.m. 100 Physics Teachers 7 Years, How Does BYU Do It?

Invited - Duane B. Merrell, Brigham Young University, Provo, UT 14222; duane_merrell@byu.edu

Brigham Young University restructured the physics teaching program in 2004. Since that time, this year we will reach our 100th physics-certified teacher. The highlights and heartaches of this program will be discussed. The efforts of the College of Math and Physical Science to bring the Physics Teaching Program back to the Department of Physics and the support this came with from the College of Education will be discussed. The working relationships between the two colleges and the local school districts will be shared. How we fund a teacher in residence and the value of the mentor teacher network to develop our students as teachers will be highlighted as one of the strengths of the program. We will also share the efforts that are made with mentoring and induction of new physics teachers as part of this talk.

AI03: 9–9:30 a.m. Physics Teacher Preparation at Buffalo State College

Invited - Luanna Gomez, Buffalo State College, Buffalo, NY 14222; gomezls@buffalostate.edu*

Daniel MacIsaac, David Henry, David Abbott, and Lowell Sylwester

The physics department at Buffalo State College offers both a BS and MS Ed. degree that lead to New York State certificate for teaching high school physics. There are two MS Ed. degree programs. One is designed for currently certified professional teachers who wish to add physics as a second certification area, and the other is designed for career changing science and engineering professionals who wish to become New York state physics teachers through a two-year alternative certification process. We will discuss the rationale behind the programs and describe the course offerings.

* Submitted abstract and speaker in place of Dan L. MacIsaac.

AI04: 9:30–9:40 a.m. Cogenerative Teaching in a Physics and Everyday Thinking Course

Natan Samuels, Florida International University, Miami, FL 33199; nsamu002@fiu.edu

Seth Manthey and Eric Brewe, Florida International University

We present the results of a cogenerative teaching experience in an elementary science content and methods course. This course implemented the Physics and Everyday Thinking (PET) curriculum, which we adapted to meet student and programmatic needs. In this talk we will discuss the cogenerative mediation process for learning environments (CMPLE) by which those adaptations occurred. Implementing CMPLE helped us to identify the needed course changes and effective teaching practices for this student population. Having done so was worthwhile, and provided us with a valued experience.

AI05: 9:40–9:50 a.m. Developing a Biology Extension within Physics and Everyday Thinking

Seth R. Manthey, Florida International University, Miami, FL 33199; smant005@fiu.edu

Natan Samuels and Eric Brewe, Florida International University

We present the results of a cogenerative teaching experience in an elementary science content and methods course. This course implemented the Physics and Everyday Thinking (PET) curriculum, which we adapted to meet student and programmatic needs. In this talk we will be discussing a specific adaptation we made to the PET curriculum. This change was achieved by uncovering the students' needs using the Cogenerative Mediation Process for Learning Environments (CMPLE) and then creating an extension from the infrared portion of the PET curriculum. This extension connected PET and physics in general to biological concepts. This extension was a result of cogenerative discussion regarding the needs of the students.

AI06: 9:50–10 a.m. Interface Physics Education with Science Education

Celia C. Chow, CSU, Simsbury, CT 06089-9726. cchungchow@comcast.net

Physics education is an essential part of science education. Physical and biological sciences should be introduced to young students as early as possible in elementary schools and kindergartens. Then physical science will be divided into physics, chemistry, astronomy, geology, etc. in senior high schools. Later, at the college/university level, they are sharply divided as different fields and highly specialized to particular topics. For high school teachers-to-be, it is challenging to teach with some areas combined at high school level due to the sharp specialization at college studies. How do we help new teachers apply physics laws to chemical, geological, and biological processes. And above all, how to apply physics laws to environmental issues. This task is for both teachers, high school and college levels.

Crkrbrl 1: Crackerbarrel on Professional Concerns of Faculty in Small Departments

Location: Skutt Student Center Ballroom ABC
Sponsor: Professional Concerns Committee
Co-Sponsor: Physics in Two-Year Colleges Committee
Date: Monday, August 1
Time: 11:30 a.m.–12:30 p.m.

Presider: Dyan McBride

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- Apparatus Competition – *2060 Harper Center*
- TYC Resource Room – *3053 Harper Center*

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Monday–Tuesday: 8 a.m.–5 p.m.
Wednesday: 8 a.m.–3 p.m.

Plenary: Reaching Out to the Public – A Necessary Dialogue

Location: Harper Center Hixson Lied Auditorium
Date: Monday, August 1
Time: 10:30–11:30 a.m.

Presider: Jill Marshall

James H. Stith

James Stith, Vice President Emeritus, American Institute of Physics, College Park, MD 20740; jstith@aip.org

What are the roles and responsibilities of scientists to reach out and establish a dialogue with the public? Why is it important for scientists to do this? This talk will also describe various American Institute of Physics (AIP) media efforts including the Discoveries and Breakthroughs Inside Science TV (DBIS) program. DBIS is a peer-reviewed, syndicate science news service that distributes twelve 90-second news segments to local television stations. Each month, DBIS can be seen by more than 52 million people in the U.S. and over 200 million people internationally. DBIS was supported by the National Science Foundation (2003-2007) and currently has financial support from a broad coalition of scientific societies.

Session BA: Don't Put that Phone Away: Personal Electronics in the Classroom

Location: Harper Center 3027
Sponsor: Physics in High Schools Committee
Co-Sponsor: Educational Technologies Committee
Date: Monday, August 1
Time: 1–2:30 p.m.

Presiders: Steve Perroni and Nina Daye

This session involves information concerning the use of personal electronic devices to enhance physics instruction in the 21st century classroom.

BA01: 1–1:30 p.m. Physics Apps for the iPhone, the Touch, and the iPad*

Invited - Andrew Duffy, Boston University, Boston, MA 02215; aduffy@bu.edu

This talk will discuss physics apps for the iPhone, the iPod Touch, and the iPad. You can create your own apps and make them available through the App Store, and we will address that process briefly. However, there are a significant number of physics-related apps already available through the App Store, and we will talk about some of these and about ways in which you can use them in your own classes. Finally, some lucky attendees will receive a code so they can download a physics app for free.

* A link to some app information: http://physics.bu.edu/~duffy/iPhone/

BA02: 1:30–2 p.m. VCalc: An iPhone app for Intro Physics Courses*

Invited - Steve J. Spicklemire, University of Indianapolis, Indianapolis, IN 46219; spicklemire@uindy.edu

VCalc is an RPN vector calculator for the iPhone/iPod designed to help in performing various vector-intensive computations on a portable device. VCalc was created out of a need to perform vector calcuations like those required in intro physics courses, particularly the great "Matter and Interactions" curriculum developed by Ruth Chabay and Bruce Sherwood. This talk is a "behind the scenes" view of the development of an iPhone application intended for student use and the likely potentialities and limitations of such an approach. Alternative approaches and related apps are also discussed.

*URL for VCalc: http://www.spvi.net/VCalc_Support

BA03: 2–2:30 p.m. Student Choices: Podcast or Text Preferences of Elementary Science Methods Students

Invited - Cathy M. Ezrailson, University of South Dakota, Vermillion. SD 57069-1094; cathy.ezrailson@usd.edu

Shane Miner, University of South Dakota

As part of an ongoing study with digital methods of content delivery, students in an Elementary Science Methods course were given the choice of content type: Podcast and/or text while studying assessment models. Student choice of and comfort level with digital media were examined. Student choice yielded some surprising results and interesting feedback.

Session BB: Best Practices in the Use of Educational Technologies II

Location: Harper Center 3029
Sponsor: Educational Technologies Committee
Date: Monday, August 1
Time: 1–3 p.m.

Presider: Andrew Garvin

Best practices for teaching with technology including clickers, homework systems, social media, computer simulations, mbl curriculum and beyond may be covered.

BB01: 1–1:30 p.m. Teaching with Clickers: How, for What, and with What Mind-Set?*

Invited - Ian D. Beatty, University of North Carolina Greensboro, Greensboro, NC 27402-6170; idbeatty@uncg.edu

Clickers are a powerful tool for classroom instruction, but like any tool, they may be used skillfully or clumsily, for more or less fruitful purposes. What purposes are fruitful? Why do some teachers give up, some muddle along, some succeed, and some entirely transform their teaching? Based on personal teaching experiences, mentoring of others, and several years of research with teachers learning to use clickers, we offer some hard-won answers to these questions. Clicker use is best aimed at supporting question-driven instruction, dialogical discourse, formative assessment, and meta-level communication in the classroom. How teachers *frame* classroom activity—their deeper attitudes, models, and professional thought habits—is the most important factor determining their results. Explicit, concrete yet flexible "question design patterns" for creating clicker questions and "pedagogical patterns" for using them in class help teachers avoid common traps, get unstuck from ruts, and take full advantage of clickers' potential.

* See http://ianbeatty.com/aapt-2011s for slides and additional materials.

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Meet new people, see old friends, and learn about Omaha!

Monday, August 1
10–11 a.m.
Harper Center 3023B

BB02: 1:30–2 p.m. EJS and Open Source Physics: Teaching with Interactive Materials Across the Curriculum

Invited - Mario Belloni, Davidson College, Davidson, NC 28036; mabelloni@davidson.edu

Wolfgang Christian, Davidson College
Anne J. Cox, Eckerd College
Todd Timberlake, Berry College

Over the past dozen years Davidson College has produced some of the most widely used interactive curricular materials for the teaching of introductory and advanced physics courses. These materials are based on Open Source Physics (OSP) programs and applications, such as Easy Java Simulations (EJS). This talk will focus on three distinct areas of using simulations: teaching introductory physics and astronomy courses using EJS-based materials, modeling in intermediate classical mechanics with EJS, and teaching computational physics using EJS to develop Java simulations.

BB03: 2–2:30 p.m. Technology Use in the Laboratory – One TYC Instructor's Perspective

Invited - Todd R. Leif, Cloud County Community College, Concordia, KS 66901; tleif@cloud.edu

It's really hard to believe but, I've never taught a physics lab without using some sort of computer interfacing equipment. As a 25-year veteran teacher, doing labs with Vernier data-collection technology has been a career-long process. In my small college setting, I can have students do very traditional problem solving labs, PER-Activity Based Labs, or I can even have them create their own student designed and driven experiment. Computer Interfaced Lab Equipment has enhanced and supplemented my lab activities for the past 25 years. This talk will discuss the origins, the changes, the advancements and what I now consider the best practices for using computer technology in the introductory physics laboratory.

BB04: 2:30–3 p.m. The Assessment Continuum – Before, in, and After Lecture

Invited - Gerd Kortemeyer, Michigan State University, East Lansing, MI 48825; korte@lite.msu.edu

This talk will discuss strategies for formative and summative assessment using LON-CAPA (http://www.lon-capa.org/). It will cover the implementation of pre-lecture questions that are embedded in the online reading materials (including Just-In-Time teaching strategies), LON-CAPA-graded clicker questions during lecture (using i>clicker and i>clicker2), online homework problems after lecture, practice exams, and exams as summative assessment (including online retakes for partial credit). For each of these elements of the assessment cycle, experiences, proven implementation mechanisms, and research results, gathered over the last 10 years, will be shared.

Session BC: PER: Problem Solving I

Location: Harper Center 3023 & 3023A
Sponsor: Research in Physics Education Committee
Date: Monday, August 1
Time: 1– 2:30 p.m.

Presider: Paul Nienaber

BC01: 1–1:10 p.m. Tutorials to Facilitate Physics Problem Solving with Differentiation and Integration*

Dehui Hu, Kansas State University, Manhattan, KS 66506-2601; dehuihu@phys.ksu.edu

Joshua Von Korff, N. Sanjay Rebello, Kansas State University

Students in introductory-level physics encounter several difficulties when solving physics problems involving differentiation and integration. Physics instructors tend to assume that students have the prerequisite mathematical skills for success in the course, however, research has shown that most students do not know how to apply mathematical tools in a physics context. Based on the knowledge of the difficulties students with the use of differentiation and integration in physics encountered from previous studies, we are developing instructional materials aimed at facilitating students to address these difficulties in several topics in introductory physics. We have implemented these materials in group problem-solving sessions aimed at enabling students to learn the mathematical concepts of tangent lines, slope, Riemann sum, and approximation in a physics context. We present a discussion about student difficulties on those concepts and the development of our instructional materials.

* This work is supported in part by U.S. National Science Foundation grant 0816207.

BC02: 1:10–1:20 p.m. The Influence of Hints and Training on Student Resource Selection*

Joshua S. Von Korff, Kansas State University, Manhattan, KS 66506-2601; vonkorff@phys.ksu.edu

Dehui Hu and N. Sanjay Rebello, Kansas State University

We consider physics problems that require students to combine their existing resources in new ways. When students do this in the context of integration and differentiation, they have many procedures, concepts, and representations to choose from. In addition, they may have varying degrees of understanding about the procedures they invent. We examine students' resource selection in problem solving situations, using an online environment to control and monitor their progress through a series of hints. Over the course of a 30-minute testing period, students work through a single problem; initially inventing their own strategies, then following our suggestions toward particular solutions. We will present results from our assessment of students' naïve understanding, as well as the impact of cues and training after a 50-minute practice session prior to the test. We will also describe students' ability to learn new ways of thinking about the problem.

* This work is supported in part by U.S. National Science Foundation grant 0816207.

BC03: 1:20–1:30 p.m. Do Prescribed Prompts Prime Sense-making During Group Problem Solving? Part One

Mathew A. Martinuk, University of British Columbia, Vancouver, BC V6T 1Z1; martinuk@physics.ubc.ca

Joss Ives, University of the Fraser Valley

Many researchers and textbooks have promoted the use of rigid prescribed strategies for encouraging development of expert-like problem-solving behavior in novice students. The UBC Physics 100 course has been using context-rich problems with a prescribed five-step strategy since 2007. We have been analyzing audio recordings of students during group problem-solving sessions to analyze students' epistemological framing based on the implicit goal of their discussions. By treating the goal of "understanding the physics situation" as "sensemaking," we analyze the effectiveness of structured prompts intended to promote a shift to a sensemaking discussion. This talk will describe the setting and research methods, and a subsequent talk will discuss the analysis and results.

BC04: 1:30–1:40 p.m. Investigating Sequencing Effect on Biomedical Physics Problem Solving

Bijaya Aryal, University of Minnesota-Rochester, Rochester, MN 55904; baryal@umn.edu

Robert L. Dunbar, University of Minnesota-Rochester

This study focused on the effect of varying the sequence of problem solving and laboratory activities on the students' ability to solve subsequent biomedical contextual physics problems. A series of laboratory and problem solving activities were designed using concrete physical situations. Following the introduction of specific physics concepts, students worked in groups to complete related laboratories and problem solving activities. The order of problem solving and laboratory activities was regularly altered throughout the semester. Subsequently, the students were asked to solve related contextual biomedical physics problems. The result of the study indicated that altering the sequence of activities had a measurable impact on students' contextual problem solving performance and strategies.

BC05: 1:40–1:50 p.m. How to Improve Transfer from Difficult Worked Examples by Designing a 'Good Looking Animated Solution

Zhongzhou Chen, The University of Illinois at Urbana–Champaign, Urbana, IL 61801; zchen22@illinois.edu

Gary Gladding, The University of Illinois at Urbana–Champaign

It is well known that transfer from worked examples to new problems can be very hard for students. The goal of this research is to promote transfer by improving the quality of the example solution. According to our experience, elaborate verbal explanation often seems to have little, if not negative, effects on transfer. Therefore, we focus on designing a better visual representation. Based on knowledge from grounded cognition research, we designed several animated multimedia solutions for some difficult physics problems, in which the underlying logic is illustrated through visual perception. When compared to two other very similar versions of animated solutions that lack the critical perceptual elements, the designed solutions significantly improved transfer of the underlying physics principles to harder problems. Moreover, transfer is improved even when the target problem involves largely abstract logical reasoning, and little visual-spatial reasoning.

BC06: 1:50–2 p.m. The Impact of Sample Size in Using IRT with FCI *

Li Chen, School of Electronic Science and Engineering, Southeast University, Nanjing, Jiangsu, 210096, China; chenli.seu@163.com

Jing Han and Lei Bao, Ohio State University
Liangyu Peng, Hunan Normal University
Yan Tu, Southeast University

Item Response Theory (IRT) is a useful tool for analyzing quantitative data. The sample size will impact the uncertainty of the estimated parameters. It is then important to find out the approximate minimum sample size, with which reliable results can be calculated. In this study, we choose R (with its LTM package) to estimate the parameters with different sample sizes, which are randomly selected from the college students' FCI data collected at The Ohio State University. The total number of the data is 3139. The results show an exponential relationship between sample size and the mean difference of the results obtained with subsets of the data. When sample size is larger than 1600, the difference is tolerable for most items and the mean total difference can be controlled within 5%. This can provide useful guide for future data analysis using IRT.

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

BC07: 2–2:10 p.m. The Effect of Problem Format on Students' Answers*

Mark Ellermann, Texas Tech University, Lubbock, TX 79409; mark.ellermann@ttu.edu

Beth Thacker and Keith West, Texas Tech University

The same problem written in multiple formats was 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 a few others. We present the data.

* This project is supported by the NIH grant 5RC1GM090897-02. Sponsored by Beth Thacker.

BC08: 2:10–2:20 p.m. What Students Learn When Studying Physics Practice Exam Problems

Witat Fakcharoenphol, University of Illinois at Urbana Champaign, Urbana, IL 61801; fakchar1@uiuc.edu

Timothy J. Stelzer, University of Illinois at Urbana Champaign

We developed a web-based tool to provide students with access to old exam problems and solutions. By controlling the order in which students saw the problems, as well as their access to solutions, we obtained data about student learning by studying old exams problems. Our data suggest that in general students learn from doing old exam problems, and that having access to the problem solutions increases their learning. However, the data also suggest the depth of learning may be relatively shallow. In addition, the data show that doing old exam problems provides important formative assessment about the student's overall preparedness for the exam, and their particular areas of strength and weakness.

BC09: 2:20–2:30 p.m. Using Problem-Solving Computer Coaches to Explore Student Decision-Making Difficulties

Qing Xu, University of Minnesota–Twin Cities, Minneapolis, MN 55455; qxu@physics.umn.edu

Ken Heller, Leon Hsu, and Andrew Mason, University of Minnesota–Twin Cities

The Physics Education Group at the University of Minnesota has been developing Internet physics coaches to help students improve their problem-solving skills in introductory physics. In this talk, we analyze keystroke data collected from students' usage of the computer programs, including the identity and timing information for all students' keystrokes and mouse clicks while using the programs, as well as derived information such as the average time spent on each module. We use the data to try to determine how students use the computer programs, where they might have the most difficulty, and details of their decision-making behavior during the problem-solving process. Other data sources such as students' written solutions will be used as a consistency check.

Session BD: Using Literature to Teach Physics

Location: Harper Center 3048
Sponsor: Physics in High Schools Committee
Date: Monday, August 1
Time: 1–1:40 p.m.

Presider: Ann Brandon

Be it science fiction, children's literature or mysteries, physics principles can be used to discover unknowns in literature and expand the science process skills. Incorporating literature into physics curricula can be as an engaging activity or the evaluation of a concept.

BD01: 1–1:10 p.m. My Best NY Times Physics Applications on the Web

John P. Cise, Austin Community College, Austin, TX 78701; jpcise@austincc.edu

From three years developing over 400 physics applications from the *New York Times,* I will show the best applications rich in data verifying physics concepts. Most applications are on mechanical concepts. The site is: http://CisePhysics.homestead.com/files/NYT.htm. The site lists 12 pages with 40 single one-page applications per page. Each single page application contains: brief edited text and graphics from the *NY Times*, introduction, questions, hints, and answers. I use these pages as: introduction to new concepts in general college physics, extra credit for students, and quiz questions. Students enjoy verifying physics concepts using *NY Times* current physics applications as seen at this site.

BD02: 1:10–1:20 p.m. The Physics in 'Einstein's Dreams'

Donald R. Franceschetti, The University of Memphis, Memphis, TN 38152; dfrncsch@memphis.edu

Einstein's Dreams by physicist/author Alan Lightman has for years been a popular selection for high school and college summer reading programs and for student presentations as narrative theater. The book describes a number of "dreams" that the young Swiss patent clerk Albert Einstein might have had during the "miracle year" of 1905. While the dream narratives can be read for their entertainment value by people with little knowledge of physics, any physicist reading them will find numerous references to relativity theory, quantum theory, thermodynamics, and cosmology. A few of the dreams also reflect aspects of physics student culture and quips that Einstein is believed to have made. These references can be used for teaching and to demonstrate the creative element in physics, which clearly bridges C. P. Snow's two cultures or the alleged left brain/right brain duality. It provides an opening for interaction with literature and history teachers as well. The presentation will discuss a number of the "dreams" and their allusions to physics, and will provide some suggestions for further reading.

BD03: 1:20–1:30 p.m. Sir Arthur Conan Doyle in Physics

Igor V. Proleiko, McKinnley Classical Academy, St. Louis, MO 63104; igor.proleiko@slps,org

In a Sherlock Holmes adventure *The Sign of Four,* the culmination is the race along the Thames. The relative speeds could be analyzed to discuss the possibility and feasibility of this part of the story. Also a discussion of projectile motion could be made from the data mined from Sir Arthur's description. The exercise is well within the grasp of introductory physics students.

BD04: 1:30–1:40 p.m. Storytime Science: Another Look at Teaching Physics through Childrens' Literature

Bill Reitz, 2921 Kent Rd., Silver Lake, OH 44224; wreitz@neo.rr.com

Once upon a time your students' imaginations and curiosity were unleashed through the fantasy of their first picture books. We can recapture some of that excitement if we reopen the classic books and allow them to guide us as we explore the real world in our high school classes. Let us examine some new examples of how children's books can model science processes, lead to science investigations and even act as assessment. This paper is follow-up to the "Seuss Science" presentation given at the Portland Summer Meeting. Additional books not mentioned in that paper will be used.

Session BE: Preparing Minority Students for Graduate School

Location: Harper Center 3040
Sponsor: Physics in Undergraduate Education Committee
Co-Sponsor: Minorities in Physics Committee
Date: Monday, August 1
Time: 1–2:30 p.m.

Presider: Theodore Hodapp

While physics grants a mere 9-10% of its bachelor degrees to under-represented minorities annually, it does even worse for advanced degrees, with 5-6% eventually earning a PhD. The talent is clearly present, but many forces conspire to divert students from this path, consequently losing both capable scientists and potential mentors for future generations. Several programs have bucked this trend, and presenters at this session will describe critical features and program elements that can help universities address the barriers. An open forum will follow presentations on the topic, with time for discussion and sharing of ideas.

BE01: 1–1:30 p.m. Physics at Morehouse College: Making a Major Difference!

Invited - Willie S. Rockward, Morehouse College, Atlanta, GA 30314; wrockwar@morehouse.edu

'Kale Oyedeji, Aakhut E. Bak, Carlyle E. Moore, and John B. Howard, Morehouse College

Physics is Phun! Physics needs everyone and everyone needs physics! With physics, the UNIVERSE is the limit! These statements are the underlying principles that we, the physics faculty at Morehouse College, embed in our students through experiences in the classroom, laboratory, advisement, mentoring, and outreach programs. How are we making a positive difference by consistently increasing the number of under-represented minorities, especially African American males, in physics? We will present our antidote which includes curriculum, research, advisement, and a few hidden ingredients.

BE02: 1:30–2 p.m. Preparing Minority Students for Graduate School: Timbuktu Academy Approach

Invited - Diola Bagayoko, Southern University and A&M College, Baton Rouge, LA 70813; Diola_Bagayoko@subr.edu

The Timbuktu Academy is a comprehensive, systemic mentoring program at Southern University and A&M College in Baton Rouge, LA (SUBR) (www.phys.subr.edu/timbuktu.htm). To date, the Academy has assisted in the production of 170 minority undergraduate scholars who have earned a Bachelor of Science degree. Seventy of 83 physics graduates, 20 of 29 chemistry graduates, and 22 of 49 engineering graduates have earned graduate degrees or are successfully enrolled in graduate school, with an emphasis on the pursuit of the PhD. The aim of this presentation is to discuss key factors that explain the success of the Academy. They include the rigorous implementation of the Ten-Strand Systemic Mentoring model of the Timbuktu Academy, with extensive research participation on and off campus. They also include standard-based curriculum, teaching, and learning (i.e., SBC, SBT, and SBL). The Timbuktu Academy received several national awards for the above model and results.

BE03: 2–2:30 p.m. APS Minority Bridge Program: Overview, Findings and Directions

Invited - Peter Muhoro, American Physical Society, College Park, MD 20740; muhoro@aps.org

Physics provides a fundamental foundation for nearly all major technical innovations, groundbreaking research, and policy recommendations. Physics also ranks at the bottom when considering the fraction of students completing either baccalaureate or doctoral degrees. In addition, the fraction of PhDs awarded to underrepresented minorities has not increased in the past decade despite the growing population of such groups. This talk will discuss some data on the current situation and describe a number of actions by the American Physical Society (APS) and its partnering organizations in addressing these issues, primarily the Minority Bridge Program, a new national initiative that seeks to dramatically increase the number of underrepresented minorities who receive PhDs in physics.

Session BF: *Panel*: Spacetime Physics

Location: Skutt Student Center Ballroom ABC
Sponsor: Physics in Undergraduate Education Committee
Co-Sponsor: Space Science and Astronomy Committee
Date: Monday, August 1
Time: 1– 2:30 p.m.

Presider: Wolfgang Christian

One of the greatest challenges in communicating the physics of relativity is the unfamiliar concept of spacetime. Panel participants Edwin Taylor (Exploring Black Holes), Anne Cox (Physlet Quantum Physics), and Thomas Moore (Six ideas that Shaped Physics) will present their insights into teaching spacetime physics.

BF01: 1–1:30 p.m. Completing John Wheeler's Vision: Undergraduate General Relativity

Panel - Edwin F. Taylor, Massachusetts Institute of Technology, Cambridge, MA 02139-4307; eftaylor@mit.edu

John Archibald Wheeler was a radical conservative: Take the laws of physics seriously, then drive them to their limits. He drove general relativity to its limits with the black hole, our "little jugged apocalypse." Wheeler's Rules of Writing include "Simplify! Simplify! Simplify!" For undergraduate general relativity this means (1) Describe curved spacetime with the metric instead of the field equations, which reduces required mathematics to simple calculus. (2) Command the moving stone to obey the Principle of Maximal Aging, a simple extension of the Twin "Paradox." A second edition of Exploring Black Holes with cosmologist Edmund Bertschinger treats the wealth of recent cosmological observations and repairs the first edition's neglect of the dark side of General Covariance: We can choose global coordinates with (almost) complete freedom, so they need have no direct relation to physical measurements and observations.

BF02: 1:30–2 p.m. Einstein for Everyone?

Panel - Anne J. Cox, Eckerd College, St. Petersburg, FL 33711; coxaj@eckerd.edu

Special relativity for the nonscience student: In an introductory freshman seminar course "Einstein for Everyone" Yes! We know that the physics of special relativity does not require mathematics beyond high school trigonometry, but how often do we offer nonscientists the chance to explore the intuitive and nonintuitive implications of the ideas at the core of spacetime physics? Using one course as an example, we will explore questions of its depth of coverage and its role in the curriculum. This will include examples of sample assignments, student projects as well as simulations that stand at the heart of the course and serve as the course "laboratory."

BF03: 2–2:30 p.m. Visual Aids for Teaching Special Relativity

Panel - Thomas A. Moore, Pomona College, Claremont, CA 91711; tmoore@pomona.edu

In my experience, successfully teaching special relativity to introductory students is much easier if one extensively uses (1) the geometric analogy for spacetime, and (2) visual aids based on that analogy, including (but not limited to) multiple-observer spacetime diagrams. In this presentation, I will describe some of these visual aids and how such tools can help students reason more intuitively about relativity and thus avoid many common errors and misconceptions, and describe resources one can use in special relativity courses at any level.

Session BG: Energy and the Environment

Location: Skutt Student Center Ballroom DE
Sponsor: Science Education for the Public Committee
Date: Monday, August 1
Time: 1–3 p.m.

Presider: John Roeder

BG01: 1–1:30 p.m. Seasonal Thermal Energy Storage

Invited - Richard Flarend, Penn State Altoona, Altoona, PA 16601; ref7@psu.edu

Tim Dolney and Jeremy Walsh, Penn State Altoona

A large demand for energy in Pennsylvania is for space heating. Unfortunately, this demand coincides with low winter solar insolence making traditional solar thermal energy impractical for space heating. However it is possible to collect this solar energy in the summer and store it for later use in the winter using a seasonal thermal energy storage system (STES). Existing STES systems have had a variety of problems due to cost, thermal losses, and/or slow thermal time constants of the storage field. This research has focused on designing and locating a potential site for a solar STES system using an abandoned coal mine that solves many of these problems. The design, dynamic simulation, and estimated performance of such a system will be presented. Construction estimates and return on investment will also be presented for a potential site in which a favorable abandoned mine has been found very close to a K-12 school.

BG02: 1:30–2 p.m. Energy and Power Density in Society

Invited - Abigail R. Mechtenberg, University of Michigan, Ann Arbor, MI 48104; amechten@Umich.edu

From the dawn of civilization, energy density and power density has been sought and fought after. This talk will walk through the foundation civilization has built for ourselves throughout the technological and nontechnological world and compare it to how nature has evolved. We will ponder if economics has broken a historical global symmetry by making the lowest energy state not the preferable state and ask ourselves why? Ten interactive Societal Ragone Plots will be presented and passed out: from vehicles to robots to hummingbirds. Results from an agent-based model of African electricity microgrids will be presented and juxtaposed to policy implications in the U.S. for our centralized grid with and without nuclear power. Monte-carlo simulation results for a designed U.S. military forward operating base in Afghanistan will be presented to discuss the risk that explains an amazing quote that "the U.S. loses one person, killed or wounded, for every 24 fuel convoys it runs in Afghanistan to run air-conditioners and power diesel generators." Energy and power density engages with society —from African health care to U.S. military risk to everyday U.S. civilian activities.

BG03: 2–2:30 p.m. A Broad Look at the Energy Curriculum

Invited - Shawn Reeves, EnergyTeachers.org, 315 Elmwood Ave., Ithaca, NY 4850; shawn@energyteachers.org

Having consulted a broad sweep of educators teaching about energy for several years for EnergyTeachers.org, Mr. Reeves will comment on the integration of energy curriculum into the physics curriculum as well as the possibility of energy becoming its own field to rival the importance of physics. Learning new and even traditional energy concepts presents a challenge in the world of standardized or traditional curriculum, especially concerning sequence and rigor. Textbooks, professional development, lesson plans, field experiences, workforce training, and academic pathways need to be developed further. The content and structure of EnergyTeachers.org represents the wide range of answers to such challenges for K-16 and informal educators, but there is much work to be done. What role will physics educators have in this work?

BG04: 2:30–3 p.m. Growth, Population, Resources, and the Meaning of Sustainability

Invited - Albert A. Bartlett, University of Colorado–Boulder, Boulder, CO 80304-2719; Albert.Bartlett@Colorado.EDU

Because they are used carelessly and indiscriminately, the words "sustainable" and "sustainability" have lost their meaning. The reasons for this loss of meaning range from simple carelessness to commercial greed. The ultimate contradiction is the oxymoron "sustainable growth." We will examine the definition of "sustainability" and then will look at what it has to mean in terms of growth, population, and the extraction of mineral and fuel resources from the Earth.

Session BH: Induction and Mentoring of Physics Teachers

Location: Skutt Student Center Ballroom F
Sponsor: Teacher Preparation Committee
Date: Monday, August 1
Time: 1–3:10 p.m.

Presider: Monica Plisch

Induction and mentoring of new physics teachers is critical to professional growth in the first years of teaching. Yet many teacher education programs fail to provide this support. This session will highlight successful mentoring and induction programs for new physics teachers.

BH01: 1–1:30 p.m. The Best of Both Worlds

Invited - Doug K. Panee, Brigham Young University / Oak Canyon Jr. High, Springville, UT 84663; doug.panee@gmail.com*

I have a unique perspective of "Developing a Network of Cooperating Teacher." I've been a cooperating teacher for the past 18 years for 20 student teachers and now I am a CFA, Clinical Faculty Assistant or TIR, at BYU. I have the best of both worlds because now I have the wonderful opportunity to support many of my friends that are cooperating teachers as a university mentor. I will share how this network has supported me as a cooperating teacher as well as how I and BYU help support the cooperating teachers in our network.

* Sponsor: Duane Merrell

BH02: 1:30–2 p.m. Mentor Me...Mentor You

Invited - Jon Anderson, Centennial High School, Circle Pines, MN 55014; anderson.jon.p@gmail.com

New physics teachers need mentoring! In addition to the need to know and understand their content, they need direction deciding upon appropriate demonstrations, analogies, examples, and labs, pacing of topics, seniors in the spring, classroom management, lab supply budgets, and much more. 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. As a former mentee, I can speak to the value of all of these.

BH03: 2–2:30 p.m. Training the Future

Invited - Jan Mader, Great Falls High School, Great Falls, MT 59404; jan_mader@gfps.k21.mt.us

As I near retirement I am beginning to panic. Who will take my place? Will they care as much as I do? Will teaching be their passion not just a job? With the diminishing number of science teachers entering the "pool" and even fewer in physics, what can veteran teachers of science do to encourage beginning teachers to enter the profession and remain in the profession when the going gets tough?

BH04: 2:30–3 p.m. A Case for Induction – Keeping New Teachers in the Classroom

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

Mentoring from a master teacher during student teaching may be the most important semester in the preparation of a new teacher. But even this mentoring does not prepare a student for what happens during the first year when they have a classroom full of their own students. I want to follow the story of two students who without induction after they graduated most likely would not be teaching now. Retention of these new teachers is as important as training new teachers. I think our role in helping with the mentoring and induction of these new teachers is as important and on par with the efforts that we make to help these students get their teaching licenses. I know these students have graduated from our teacher preparation programs but they still need to see that friendly face, hear that friendly voice. These students just need to know you as their teacher preparation mentor are still there and care. I will try to show how I think that the two students I have talked about above may not be teaching if they had not been confident that a university mentor would help.

BH05: 3–3:10 p.m. Connecting Teacher Preparation to Professional Practice

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

In this talk I will describe how the Rutgers Physics Teacher Preparation program connects pre-service training to post-graduation professional development and practice. The key here is to use social networks and face-to-face meetings as two components of a professional learning community. I will show how one can maintain such a community with very little time investment and no additional funding. The learning community not only supports beginning teachers during their most difficult years of teaching but also allows pre-service teachers to have high quality student teaching experience. I will share the achievements of the community and the difficulties that arise. Rutgers has been producing large numbers of physics teachers for the past eight years. Over 90% of these teachers remain in the profession.

Session BI: Cross Campus Collaboration: What I Learned from the Liberal Arts about Teaching Physics

Location: Skutt Student Center 104
Sponsor: Women in Physics Committee
Co-Sponsor: Physics in Two-Year Colleges Committee
Date: Monday, August 1
Time: 1– 2:40 p.m.

Presider: Stephanie Magleby

Left-brained in a right-brained world: insights, techniques and best practices gleaned either from collaborative teaching experiences with colleagues from the liberal arts or from teaching students majoring in the liberal arts.

BI01: 1–1:30 p.m. Brigham Young University's 15-Week University Course

Invited - R. Steven Turley, Brigham Young University, Provo, UT 84602; turley@byu.edu

Susan Gong and Tyler Jarvis, Brigham Young University

Brigham Young University's "15-Week University" course brought together students and faculty with diverse backgrounds and wide-ranging ability to experiment with learning principles as they applied to physics, calculus, English, and music. The challenge was to explore core ideas with enough depth and rigor to ensure that gains in learning could be retained, improved, and applied for long-term growth. A learning community emerged as everyone became a learner and teacher engaged in: 1) identifying key elements and core ideas, 2) maximizing resources through innovative use of technology, and 3) solving challenging problems that connected fundamental principles to concrete skills and personal values. Results included substantial (in some cases dramatic) increases in quantitative skills and writing ability, and enthusiasm for learning in general. The synergy of this wide-ranging learning experience happened as participants rotated their teacher/learner roles, connected ideas and information, and reframed their knowledge from multiple perspectives.

BI02: 1:30–2 p.m. Behind the 15-Week University

Susan P. Gong, Brigham Young University, Provo, UT 84602; spgong@gmail.com

Steve Turley, Brigham Young University

The 15-Week U was an experience of re-imagining classroom relationships, content, and time. Rather than treating the inevitable spread in ability and background as a hindrance, this class emphasized and heightened the differences by shifting learner and teacher roles. Teachers from the various disciplines of the course became model learners as the topics shifted. Students with certain strengths became teachers as the course emphasis changed. Such shifts created a rich source of individualized input for every member of the community and multiplied the sources of energy and motivation for learning. The interdisciplinary nature of the course meant that content was viewed from multiple perspectives. Rather than dilute content, this framework intensified both quantitative and non-quantitative thinking. Students with little science background made surprising leaps forward in their engagement and competence, and students with a stronger background consolidated the magnified their grasp of skills and subject matter.

BI03: 2–2:10 p.m. The Physics of Theatre: Influences on Teaching and Research

Eric C. Martell, Millikin University, Decatur, IL 62522; emartell@millikin.edu

The Physics of Theatre project was started to address a clear need within the theatrical community for better understanding of physics concepts in order to design and build increasingly more complex and potentially dangerous equipment safely and efficiently. My efforts within the project are in two main areas: 1) experimentally studying the properties of materials commonly used in theatre and 2) educating theatre technicians about the principles of physics through lectures, workshops, and the development of pedagogical materials. Through this project, we have developed lecture materials and labs that I use in both introductory and advanced undergraduate classes. I have also been able to expand my research interests into areas which are accessible to undergraduates as early as their sophomore year. The physics in these projects is not particularly advanced, but students can develop a much deeper understanding of what they did and have true ownership of their projects.

BI04: 2:10–2:20 p.m. Introductory Physics at a Small Campus

Gabriela Popa, Ohio University Zanesville, Zanesville, OH 43701; popag@ohio.edu

Traditionally, introductory physics courses require a good handling of mathematical manipulations. Many students come to college with a desire to learn physics, and they say that they like it. But when they take college physics they find the mathematics involved in it challenging. However their desire to do well is not enough sometimes to solve problems. Many students have a good feeling for the concepts and like laboratory experiments. In an introductory physics class at a small college, the student population is very diverse in background and expectations. Talking with my colleagues from other disciplines I learn about their type of assignments, and I offered my students choices. I will present different types of choices for in class and at home assignments.

BI05: 2:20–2:30 p.m. Development of Active Learning Tools for a Course on Physics and Music

Heather Whitney, Wheaton College, Wheaton, IL 60187; heather.whitney@wheaton.edu

The physics education research literature provides a wealth of information on active-learning procedures, such as interactive lecture demonstrations (ILDs), peer instruction facilitated with clickers, or tutorial systems. However, much of this material has been focused on their use in courses that cover the canon of topics, such as introductory physics courses designed for science majors or conceptual physics courses. Courses that investigate the connections between physics and music are common in physics department course offerings for general education purposes, and they provide an important opportunity to instruct students who may not otherwise take a course in the field. A suite of these tools has been developed for a course on physics and music. Discussion will include clicker ILDs, clicker questions, and lab-based activities, all designed to enhance the learning of students in topics such as motion, oscillations and waves, and sound.

BI06: 2:30–2:40 p.m. Physics for Filmmakers: Goals, Tracker Labs, and Projects

Timothy L. McCaskey, Columbia College Chicago - Dept. of Science and Mathematics, Chicago, IL 60605; tmccaskey@colum.edu

Columbia College offers an introductory, algebra-based mechanics course called "Physics for Filmmakers." The course is for students who wish to learn how to use the laws of physics in making more accurate and/or artistically deliberate choices in their filmmaking. We debunk common movie errors and misconceptions, and students must also complete a film project that demonstrates correct physics in some way. In this talk, I will discuss how we use Tracker (http://www.cabrillo.edu/~dbrown/tracker/) in our labs to teach both filming ideas and physics concepts, some final film projects we have seen, and how we use PER-influenced ideas to further support our learning goals.

Session BJ: Astronomy Teaching and Learning

Location: Skutt Student Center 105
Sponsor: Space Science and Astronomy Committee
Date: Monday, August 1
Time: 1–1:50 p.m.

Presider: Spencer Buckner

BJ01: 1–1:10 p.m. Near-Earth Asteroids: Risk Assessment with Middle School Students

Kathryn E. Devine, The College of Idaho, Caldwell, ID 83605; kdevine@collegeofidaho.edu

Robin Cruz, Ann Koga, and James Dull, The College of Idaho

The College of Idaho (C of I), located in Caldwell, ID, runs a cooperative summer program with Syringa Middle School (Caldwell, ID). This program, titled The C of I/Syringa Math and Science Summer Institute (MSSI), is now in its third year. MSSI is an educational enrichment program for Caldwell 7th and 8th grade students that specifically targets students who demonstrate potential for academic success but who are at risk for dropping out of school. The MSSI provides enrichment activities in science/engineering with a strong mathematical component. The 8th grade students spend the week-long program studying near-Earth asteroids and probability. The students discover what types of asteroids pose a risk to civilization, and apply their knowledge of probability to determine whether civilization is, indeed, at risk. This talk will focus on the misconceptions MSSI students have about probability and asteroid collisions, as well as the benefits of a summer enrichment program for these students.

BJ02: 1:10–1:20 p.m. Astronomical Imaging for Introductory Honors Astronomy Students

Robert D. Moore, University of West Georgia, Carrollton, GA 30118; rmoore@westga.edu

Bob Powell, University of West Georgia

The University of West Georgia has acquired several astronomical cameras and guided telescopes to accommodate an increasing number of introductory astronomy students and projects that are being conducted by students. This equipment was purchased using local Tech Fee grants. Beginning in the fall semester 2010, honors astronomy students are required to image two celestial objects and to process those images. A majority of these students are non-science majors. Students are given a CD with their images and the images made by their classmates. During the first two semesters of this requirement, the images made by students are excellent, and the student attitudes about the work are positive.

BJ03: 1:20–1:30 p.m. Problem Solving and Epistemology in Nonquantitative Introductory Science Classes

Bradley McCoy, Azusa Pacific University, Glendora, CA 91740; bmccoy@apu.edu

General-studies science classes at many universities, such as physical science, earth science, or astronomy, stress memorization and repetition of concepts. This approach leaves students with little appreciation for how science is used to explain phenomena from general principles. We present a novel instructional technique for an earth science class in which the students are instructed in the use of a general problem-solving strategy, adapted from well-known quantitative problem-solving strategies, in order to train the students in how to apply physical principles. Preliminary data using the Epistemological Beliefs Assessment for Physical Science has shown that explicit training in problem solving significantly improves students' epistemology.

BJ04: 1:30–1:40 p.m. The History of Giant Star

Fatemeh Delzendehrooy, Negaresh School, Shiraz, Fars, 7144847778, Iran; fatemehastronaut@yahoo.com

We report on what we know about stars whenever their core temperature rises to 106 helium glowing, the result of that is to stop H burning and begin the process of three alphas. In this paper we have concluded: 1) In the main sequence stars, according to Newton's third law inner strength of star will deal with the force of gravity. 2) Unlike much development, helium glowing for low-mass stars pass quickly. 3) Because the radius of a giant star is 100 times bigger than initial radius so according to the distance from Sun to Mercury which is 58,000,000 km, Mercury gets swallowed by Sun. 4) Because the death of each star is the field of birth of another star, so elements in the Sun are out of its mother. 5) Perhaps the reason of becoming red for star in addition to cooling outer layers, is forming of elements such as P, C and etc. 6) Betelgeuse, Antares, and Sirius stars have swept among several steps between major quasi-phase and giant level.

BJ05: 1:40–1:50 p.m. Astronomy, History, and Computer Simulations: Teaching the Nature of Science

Todd K. Timberlake, Berry College, Mount Berry, GA 30149-5004; ttimberlake@berry.edu

Introductory astronomy courses are among the most popular science courses taken by non-science majors in college. As a result, these courses represent a crucial opportunity to educate students about the nature of science. I have developed two courses that focus on teaching the nature of science through an exploration of the history of astronomy. One course examines the development of planetary astronomy from Aristotle to Isaac Newton. The other course follows changing notions about our place among the stars from Aristotle to Hubble. In both courses, students make frequent use of computer programs to simulate observations and to visualize theories. The goal of these activities is to help students see how scientific theories are judged against empirical data, consistency with other knowledge, and aesthetic criteria. Course materials are available at http://facultyweb.berry.edu/ttimberlake/copernican/ and http://facultyweb.berry.edu/ttimberlake/galaxies/.

Plenary: APS Division of Condensed Matter Physics Session: Frontiers in Nanoscience

Location: Harper Center Hixson-Lied Auditorium
Date: Monday, August 1
Time: 3:30–5 p.m.

Presider: Dick Peterson

Barbara Jones

A Perspective on the Future of Nanotechnology (3:30–4:15 p.m.)

Barbara Jones, IBM's Almaden Research Center, San Jose, CA 95120-6099; bajones@almaden.ibm.com

I will give an overview of the state of nanotechnology, beginning with some current challenges, and including the promise it holds for the future, in particular for the IT industry. From carbon nanotubes to molecular electronics, spintronics to quantum computing, there are many promising avenues for new memory and devices, and I will show how these interesting systems all employ nanometer-scale, and even atomic-scale, critical features. I will give a specific example of my own nanoscience research, describing some surprises in the behavior of atomic-scale engineered spin chains. Finally, I will discuss some fundamental challenges that remain, and conclude with some open questions for the future of the IT industry and the important role that science can play.

Jeremy Levy

Etch-a-Sketch Nanoelectronics (4:15–5 p.m.)

Jeremy Levy, University of Pittsburgh, Department of Physics and Astronomy, Pittsburgh, PA 15260; jlevy@pitt.edu

The popular children's toy Etch-a-Sketch has motivated the invention of a new method for creating electronic circuits that are so small, they approach the spacing between atoms. The interface between two normally insulating materials, strontium titanate and lanthanum aluminate, can be switched between the insulating and conducting state with the use of the sharp metallic probe of an atomic-force microscope. By "sketching" this probe in various patterns, one can create electronic structures with remarkably diverse properties. This new nanoelectronics platform may lead to new ultra high density information storage and processing and sensing applications, create new types of particles (called Majorana fermions), and meet the challenge of quantum computation.

Session CA: Use and Misuse of Lasers

Location: Harper Center 3027
Sponsor: Apparatus Committee
Date: Monday, August 1
Time: 6:30–7:30 p.m.

Presider: Sam Sampere

Laser pointers are increasingly popular and readily accessible. Whether fortunate or not, anyone can gain access to very powerful lasers. What can we do with these lasers in the classroom? What safety precautions MUST be taken. What potential tragic outcomes must we avoid?

CA01: 6:30–7 p.m. How Physics Teachers Learned to Love the Laser

Invited - Thomas B. Greenslade, Jr., Kenyon College, Gambier, OH 43022; Greenslade@kenyon.edu

One can become almost incoherent trying to remember how we taught physics without the laser. In April 1963 the first issue of *The Physics Teacher* appeared, and the journal soon began to carry seductive advertisements for lasers showing how the physics teacher could use this wonderful new device in the lecture room and the laboratory. Two years later the Kenyon College physics department paid $1,650 for a relatively short-lived laser, and I was hooked. In this talk I will use advertisements from *TPT* to show how the prices decreased and our expertise in using the laser increased. Soon it became as indispensable to teaching physics as a multimeter or a meter stick.

CA02: 7–7:30 p.m. Laser Safety

Invited - Thomas A. Machacek, University of Nebraska–Lincoln/Environmental Health and Safety, Lincoln, NE 68588-0824; tmachacek1@unl.edu

Laser safety is not always given the attention it might warrant. When one evaluates the level of laser safety required, using a laser pointer is substantially different than aligning a Class 4 laser. This presentation will emphasize basic laser safety when using Class 3B or Class 4 lasers in a university setting but could easily be applied to any similar facility or classroom environment. Laser safety information presented and practices described will be in accordance with the *American National Standard for Safe Use of Lasers* (ANSI Z136.1 - 2007) and CLSOs' *Best Practices in Laser Safety* (Laser Institute of America - 2008).

Session CB: PER: Student Reasoning I

Location: Harper Center 3023 & 3023A
Sponsor: Physics Education Research Committee
Date: Monday, August 1
Time: 6:30–7:50 p.m.

Presider: Stamatis Vokos

CB01: 6:30–6:40 p.m. Student Reasoning about Graphical Representations of Definite Integrals

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

John R. Thompson and Thomas Wemyss, University of Maine

Physics students are expected to apply the mathematics learned in their mathematics courses to physics concepts and problems. Few PER studies have distinguished between difficulties students have with physics concepts and those with either mathematics concepts, application of those concepts, or the representations used to connect the math and the physics. We are conducting empirical studies of student responses to mathematics questions dealing with graphical representations of (single-variable) integration. Reasoning in written responses could roughly be put into three major categories related to particular features of the graphs: area under the curve, position of the function, and shape of the curve. In subsequent individual interviews, we varied representational features to explore the depth and breadth of the contextual nature of student reasoning, with an emphasis on negative integrals. Results suggest an incomplete understanding of the criteria that determine the sign of a definite integral.

CB02: 6:40–6:50 p.m. Expanding the FCI to Concepts of Energy-Work, Momentum, and Rotational Dynamics

Alex Chediak, California Baptist University, Riverside, CA 92506; achediak@calbaptist.edu

Katrina Hay, Pacific Lutheran University
Carolina Ilie, SUNY Oswego
H. Trevor Johnson-Steigelman, SUNY Brockport

The Force Concept Inventory (FCI) has deservedly become a widely accepted assessment tool. The metric "normalized gain" can be used to evaluate conceptual mastery in a high school, college, or university-level mechanics course. Left out of this analysis, however, is student mastery of other physics concepts typically presented in the same course. For example, conservation of energy and momentum, as well as rotational motion, receive virtually no coverage on the FCI (or, for that matter, the Mechanics Baseline Test). The authors will present a revised assessment tool, one that incorporates the strengths of the FCI, but also assesses these other mechanics-related concepts. Our tool will preserve the straightforward multiple-choice format of the FCI. Ten additional questions have been written, in part inspired by material from the Physics Education Group at the University of Washington and in part inspired by the authors' own experiences with common student misperceptions.

CB03: 6:50–7 p.m. The Impact of Virtual Experiments on Student Reasoning in Physics

Jiawu Fan, Beijing Normal University, Beijing, China; wojiaofjw@yahoo.com.cn

Shaona Zhou, South China Normal University
Chunhui Du, Jing Han, and Lei Bao, Ohio State University

Using computer technology, we developed a virtual reality (VR) platform that supports interactive physics activities. We use the platform to help students conduct guided explorations to learning physics concepts and reasoning. A teaching experiment with two random selected groups of students was conducted. Students were asked to complete a one-hour exploration on one-dimensional motion (1D motion) and circular motion. Using a cross-controlled design, we find that students doing virtual experiments outperform their peers doing paper-based problem solving.

CB04: 7–7:10 p.m. Probing Student Understanding with Alternative Questioning Strategies

Jeffrey M. Hawkins, The University of Maine, Orono, ME 04469; jeffrey.hawkins@maine.edu

Brian Frank, John Thompson, Michael Wittmann, and Thomas Wemyss, University of Maine

Common research methodology uses research tasks that ask students to identify a correct answer and justify their answer choice. We propose expanding the array of research tasks to access different knowledge that students might have. By asking students to discuss answers they may not have chosen naturally, we can investigate students' abilities to explain something that is already established or to disprove an incorrect response. The results of these research tasks also provide us with information about how students' responses vary across the different tasks. We discuss three underused question types and their possible benefits. Additionally, we present results from data gathered using these question types and contrast these with results gathered using a traditional question.

CB05: 7:10–7:20 p.m. Students' Contradictory Commitments in Damped Harmonic Motion Problems

Adam Kaczynski, The University of Maine, Orono, ME 04469; A.Kaczynski@gmail.com

Michael C. Wittmann, The University of Maine

Students working through the Intermediate Mechanics Tutorials on damped harmonic motion are expected to use mathematical, graphical, and physical reasoning, as well as their intuitions. We observe that students remain committed to assumptions they bring to the problem, not using the instructional resources provided by the tutorials. We also observe moments when commitment to an assumption in, for example, mathematical reasoning conflicts with a conclusion found through physical reasoning. We will discuss the effect of multiple commitments on students' classroom discussion and the way that students reconcile contradictory commitments and conclusions.

CB06: 7:20–7:30 p.m. How Students' Conceptual Structure Relates to their Sophistication of Reasoning

L. Mojgan Matloob Haghanikar, Kansas State University, Manhattan, KS 66506; mojgan@phys.ksu.edu

Sytil Murphy and Dean Zollman, Kansas State University

While investigating the impact of interactive learning strategies on pre-service elementary science teachers, we devised open-ended content questions focusing on the application of learned concepts to new contexts. We designed a protocol to evaluate students' responses through different lenses. First, we classified concepts into three types: descriptive, hypothetical, and theoretical[1], and categorized the level of abstraction of the responses in terms of the types of concepts and the links between them.[2] Second, we devised a rubric based on Bloom's revised taxonomy[3] with seven traits (both knowledge types and cognitive processes) and a defined set of criteria to evaluate each trait. Looking at the same responses with both lenses we can investigate the correlation between the level of abstraction and the sophistication of students' reasoning as indicated by the traits of our rubric. Supported by NSF grant ESI-055 4594.

1. A.E. Lawson, et. al, "What kinds of scientific concepts exist? Concept construction and intellectual development in college biology," *JRST*,**37**(9) (2000).
2. M. Nieswandt & K. Bellomo, *JRST*, **46** (3)
3. L.W. Anderson & D.R. Krathwohl, *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives.* New York: Longman (2001).

CB07: 7:30–7:40 p.m. Learning Mathematics in a Physics Classroom

Jing Wang, Eastern Kentucky University, Richmond, KY 40475; jing.wang@eku.edu

Jerry Cook, Eastern Kentucky University

It has long been known that a students' entering mathematical skill level is one of the best indicators of success in introductory physics courses.[1, 2] Physics teachers expect that students who meet the prerequisite requirement of an introductory physics course will be well-prepared, however, this is not always the case. In reality, every physics teacher faces the challenging question: Can we identify and save the students who meet the required course prerequisite yet who are not really prepared? A recent study at the Department of Physics and Astronomy at Eastern Kentucky University suggests that when students take physics, their mathematical skills improve significantly, perhaps even more so than they do in a traditional mathematics course. This work will focus on the analysis of what mathematical skills have been improved, and reveal the link between the course content and mathematical skill improvement.

1. I. A. Halloun and D. Hestenes, "The initial knowledge state of college physics students," *Am. J. Phys.* **53**(11), 1043-1055 (1985).
2. D. E. Meltzer, "The relationship between mathematics preparation and conceptual learning gains in physics: A possible hidden variable in diagnostic pretest scores," *Am. J. Phys.* **70**(12), 1259-1268 (2002).

CB08: 7:40–7:50 p.m. Students' Understanding of the Concept of Sampling*

Shaona Zhou, South China Normal University, Guangzhou, Guangdong 510631; zhou.shaona@gmail.com

Hua Xiao, South China Normal University
Jing Han and Lei Bao, Ohio State University
Yu'an Pi, Central China Normal University

Sampling is an important scientific reasoning ability frequently used in experimental design and data interpretation. As part of the research on assessment of students' scientific reasoning skills, we designed a series of multiple-choice instruments that probe students' understanding of the concept of sampling. The assessment was carried out among the students from grade four to grade 11 to study the development of students' understanding about sampling which was involved in the scientific context. Results from students at different grade levels indicated that students did not understand and consider the concept of sampling as a significant scientific reasoning skill until grade eight.

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

Session CC: Best Practices in the Use of Educational Technologies III

Location: Harper Center 3029
Sponsor: Educational Technologies Committee
Date: Monday, August 1
Time: 6:30–8 p.m.

Presider: Cathy Ezrailson

This session is a contributed session to encourage physics teachers at all levels to share their best practices in unique ways of using technologies, on the web and in the lab.

CC01: 6:30–6:40 p.m. PhET Sims for Middle School – Design, Use, and Classroom Implementation*

Noah S. Podolefsky, University of Colorado, 390 UCB, Boulder, CO 80309; Noah.Podolefsky@Colorado.EDU

The PhET Interactive Simulations project is a collection of more than 100 simulations of physical phenomena that create animated, interactive, game-like environments in which students learn through scientist-like exploration. While the sims are designed and tested with introductory college-level courses, anecdotal data from middle school teachers suggested that PhET sims could be used effectively with fifth-eighth graders —with teachers citing the intuitive controls and engaging, game-like style. These reports motivated us to study how sims can be best designed for and used in middle schools more systematically. We have conducted numerous interviews with middle school students using PhET sims, and collected video and observational data from middle school classes using sims. We will present our findings from these studies, including effective design principles for middle school sims, insights into how middle school students learn from sims, and benefits of and challenges to using sim-based activities in middle school classes.

* This work is funded by the Hewlett Foundation, NSF DRK12 Grant #1020362, The O'Donnell Foundation and the University of Colorado–Boulder.

CC02: 6:40–6:50 p.m. Going Beyond End of Chapter Problems in LON-CAPA

Boris Korsunsky, Weston High School, Weston, MA 02493; korsunskyb@mail.weston.org

Raluca E. Teodorescu, Carolin N. Cardamone, Saif Rayyan, and David Pritchard, MIT

We describe the open-source library of physics problems we are collecting in LON-CAPA (http://loncapa.mit.edu). Currently, the library features both traditional and research-based problems intended to expose students to various contexts, problem features, knowledge and cognitive processes. We are adding conceptual questions and challenge problems that require out-of-the-box thinking. The conceptual questions were developed at Ohio State University and MIT. The challenge problems are inspired by various tasks published in *The Physics Teacher*.[1-3] We are planning to evaluate the difficulty and pedagogical effectiveness of those problems using Item Response Theory (IRT). This permits determination of a student's skill independent of which problems they do. We welcome collaborators willing to add their problems to our library.

1. B. Korsunsky, "Ready, SET, Go! A research-based approach to problem solving," *Phys. Teach.* **42**, 493-497. (2004).
2. B. Korsunsky, *Physics Challenges for Teachers and Students* (a monthly column). *Phys Teach*. The library of past Challenges is online at http://tpt.aapt.org/features/physics_challenge_solutions. (2001-present)
3. B. Korsunsky, "Braintwisters for physics students," *Phys. Teach*. **33**, 550-553. (1995).

CC03: 6:50–7 p.m. First Assessment of the Integrated Learning Environment for Mechanics

Raluca E. Teodorescu, Massachusetts Institute of Technology, Cambridge, MA 02139; rteodore@mit.edu

Sara Julin, Whatcom Community College
Analia Barrantes, Daniel Seaton, and David Pritchard, MIT

We present the first evaluation of our open-source Integrated Learning Environment for Mechanics (ILEM)[1] - http://loncapa.mit.edu. The centerpiece of this environment is a collection of multi-level research-based homework sets organized by topic and cognitive complexity, whose design helps students learn physics problem solving. These sets are associated with learning modules that contain short expositions of the content supplemented by integrated open-access videos, worked examples, simulations, and tutorials. In our evaluation of homework problems, we analyze student attempts, preferences, and performance on different types of problems (e.g. representation, ranking and strategy writing problems). In our evaluation of content, we analyze observations generated by student comments in the discussion boards and during critical thinking activities. We continue to expand and improve the content and we welcome users and collaborators.

1. R. Teodorescu, A. Pawl, S. Rayyan, A. Barrantes and D. E. Pritchard, "Toward an Integrated Online Environment," *2010 Physics Education Research Conference Proceedings*, edited by S. Rebello, M. Sabella and C. Singh.

CC04: 7–7:10 p.m. Expanding LON-CAPA Homework Sets to Include Student-Generated Graphs

James T. Laverty, Michigan State University, East Lansing, MI 48825; laverty1@msu.edu

Gerd Kortemeyer, Michigan State University

The ability to work with graphs is a necessary skill in all of the sciences, yet students still struggle with it. Previous graph-related problems in LON-CAPA (http://www.lon-capa.org/) required students to pick the correct graph from a set of graphs or infer data from a given graph. Data gathered from the Test of Understanding Graphics – Kinematics (TUG-K) confirms that these problem types only minimally improve representation translation skills. A new problem type has been developed in LON-CAPA that allows students to construct (draw) graphs for themselves, in response to a given textual (or formulaic) description. These graphs are then checked by the server, which determines whether or not the student submitted graph is correct or incorrect. We present some preliminary experiences with this new problem type, while a study is under way to test the effectiveness of this approach.

CC05: 7:10–7:20 p.m. Item Response Theory Analysis of the Mechanics Baseline Test

Carolin N. Cardamone, Massachusetts Institute of Technology, Cambridge, MA 02139; cnc@mit.edu

Saif Rayyan, Daniel Seaton, Raluca Teodorescu, and Dave Pritchard, MIT

Item Response Theory (IRT) algorithms are being developed to better assess student performance in our Integrated Learning Environment for Mechanics (ILEM; [1]). A student's skill, as determined by IRT, provides more information than the traditional student score because it takes into account universally calibrated problem difficulties. Importantly, it allows determination of skill on a universal scale independent of which questions the student answers. Our approaches seek to dynamically update student and class skill level in ILEM throughout the course based on their performance, rather than relying primarily on the gain from pre/post testing. We present results comparing IRT and pre/post gain analysis of the Mechanics Baseline Inventory Test, including discussion of item parameters for the 26 questions on the MBT exam.

1. R. Teodorescu, A. Pawl, S. Rayyan, A. Barrantes and D. E. Pritchard, "Toward an Integrated Online Environment," *2010 Physics Education Research Conference Proceedings*, edited by S. Rebello, M. Sabella and C. Singh

CC06: 7:20–7:30 p.m. Integration of Computer-based Pre-, in- and Post-lecture Activities in Physics

Kelvin Cheng, Texas Tech University, Lubbock, TX 79409; kelvin.cheng@ttu.edu

Amy Pietan, Mehmet Calglar, and Hani Dulli, Texas Tech University

Monitoring and assessing the students' learning activities before (pre-), during (in-) and after (post-) lecture teaching in a large (more than 150 students) introductory physics class are important to evaluate the efficacies of new teaching pedagogies and methods. At Texas Tech, an online and integrative computer-based approach of using an interactive pre-lecture Just-in-Time tutorial, in-lecture Peer-Instruction clickers, and post-lecture Lab and online homework was implemented in the last two semesters. Using standard mechanics concepts and baseline surveys as well as independent classroom observations, the effects of these computer-based technologies on students' learning of physics concepts and problem-solving skills among different student subgroups taught by TAs and lecturers using different levels of student interactive engagement in class are investigated. Comparisons among computer-based technology interventions and their predictive roles in learning outcomes will be examined using Pearson correlation and multivariate analysis methods. (This work was supported by an NIH-STEM grant 1RC1GM090897)

CC07: 7:30–7:40 p.m. PASE: A Professional Development and Equipment Loaner Program

Susan M. Engelhardt, S.C. Governor's School for Science and Mathematics, Hartsville, AC 29550; engelhardt@gssm.k12.sc.us*

Learn about the Portable Advance Science Exploration (PASE) program and how it provides professional development and equipment loans to middle and high school teachers, allowing over 40 teachers to have engaged 3,500+ students with inquiry-based labs using technology at no cost to the teachers. PASE is an outreach program sponsored by the South Carolina Governor's School for Science and Mathematics (GSSM). Also learn about other outreach initiatives conducted by GSSM which reach hundreds of teachers and thousands of students.

*Sponsor: Larry Engelhardt

CC08: 7:40–7:50 p.m. Teaching Kids to Create Computer Simulations Using EJS

Larry Engelhardt, Francis Marion University, Florence, SC 29505; lengelhardt@fmarion.edu

Easy Java Simulations (EJS) is a free, open-source tool for creating interactive computer simulations. This summer (June 2011) I will be using EJS to teach 9th and 10th graders to create computer simulations in a week-long (summer science camp) course. Will we succeed? What will they create? Come find out! During the past year I have also used EJS for teaching multiple undergraduate courses in computational physics, so I will address the specific challenges and opportunities that arose when teaching high school students versus college students.

CC09: 7:50–8 p.m. Electricity and Magnetism Self-Testing and Test Construction Tool*

John C. Stewart, University of Arkansas, Fayetteville, AR 72701; johns@uark.edu

This talk presents an online resource for teaching and evaluating introductory electricity and magnetism classes. 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.

Session CD: Alternative Assessments and Practicums

Location: Harper Center 3048
Sponsor: Physics in High Schools Committee
Date: Monday, August 1
Time: 6:30–7:30 p.m.

Presider: Pat Callahan

This session will explore alternative methods of assessing student understanding in the high school physics class.

CD01: 6:30–7 p.m. Using Chapter Challenges in Active Physics

Invited - John L. Roeder, The Calhoun School, New York, NY 10024; JLRoeder@aol.com

The Chapter Challenges in Active Physics provide an alternative way to assess student learning. The author will share how he has used them in his 17 years of teaching Active Physics to ninth graders at The Calhoun School in New York City.

CD02: 7–7:10 p.m. Project-based Curricula in the Active Learning Environment

Simon P. Huss, Windward School, Los Angeles, CA 90066; shuss@windwardschool.org

Rebecca Carter, Windward School

Windward's Science and Technology Department has incorporated several unit-long, hands-on projects into the introductory level through AP Physics level curricula. Project-based learning provides more meaningful context for instruction and creates opportunities for teamwork, limited competition, and the activation of multiple learning modalities. Student role selection, differentiated instruction, methodologies for varied assessment, and project inspiration are all discussed. Specific strategies for implementation of a few select projects are discussed in detail.

CD03: 7:10–7:20 p.m. Problem-based Learning in Physics Instruction

David G. Schultz, Maine East High School, Park Ridge, IL 60068; dschultz@maine207.org

Rebecca Stewart and Tom Foley, Maine East High School

Problem-based learning (PBL) focuses on experiential learning organized around the investigation and resolution of a real-world, or "messy" problem. The problem is typically one that is closely tied to students' communities and involves stakeholders from both within and outside of a particular school building. We present several examples of how the PBL methodology has been successfully applied to secondary-level physics instruction. In these examples, students 1) investigated how to incorporate renewable energy technologies within their school district, and 2) evaluated the impacts of noise pollution upon the school environment. In PBL projects, student evaluation relies heavily upon final presentations to stakeholders, and is more authentic than traditional pencil and paper tests. Students master curricular goals while at the same time achieving deeper levels of understanding through inquiry and the exploration of multifaceted problems.

CD04: 7:20–7:30 p.m. What Are the Effects of Self-Assessment Preparation?

Sara Severance, University of Colorado–Boulder, Boulder, CO 80207; sarasev14@gmail.com*

This research was conducted by an urban middle school science teacher who sought to investigate the effects of self-assessment on student performance. A group of students were asked to give themselves a score on each learning target assessed in class and to provide evidence for their decision. Student self-assessment scores were compared to scores given by the teacher to see if students who accurately assessed their own learning scored higher on final assessments than students who did not. Assessment scores between groups of students who completed the self-assessment preparation and students who did not were also analyzed. Preliminary findings will be discussed in this presentation as well as further implications for this teacher's classroom.

*Sponsor: Valerie Otero

Session CE: Online Courses and Simulated Learning

Location: Harper Center 3040
Sponsor: Physics in Two-Year Colleges Committee
Co-Sponsor: Educational Technologies Committee
Date: Monday, August 1
Time: 6:30–7:30 p.m.

Presider: David Weaver

Physlets, Easy Java Simulations, VPython, PhET... All of these simulations stand on the shoulders of so many others, but they are powerful tools to help students learn physics. Whether students interact with pre-existing sims (or even video games?) or write their own code, how do these activities enhance their physics learning?

CE01: 6:30–7 p.m. Multivariable Regression Analysis of Online Physics Success

Invited - Erik L. Jensen, Chemeketa Community College, Salem, OR 97309; erik.jensen@chemeketa.edu

I used a multivariable regression to analyze success (grades) in six years of online and campus-based introductory physics classes at Chemeketa Community College. I analyzed independent variables including incoming GPA, grade in trigonometry, gender, age, home institution, and delivery method to determine their effects on success. I found that incoming GPA, home institution (Chemeketa students fared worse than outside students), and delivery method (there was an online "penalty" of about half a grade) significantly impacted success while other independent variables did not. In addition to presenting the multivariable regression analysis, I will provide both evidence of academic honesty and evidence that my students conduct substantive labs at home; these appear to be points of considerable skepticism among physics educators. I will also provide data and practices regarding retention, a challenge for any class with any delivery method at a community college.

CE02: 7–7:10 p.m. Taking Advantage of Sensor Technology to Create a Home-Based Kinematics Class

Richard Gelderman, Western Kentucky University, Bowling Green, KY 42101-1077; gelderman@wku.edu

Sonic ranger sensors have been successfully used in physics labs and play a major role in the design of reformed introductory physics classes. We have recently taken advantage of advances in the portability and ease of use of sonic rangers to develop a lab-based kinematics course delivered completely online. Following established curriculum plans utilizing progressively scaffolded interactive labs, this course uses digital data collection and analysis as the foundation of an interactive peer learning experience. Students in our online "Concepts of Force and Motion" course are required to purchase an equipment kit that includes a USB-interface motion detector and data collection and analysis software. The overwhelming success of this effort is how much students enjoy using this lab equipment at their home. Our experience is that every student has managed to overcome any initial trepidation, to complete the class with a positive reaction to both the technology and the emphasis on experimentation.

CE03: 7:10–7:20 p.m. Simulations of Mechanics with DynaMo

Michael G. Duffy, Emory & Henry College, Emory, VA 24327; mgduffy@ehc.edu

DynaMo is a program for developing, editing, and delivering simulations of a wide range of physical systems typically encountered in introductory physics and classical mechanics classes. I will be demonstrating a variety of newly created simulations and discussing various ways they can be delivered to students.

CE04: 7:20–7:30 p.m. Student Use of Geometer's Sketchpad to Model Physics Concepts

Dale Yoder-Short, Iowa Mennonite School, Kalona, IA 52247; dyodershort@gmail.com

Geometer's Sketchpad by Key Curriculum Press was created as a tool for teachers and students to model geometric situations. We have adapted it to create dynamic models of physics phenomena. We will show how to create an illustration and give examples of teacher and student sketches. We suggest the student is learning physics by building the sketch and then by using it as a tool to explore and analyze physics concepts

Session CF: Physics of Sports

Location: Skutt Student Center Ballroom ABC
Sponsor: Physics in Undergraduate Education Committee
Co-Sponsor: Physics in High Schools Committee
Date: Monday, August 1
Time: 6:30–7:50 p.m.

Presider: Bruce Mason

Physics applications in sports are often used to engage students and enliven physics classes. The physics of sports is also used in outreach and informal education. This session will explore topics in sports science that are being used in both formal and informal educational settings.

CF01: 6:30–7 p.m. Using Physics for Baseball Analysis

Invited - Alan M. Nathan, University of Illinois, Urbana, IL 61801; a-nathan@illinois.edu

The trajectory of a baseball moving through the air is very different from the one we teach in our introductory classes in which the only force is that due to gravity. In reality, the aerodynamic drag force (which retards the motion) and the Magnus force on a spinning baseball (which causes the ball to curve) play very important roles that are crucial to many of the subtleties of the game. These forces are governed by three phenomenological quantities: the coefficients of drag, lift, and moment, the latter determining the spin decay time constant. In past years, these quantities were studied mainly in wind tunnel experiments, whereby the forces on the baseball are measured directly. More recently, new tools that focus on measuring accurate baseball trajectories have been developed, from which the forces can be inferred. These tools include high-speed motion analysis, video tracking (the so-called PITCHf/x and HITf/x systems), and Doppler radar tracking via the TrackMan system. In this talk, I will discuss how these new tools work, what they are teaching us about baseball aerodynamics, and how they have the potential to revolutionize the analysis of the game itself.

CF02: 7–7:30 p.m. Making Sport of Physics

Invited - John E. Goff, Lynchburg College, Lynchburg, VA 24501-3113; goff@lynchburg.edu

The sports world provides an unlimited number of introductory physics examples. I will use a few of those examples to illustrate how an introductory physics teacher (high school or college/university) can use sports to not only teach physics but to help motivate students. Students in need of a little push may find connections to sports a way to make physics more "real world" than traditional examples.

CF03: 7:30–7:40 p.m. The Physics of Kubb

Erick P. Agrimson, St. Catherine University, St. Paul, MN 55105; erickagrimson@stkate.edu

If one defines a sport as an activity of diversion in which one engages in relaxation, Kubb or otherwise known as "Viking chess," is a sport to many Scandinavians. The physics behind this Viking game will be discussed such as forces involved, inertia of batons as well as a short synopsis of the game for the uninitiated.

CF04: 7:40–7:50 p.m. Student Projects with Video Analysis

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

Shawn Sloan, Luke Grome, Mary Funke, and Nikki Sanford, High Point University

Using video analysis software such as Tracker and inexpensive high-speed video cameras, students can do very interesting projects at the introductory level. In this presentation, I will demonstrate two projects completed by students in my introductory calculus-based physics class. (1) High-speed video analysis of a soccer ball kicked with backspin was used to measure the force and torque on the soccer ball by the foot. The force and torque were used to calculate how far off center the foot impacted the ball, i.e. the moment arm. (2) A mechanical device was used to model a hula hoop rotating around a person's arm. High-speed video analysis of a hula hoop rotating on the device showed that a point on the hoop travels in a spiral-like path. A graph of x-position vs. time for a point on the hoop was a sum of two sine curves of similar frequencies, similar to a beat pattern in acoustics.

Session CG: Indigenous Astronomy

Location: Skutt Student Center Ballroom DE
Sponsor: Space Science and Astronomy Committee
Date: Monday, August 1
Time: 6:30–7:30 p.m.

Presider: Tom Foster

All of the official constellations in the night sky come from western European traditions. But every culture has looked to the sky and connected the dots in their own manner. This session will introduce many different stories about the stars you thought you already knew.

CG01: 6:30–7 p.m. Ethnoastronomy: Exploring Native Astronomy on the Great Plains

Invited - Mark Hollabaugh, Normandale Community College, Bloomington, MN 55431; mark.hollabaugh@normandale.edu

Ethnoastronomy is the study of an indigenous people's astronomy. Through legends, winter counts, and second-hand reports, we know a great deal about astronomy on the Great Plains in the 19th century. This talk will explore how ethnoastronomers use many well-known tools of astronomy to understand phenomena, events, and beliefs of a native people. Focusing primarily on the Lakota people of the western Dakotas, examples will include eclipses, meteor showers, and the aurora borealis.

CG02: 7–7:30 p.m. Ways of Seeing: Native Perspectives in Astronomy

Invited - Diana Wiig, University of Wyoming, Rock Springs, WY 82901; dwiig@uwyo.edu*

While attending a cultural festival at the Wind River Reservation, I brought my telescope to share with the students and their parents. During our night sky navigation, I began to hear murmured stories that were unfamiliar to me. I was intrigued; so began my journey into the rich oral/written narratives of Northern Arapaho and Shoshone cultures. This presentation will share some of the stories, resources, and websites to further enhance the astronomy experience from a native perspective.

*Sponsor: Thomas Foster

Session CH: Science and Society

Location: Skutt Student Center Ballroom F
Sponsor: Science Education for the Public Committee
Date: Monday, August 1
Time: 6:30–8 p.m.

Presider: Steve Shropshire

CH01: 6:30–6:40 p.m. Do Physics Best-Sellers Sell Physics Short?

Craig C. Wiegert, University of Georgia, Athens, GA 30602-2451; wiegert@physast.uga.edu

There are many examples of non-technical physics and astronomy books that top the charts on Amazon and make it to the *New York Times* best-seller list. The most popular books often explore mind-bending topics like string theory, general relativity, and cosmology. While these books certainly generate excitement and fascination with physics among the general public—and future students—their prominence has the unfortunate side effect of misrepresenting the discipline as a whole. I'll discuss the sometimes unrealistic perceptions that our beginning college physics majors have about areas of research in physics and astronomy, and what we're doing to modify those perceptions without (hopefully!) diminishing students' interest in the field.

CH02: 6:40–6:50 p.m. The Haunted Physics Lab at Creighton University

Thomas H. Zepf, Creighton University, Omaha, NE 68178; thzepf@creighton.edu

For over 25 years at Creighton University, "Dr. Zepf's Haunted Physics Lab" has been a popular outreach attraction for teaching basic principles of physics to students and the general public. Currently it is an annual Physics Club project at Creighton University during the Halloween season. In 2004 an article* about it in *TPT* generated wide interest. Today, applications of the haunted lab theme for teaching science are widespread both in this country and abroad. In this presentation one of the exhibits in Dr. Zepf's Haunted Physics Lab will be explained and a video of it that was made during an actual session will be shown. Watch as visitors are greeted by a seemingly bodiless "Department Head." It talks. It answers questions. It's alive!

*T. H. Zepf, 'The haunted physics lab," *Phys. Teach.* **42**, 404 (Oct. 2004).

CH03: 6:50–7 p.m. Data from the Use of a Domestic Ground-Source Heatpump

Tom Carter, College of DuPage, Glen Ellyn, IL 60137; cartert@cod.edu

During last summer's Physics and Society session, there was a discussion of the benefits of the use of ground source (a.k.a "geothermal") heatpumps. In this talk, I will briefly review how a ground source heatpump works and present some historical energy data from the use of my own unit in northern Illinois. I will also point out some reasons why these units are not the best green technology for all situations.

CH04: 7–7:10 p.m. A Physics of Energy Course by Train, West Coast, USA

Katrina M. Hay, Pacific Lutheran University, Tacoma, WA 98447; hay@plu.edu

Peter B. Davis, Pacific Lutheran University

Inspired by concern for sustainability and environmental impact of conventional fuel usage, an introductory interdisciplinary travel course was designed. The course provides students with an understanding of the underlying physical principles of traditional and alternative methods of energy production. The Western United States is an ideal region to study practical use and research of hydroelectric, wind, nuclear, solar, ocean wave, and geothermal energy. This course, taught for the first time in January 2011, traveled by Amtrak Coast Starlight train, making stops in Washington, Oregon, and California. Students became aware of their impact on global energy by experiencing first hand the physics connection between communities and energy. This presentation will include learning objectives, energy source locations, an interdisciplinary connection to geology, and discussion of the unique opportunity for faculty to connect with students in an off-campus environment.*

* Blog created by the participants of the course: http://plu-west-coast-2011.blogspot.com/

CH05: 7:10–7:20 p.m. Integrating Sustainability Across the Science Curriculum of Gustavus Adolphus College

Charles F. Niederriter, Gustavus Adolphus College, Saint Peter, MN 56082; Chuck@gustavus.edu

Amanda Hochstatter and Hasanga Samaraweera, 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 this CCLI project is 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 our first summer's work developing laboratory and classroom experiences and discuss plans for future work.

CH06: 7:20–7:30 p.m. Physics and the Sewing Machine

Courtney W. Willis, University of Northern Colorado, Greeley, CO 80639; courtney.willis@unco.edu

Few products of the industrial revolution have had as much impact on modern society as the sewing machine. The sewing machine, sometimes referred to as the "Queen of Inventions," was the first home appliance but it also brought us the "American System" of manufacturing with interchangeable parts, ready to wear clothing, the modern department store, the time payment plan, and the sweat shop. Introduced in the mid 1800s, the scientifically inclined were kept informed of each new development in the pages of *The Scientific American*, and by the turn of the 20th century high school physics curriculum was being developed utilizing the sewing machine. Since most schools had little scientific apparatus and the sewing machine was rather ubiquitous, many hands-on activities were designed around the sewing machine for use in physics classrooms.

CH07: 7:30–7:40 p.m. Gender Bias in Faculty Hiring and Promotion: A Research Proposal

Ramon S. Barthelemy, Western Michigan University, Kalamazoo, MI 49004; ramon.s.barthelemy@wmich.edu

Charles R. Henderson, Western Michigan University

According to the AIP, in 2006 only 10% of faculty at Physics PhD-granting institutions were female. One potential contributor to this underrepresentation of women is gender bias in the hiring and promotion process. This talk will discuss a study of such gender bias in the field of psychology* and present a proposal for a similar study in physics. In the psychology study, a curriculum vita from a faculty member at the beginning or tenure phase of their career was sent to randomly selected faculty. Participants were asked to rate the content of the CV along with their decision for hiring the individual or granting tenure. The CVs were identical except that some had a traditionally male name and others had a traditionally female name. The psychology results found significant gender bias in hiring. Feedback will be invited on the design of a similar study in physics.

*R. Steinpreis, K. Anders, D. Ritzke, "The impact of gender on the review of the CVs of job applicants and tenure candidates: A national empirical study," *Sex Roles* **41**, 509-528, (1999).

CH08: 7:40–7:50 p.m. A Project-based Curriculum in Energy Studies*

*Theresa Edmonds,** Creighton University, Energy Studies Program, Omaha, NE 68178; mgc91339@creighton.edu*

Jay Leighter, Gina Merys, and Michael Cherney, Creighton Universtiy

A new program in Energy Studies at Creighton University recently welcomed its first students. This STEM program addresses energy issues from an interdisciplinary perspective. The new bachelor of science curriculum develops applied scientists with communications skills, knowledge of public policy, law, and the human factors relevant for implementing their work. In addition to a strong emphasis on problem solving, the program seeks to instill life-long learning skills, augment team work talents, reward innovation, and enhance communication abilities. The project-based curriculum works to tailor the experience to the student. Students are asked to identify what they want from a particular learning experience and to establish expectations. Projects are formulated so that students are required to work on the areas where they need development. Projects are structured to involve active participation of the students. Students are expected periodically to reflect on their work and follow up appropriately. A BA program is also offered.

*This work is supported by the United States Department of Energy.

**Sponsor: Michael Cherney

CH09: 7:50–8 p.m. Education Outreach Efforts of the Acoustical Society of America

Wendy K. Adams, Acoustical Society of America, 1914 18th Ave., Greeley, CO 80631; wendy.adams@colorado.edu

The Acoustical Society of America has recently been focusing effort on K-12 (note: the HS material works well for intro college students) outreach through a partnership with the Optical Society of America and AAPT/PTRA (Physics Teaching Resource Agents). This year the acoustical society has created a website with activities for students and materials for teachers at http://exploresound.org. The material addresses the science of sound including physics, music, our ears, animal bioacoustics, architectural acoustics, underwater acoustics, speech and medical acoustics. We've also put together a poster series with guidebooks and are working on an activity kit that will be freely available to teachers. All materials are research based and tested with students. In this presentation we will show the type and breadth of material that's available and where to find it.

Session CI: Methods to Improve Conceptual Learning in Quantum Mechanics

Location: Harper Center 3028
Sponsor: Physics in Undergraduate Education Committee
Date: Monday, August 1
Time: 6:30–7:40 p.m.

Presider: Mario Belloni

CI01: 6:30–6:40 p.m. Operators and Measurements in Paradigms in Physics, Part 1

Corinne A. Manogue, Oregon State University, Corvallis, OR 97331; corinne@physics.oregonstate.edu

Elizabeth Gire, University of Memphis
David McIntyre, Janet Tate, and Dedra Demaree, Oregon State University

Operators have a central role in the formalism of quantum mechanics. However, many students have trouble using operators in computations related to quantum measurements. Many students erroneously believe that, for operators representing observables, the linear transformation of the quantum state vector corresponds to the process of making a measurement on the system. The upper level quantum mechanics curriculum at Oregon State University takes a "spins first" approach that emphasizes quantum measurements. Within this curriculum, we have developed a variety of activities to help address this common student difficulty.

CI02: 6:40–6:50 p.m. Operators and Measurements in Paradigms in Physics, Part 2

Elizabeth Gire, Oregon State University, Corvallis, OR 97331; corinne@physics.oregonstate.edu

Corrine Manogue, David McIntyre, Janet Tate, and Dedra Demaree, Oregon State University

The Paradigms team at Oregon State University has developed a series of activities that emphasize quantum measurements. Some of these activities specifically target students' conceptual understanding of the role of operators in computations related to measurements. We will discuss evidence of how these activities help students develop productive conceptual understandings of operators. This evidence is gathered from classroom video of students working through the activities in small group, whole class discussions, and clinical interviews, as well as students' homework and exams.

CI03: 6:50–7 p.m. A Hands-On Introduction to Quantum Mechanics for Sophomores

David P. Jackson, Dickinson College, Carlisle, PA 17013; jacksond@dickinson.edu

Brett J. Pearson, Dickinson College

The Physics Department at Dickinson College has re-designed its curriculum for physics majors to take advantage of recently developed single-photon experiments in quantum mechanics.* The ultimate goal is to bring students face to face with some of the fascinating and subtle features of quantum mechanics in a hands-on setting. This is mainly accomplished in a sophomore-level course titled "Introduction to Relativistic and Quantum Physics." Experiments include the behavior of a photon at a beam splitter—it "must" go one way or the other—and the behavior of a photon at a Mach-Zehnder Interferometer—it "must" go both ways. This talk will describe our curriculum changes and discuss some of the successes and difficulties we have experienced.

*This work was supported by NSF grant DUE-0737230.

CI04: 7–7:10 p.m. Illustrating Quantum Non-Locality with the Two-Slit Interferometer

Scott C. Johnson, Intel, 4635 NW 175th Place, Portland, OR 97229; scott.c.johnson@intel.com

The classic demonstration of interference is the two-slit interferometer, so students are generally comfortable with this system and the calculations that go with it. This familiarity makes it a good system for illustrating new concepts, such as the non-local correlations seen in quantum entanglement. These can be illustrated with a modified interferometer that uses two sets of slits, one on each side of a source of momentum-entangled photons. (This actual system has not yet been realized, but a similar Mach-Zehnder interferometer has been constructed.) This system shows interference-like correlations between photons detected on opposite sides of the source, which can be very far away from each other. These correlations change with the spacing of both sets of slits, illustrating Einstein's "spooky action at a distance."

CI05: 7:10–7:20 p.m. A New Multimedia Resource for Teaching Quantum Mechanics Concepts

Antje Kohnle, University of St. Andrews, KY16 9SS; United Kingdom; ak81@st-andrews.ac.uk

Donatella Cassettari, Tom Edwards, Callum Ferguson, Alastair Gillies, Christopher Hooley, Natalia Korolkova, Joseph Llama and Bruce Sinclair, University of St. Andrews

Since 2009, we have been developing and evaluating visualizations and animations for the teaching of quantum mechanics concepts [Kohnle et al., *Eur. J. Phys.*, 31 6 (2010) 1441]. This new resource builds on existing education research as well as 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. Animations and instructor resources are freely available at www.st-andrews.ac.uk/~qmanim, and can be played or downloaded from this site. Animations have been used and evaluated in several quantum mechanics courses. Recent work includes extending the range of topics and levels of the animations, and a study of students' interactions with a previously unseen animation, aiming to test whether interface and content make sense, and whether the animations encourage interaction and exploration. Results of this work will be used to optimize the animations.

CI06: 7:20–7:30 p.m. Assessment of Student Understanding in Modern Physics

Jessica L. Uscinski, American University, Washington, DC 20016-8058; uscinski@american.edu

Teresa L. Larkin, American University

A number of tools are widely available to assess student understanding of key concepts in introductory physics, but less so for modern physics and quantum mechanics. The Modern Physics course at American University presents an ideal opportunity for conceptual assessment given its somewhat atypical student composition. In this study, student understanding of the photoelectric effect is probed using a variety of measures. A quantitative assessment was first performed using the Quantum Physics Conceptual Survey (QPCS).* A series of both qualitative and quantitative exam questions were then developed and given as additional assessment measures of the photoelectric effect. In this presentation we summarize the pre-/post-gains of the assessments and correlate them with academic background and performance. The preliminary results from these assessment methods will be discussed in the larger context of how assessment measures can be maximized to enhance student understanding in a modern physics course.

*S. Wuttiprom, M.D. Sharma, I.D. Johnston, R. Chitaree, and C. Soankwan, "Development and use of a conceptual survey in introductory quantum physics," *Intl. J. of Sci. Educ.* **31**(5), 631-654 (2009).

CI07: 7:30–7:40 p.m. Educational Proposal for Teaching QED*

George E. Kontokostas, University of Athens, Pedagogical Department, 17562 Athens, Greece; gakon67@hotmail.com

The session will focus on mentoring and induction programs for new physics teachers. Students need and desire to know the latest scientific knowledge. Quantum is introduced in order to give students an understandable qualitative view of the origin of Feynman diagrams as representations of particle interactions. Elementary diagrams are combined in a simple way in order to understand the standard Model. In this presentation we examine how an alternative way of teaching can help students to design, predict interactions, and understand how the diagrams work. Using special pedagogical methods and with the help of technology, we note that most students were able to design the three interactions and to predict the formation of some particles. Without using much math, the students were allowed to develop an understanding of QED. Some misconceptions were dealt with successfully.

*http://accelaratingeducation.blogspot.com http://micro-kosmos.uoa.gr/

Session CJ: Potpourri of Teacher Preparation Programs II

Location: Skutt Student Center 104
Sponsor: Teacher Preparation Committee
Co-Sponsor: Minorities in Physics Committee
Date: Monday, August 1
Time: 6:30–7:30 p.m.

Presider: Taha Mzoughi

As more of us attempt to start or enhance physics teacher programs, we can benefit from learning about other programs.

CJ01: 6:30–6:40 p.m. Science Teachers Acquired through New Directions in New Mexico (STAND-NM)*

Jennifer J. Neakrase, New Mexico State University, Las Cruces, NM 88003; neakrase@nmsu.edu

Traditionally the certification of physics teachers at New Mexico State University has been part of the secondary education program in the College of Education. Students select a specific science discipline (e.g., physics) as part of a general science certification, in which they declare secondary education as their undergraduate major or receive their license through a Master of Arts program as graduate students. As part of the traditional program, students take a limited number of discipline specific courses. Previously there was no option for science majors to receive a secondary science teaching license without switching majors away from their science discipline or entering the Masters program. STAND-NM, an NSF Noyce-funded program, provides a new option for science majors to pursue secondary science licensure while finishing their undergraduate degree within their science major. This talk introduces the program at NMSU and discusses difficulties in recruitment, especially with our physics majors.

*Funding provided through an NSF Robert Noyce Scholarship grant DUE-0934919.

CJ02: 6:40–6:50 p.m. Florida PROMiSE: The Perspective of Three Physics Faculty Participants*

Mark W. Meisel, University of Florida and NHMFL, Gainesville, FL 32611-8440; meisel@phys.ufl.edu

Selman Hershfield and James S. Brooks, Florida State University and NHMFL

Florida PROMiSE (http://www.flpromise.org/) has a mission "to improve Florida student achievement in mathematics and science through professional development for Florida's Educators and to build capacity to sustain quality implementation of the Next Generation Sunshine State Standards (NGSSS)." We participated in the design and inaugural deliveries (Summer 2009) of two institutes: Matter and Energy for K-8 teachers and Force and Motion for 6-12 teachers. With our continued participation, these institutes were revised and held again in summer 2010. This brief presentation serves to increase awareness of PROMiSE and to provide an overview of our participation, especially as it relates to "increasing the content knowledge of the participants." One outcome is our increased awareness of the "misconceptions" that K-12 students and teachers possess, and the role that a faculty member plays in reversing these misconceptions.

*Supported, in part, by NSF DMR-0701400 (MWM), NSF DMR-0654118 (NHMFL), and the State of Florida.

CJ03: 6:50–7 p.m. First Attempt at a Physics Methods Course

Michael R. Meyer, Michigan Technological University, Houghton, MI 49931; mrmeyer@mtu.edu

High school physics teachers have historically been certified at Michigan Technological University with only a general "teaching science" methods course in their education curriculum. In the spring semester of 2011 I piloted the first physics teaching methods course specifically designed to give pre-certification teachers exposure to and practice in PER-supported pedagogies. This presentation will review the curriculum and results of the new course, discuss lessons learned and take a quick look toward the future.

CJ04: 7–7:10 p.m. Helping Middle and High School Teachers' Students Do Inquiry

Gordon J. Aubrecht, Ohio State University–Marion, Marion, OH 43302-5695; aubrecht.1@osu.edu

An Ohio Department of Education-supported project has concluded three years of funding, with a fourth pending. Student scores on the Ohio Achievement Test have climbed from the original poor level to a higher poor level in a district with about 80% of students receiving free or reduced-cost breakfast and lunch. Teachers want to continue to change. Details of the project will be presented.

CJ05: 7:10–7:20 p.m. Core Knowledge Movement Inspired Teachers' Preparation in Middle School Physics

Ana Rita L. Mota, CFP e Departamento de Fìsica e Astronomia da Faculdade de Ciências da Universidade do Porto, 4169 - 007 Portugal; anaritalopesmota@gmail.com*

J. M.B. Lopes dos Santos, Universidade do Porto

We present a study involving physics teaching in Portuguese schools (seventh and eighth grades) inspired by the Core Knowledge movement (CKM), which defends the need for common curricula, well-defined teaching objectives and carefully planned classes. The project combined this approach with teacher training and weekly lab work, and required careful preparation of teaching materials (lesson plans and proposals for experimental activities), which were an outcome of the project. It was assessed with an analysis of the results of two groups; the experimental group under this instruction (CKM) and the control one, where the classes were taught the traditional Portuguese way. Data sources included analysis of the students' pre- and post-tests and interviews with the teachers involved. We found that the CKM instruction, inserted in an interactive and well-designed teaching environment, was more effective in promoting conceptual change and scientific understandings than the instruction in a traditional course.

*Sponsor: Carlos Manuel C. Guimaraes Carvalho

CJ06: 7:20–7:30 p.m. Attracting Undergraduate Physics Majors into Becoming High School Physics Teachers

Michael W. Prim, UNC-Chapel Hill, Chapel Hill, NC 27599; mwprim@earthlink.net

How do universities and colleges attract undergraduate physics majors into becoming high school physics teachers? It has been my task at UNC-Chapel Hill to talk to the physics majors and present the reasons why teaching high school physics can lead to a satisfying career as well as making a major social contribution to the planet. Few careers offer the enormous influence and satisfaction as does teaching high school physics. Many people look back on their life and wonder what they have given to the planet. An effective physics teacher can influence the manner in which a person thinks and lives their life. Now is the time to create a new breed of extraordinary high school physics teachers.

Session TYC: Favorite Activities from the TYC Classroom

Location: Harper Center 3053 (TYC Resource Room)
Sponsor: Physics in Two-Year Colleges Committee
Date: Monday, August 1
Time: 12–1 p.m.

TYC01: Math Machines: Connecting Physics with Math and Engineering*

Poster - Fred Thomas, Sinclair Community College, Englewood, OH 45322; fred.thomas@mathmachines.net

Robert Chaney, Sinclair Community College

Math Machines is a unique technology that establishes explicit links to mathematics and engineering within physics labs and student-focused classrooms. Students design and test free-form mathematical functions to control engineering-style physical systems and complete immediate, physical and dynamic tasks. Examples include programming a light to follow an accelerating object, programming an astronomical clock to replicate the motions of the moon, programming motions of a platform to simulate earthquakes of arbitrary magnitude, and programming red, green and blue lights to display oscillating colors in various combinations. Equipment is inexpensive, consisting primarily of such things as a hobby servo motor and a 3-color LED in combination with a SensoDAQ or NI myDAQ computer interface. Schools are encouraged to build similar equipment and share it with math, science, engineering and technology teachers in their region.

*Supported in part by NSF's Advanced Technological Education Program through grant DUE-1003381. More information is available at www.mathmachines.net.

TYC02: Using a Slinky as a Solenoid in an Open Ended Lab

Poster - Dwain M. Desbien, Estrella Mountain CC, Avondale, AZ 85392; dwain.desbien@emcmail.maricopa.edu

This poster will show the lab my students perform using a Slinky as a solenoid to investigate the magnetic field inside the solenoid. This is an open-ended lab with little instruction given to the students. The basic equipment is a Slinky, D cells, a 10 Ohm resistor, wires and a way to detect the magnetic field. Student results from the lab will be shown.

TYC03: Visualizing and Conceptualizing Linear Momentum

Poster - Michael C. Faleski, Delta College, University Center, MI 48710; michaelfaleski@delta.edu

Linear momentum is one of the concepts that students have the most difficulty understanding. Beyond applying a simple equation or a memorized result for specific scenarios, students seem to forget about using linear momentum and do not have a "feel" of what it is. This presentation will show some simple in-class questions to pose to students with quick activities that immediately demonstrate the results. In addition, a possible way to look at linear momentum from a conceptual/visualize point of view with extensions into ideas of energy will be presented.

PST1: Poster Session 1

Location: Kiewit Fitness Center Courts
Date: Monday, August 1
Time: 8–9:30 p.m.

Odd number poster authors will be present 8–8:45 p.m.
Even number poster authors will be present 8:45–9:30 p.m.
(Posters should be set up by 9 a.m. Monday and taken down by 10 p.m. Monday)

Astronomy

PST1A01: 8–8:45 p.m. A Novel Way to Measure the Distance to an Asteroid

Poster - Richard D. Dietz, University of Northern Colorado, Greeley, CO 80639, rdietz@unco.edu

Maurice I. Woods, James P. McDonald, Hunter P. Nolen, and Travis W. Riggle, University of Northern Colorado

We have successfully measured the distance between the Earth and a main belt asteroid, 298 Baptistina. We used remotely operated telescopes in New Mexico and Spain to take simultaneous images of the asteroid. The position of the asteroid with respect to the background stars was slightly different in the two images, and application of the method of parallax to the images enabled an accurate determination of the distance to the asteroid.

PST1A02: 8:45–9:30 p.m. Robotic Telescope Observations & Active Learning Exercises in Introductory Astronomy

Poster - Gintaras Duda, Creighton University, Omaha, NE 68178; gkduda@creighton.edu

Jack Gabel, Creighton University

This poster will describe the current and future implementation of an NSF CCLI grant at Creighton University to rebuild and re-imagine the introductory astronomy curriculum. Traditional introductory lectures will be transformed through the addition of RF clickers and other innovations such as tutorial-style active learning exercises. The capstone to the project will be the purchase, installation, and operation of a robotic telescope capable of remote observations that will be made available to students and faculty at local and regional institutions as well as middle and secondary students in the region. This addition will greatly enhance Creighton astronomy lab courses, bringing a hands-on science experience to our curriculum that is currently lacking. The robotic telescope will allow the implementation of project-based learning with emphasis on advanced observational astronomy techniques and instrumentation including imagery, photometry, and spectral analysis at the introductory and advanced levels.

PST1A03: 8–8:45 p.m. Deliberately Building Spectroscopy into the Intro Astronomy Course

Poster - Richard Gelderman, Western Kentucky University, Bowling Green, KY 42101-1077; gelderman@wku.edu

We present and discuss a series of "minds-on" interactive student-centered exercises and activities built into an introductory astronomy course. The lessons are structured to help students improve their ability to recognize patterns and improve their ability to really see the details in front of them. Another goal is for students to realize there is "more than meets the eye" to learn how to discover "hidden" diagnostics, such as different sources of light their eyes see as white light. A curriculum that emphasizes spectroscopy also provides the opportunity to stress the story of the "Harvard Women," a tale that bridges gender gaps and often humanizes scientists in the eyes of non-science majors. Finally, with a solid foundation in spectroscopy, students are better prepared to understand exciting topics such as Hubble's law and the importance of primordial nucleosynthesis.

PST1A04: 8:45–9:30 p.m. Automating Small Observatory Domes

Poster - Brian K. Hubbard, University of West Georgia, Carrollton, GA 30118; bhubbar1@my.westga.edu*

Robert Moore Jr. and Bob Powell, University of West Georgia

Many small observatories have computerized telescopes housed in manually operated domes. As the telescope automatically slews to another part of the sky, the operator must activate a motor to move the shutter of the dome to allow the light from the target object to enter the telescope. Retrofitting an observatory dome for automated tracking, the direction the telescope is pointed is likely to be too expensive for a smaller institution. Using an Arduin microcontroller, a compass module, and Xbee wireless communications, we were able to track an independently operated telescope without the use of bulky and expensive rotary encoders. This demonstration is a low-cost solution of consumer microcontrollers and accessories and is a viable wireless solution to observatory dome automation.

* Sponsor: Bob Powell

PST1A05: 8–8:45 p.m. Effectiveness of Two Interactive Learning Techniques in Introductory Astronomy

Poster - Jessica C. Lair, Eastern Kentucky University, Richmond, KY 40475; jessica.lair@eku.edu*

Jing Wang, Eastern Kentucky University

As a part of the shift to active learning environments in the Department of Physics and Astronomy at Eastern Kentucky University, we have implemented the use of a clicker system in all the introductory astronomy courses. The clickers were used in class on a daily basis to allow the students to actively participate in the lectures. We present pre- and post-test data from the solar system astronomy class utilizing the Astronomy Diagnostic Test (ADT) from the first semester of clicker use compared to previous semesters. We also present the differences in the ADT results between the laboratory and non-laboratory sections of the introductory astronomy course.

* Sponsor: Jing Wang

PST1A06: 8:45–9:30 p.m. Stellar Bar Codes

Poster - Doug Lombardi, University of Nevada, Las Vegas, Las Vegas, NV 89123; lombar37@unlv.nevada.edu

Donna Young, Chandra X-ray Observatory
Pamela Perry, Lewiston High School

Astronomers classify stars based on the major components of their spectra. Much like barcodes on store items, stellar spectra are each slightly different. The study of spectra provides scientists with important information about stars that is otherwise inaccessible, including composition, temperature, mass, luminosity, age, and evolutionary history. Spectroscopy is the study of starlight—which is analyzed and plotted by intensity versus wavelength—and visually represented as spectra. The stellar classification system of O,B,A,F,G,K,M is based upon spectral analysis. Spectra also determine the position of an object on the Hertzsprung-Russell diagram; each location on the diagram has a unique combination of magnitude and temperature, which gives information about the evolutionary stage of the star. This poster discusses an activity that uses real stellar spectra to help students learn about star properties and characteristics.

PST1A07: 8–8:45 p.m. A 'Make and Take' Overnight Workshop at the SLL Observatory

Poster - Steven J. Maier, Northwestern Oklahoma State University, Alva, OK 73717; sjmaier@nwosu.edu

Bobette Doerrie, Northwestern Oklahoma State University

In the summer of 2011, an overnight astronomy workshop was held at the Selman Living Laboratory (SLL) Observatory.[1] In operation since 2000, the SLL Observatory regularly hosts summer programs for public groups, led by NWOSU faculty and members of a local astronomy club, SAS.[2] Located in northwest Oklahoma, many state park tourists and wildlife and nature conservation enthusiasts frequent the facility. For our summer 2011 program, several Oklahoma science teachers were invited to take advantage of our facility's dark skies, 12" Meade and 10" Dobsonian telescopes. Participants also took away numerous free instructional materials purchased through funding provided by the AAPT Bauder Fund grant program.[3] This poster will present some of the highlights of the workshop and summarize our efforts in making astronomy more accessible to teachers in a region where astronomy is very rarely included as part of regular HS/MS science curricula.

1. www.nwosu.edu/sll-observatory
2. www.starcreek.org
3. www.aapt.org/Programs/grants/bauderfund.cfm

PST1A08: 8:45–9:30 p.m. Service Learning in Introductory Astronomy at Misericordia University

Poster - Michael P. Orleski, Misericordia University, Dallas, PA 18612; morleski@misericordia.edu

Misericordia University's Introduction to Astronomy course during the fall 2010 semester incorporated a service learning component. The students in a service learning course use course content in a service project. They then reflect on the service and how it affected their learning. The astronomy students held observations for two groups of local elementary school students. This poster provides details on service learning, the observation sessions, and a summary of comments made by the astronomy students regarding the service learning experience.

Pre-college/Informal and Outreach

PST1B01: 8–8:45 p.m. What Does the Fukushima Disaster Mean for Nuclear Energy?

Poster - Gordon J. Aubrecht, Ohio State University–Marion, Marion, OH 43302-5695; aubrecht.1@osu.edu

The 9.0 earthquake, tsunami and its consequences will influence global acceptance of nuclear energy. We examine some of these.

PST1B02: 8:45–9:30 p.m. Scientific Duty: Letters to the Editor

Poster - Gordon J. Aubrecht, Ohio State University–Marion, Marion, OH 43302-5695; aubrecht.1@osu.edu

The author believes that letters to the editor of his local paper trying to explain what science is and how scientists work in response to letters demonstrating ignorance of those characteristics is a duty of all working scientists in view of the anti-scientific tidal wave sweeping America.

PST1B03: 8–8:45 p.m. Education Outreach Efforts of the Acoustical Society of America

Poster - Wendy K. Adams, Acoustical Society of America, 1914 18th Ave., Greeley, CO 80631; wendy.adams@colorado.edu

The Acoustical Society of America has recently been focusing effort on K-12 (note: the HS material works well for intro college students) outreach through a partnership with the Optical Society of America and AAPT/PTRAs (Physics Teaching Resource Agents). This year the acoustical society has created a website with activities for students and materials for teachers at http://exploresound.org. The material addresses the science of sound including physics, music, our ears, animal bioacoustics, architectural acoustics, underwater acoustics, speech and medical acoustics. We've also put together a poster series with guidebooks and are working on an activity kit that will be freely available to teachers. All materials are research based and tested with students. In this poster we will describe the type and breadth of material that's available and where to find it.

PST1B04: 8:45–9:30 p.m. Teaching and Intuitive Learning of Electronics Based Upon Projects

Poster - Isabel Cárdenas, Grupo de Física / Gimnasio La Montaña, Bogotá, CU 09002, Colombia; grupofisica@glm.edu.co

Alejandra Corzo and Mauricio Mendivelso-Villaquirán, Gimnasio La Montaña,

Based on intuitive learning of electronics and programming, with minimum teacher intervention, two 12-year-old girls can develop two physics lab interfases using open source hardware and software: distance ultrasound monitor and water level monitor. Issues about cognitive processes, building processes and teacher intervention are detailed.

PST1B05: 8–8:45 p.m. Cosmic Math Teacher Workshop

Poster - Judy Vondruska, South Dakota State University, Brookings, SD 57006; Judy.Vondruska@sdstate.edu

Larry Browning and Christine Larson, South Dakota State University

Cosmic Math is a curriculum project designed to use astronomy as a means of motivating students in learning geometry, algebra, trigonometry, Earth and physical science concepts in middle school and high school. The project begins with a week-long summer workshop on the campus of SDSU and continues with follow-up sessions during the fall and spring semesters. During the week's summer workshop, teams of teachers are involved in inquiry-based activities focused on building models (space and shape concepts), collecting and analyzing data (manipulation of quantities), and sharing ideas for implementation of activities into the classroom. The workshop is offered to physical science and mathematics teachers at both the middle and high school level with the intent of building local partnerships in teaching math skills. Teachers are encouraged to develop projects that cross between their classrooms so that students see the connections between science and math in each class.

PST1B06: 8:45–9:30 p.m. Math and Science Summer Institute for at Risk Students

Poster - James D. Dull, College of Idaho, Caldwell, ID 83605; jdull@collegeofidaho.edu

Robin A. Cruz and Kathryn Devine, College of Idaho
Melissa Ferro and Monica White, Syringa Middle School

The College of Idaho has collaborated with Syringa Middle School in Caldwell, Idaho, to promote the study of math and science in a population at high risk for dropping out of high school. Participants include the economically disadvantaged, rurally isolated, and traditionally under-represented students. The goal of the program is to engage these students with the potential for academic success by exposure to enrichment activities in science, engineering, and mathematics. Moreover, our program encourages these students to consider the importance of math and science in high school and promotes college as both a desirable and attainable goal through the participation of college student assistant role models.

PST1B07: 8–8:45 p.m. Opening up the Department: Day Camps and Workshops

Poster - Timothy T. Grove, Indiana University Purdue University Fort Wayne, Fort Wayne, IN 46805; grovet@ipfw.edu

Mark F. Masters, Indiana University Purdue University Fort Wayne

We present information regarding two LaserFest events that happened at our home university (IPFW). Over the past two summers (2010 and 2011) we have had a day camp for high school age students and in 2010 we had a workshop for high school teachers. The day camps had several purposes: to teach about lasers as well as providing "fun" activities featuring lasers. The workshop was designed to have the teachers learn more about lasers and light so that they can incorporate them into their classes. We will present information regarding the activities we developed.

PST1B08: 8:45–9:30 p.m. Physics Outreach in Canada: A University-Industry-Government Collaboration

Poster - Marina Milner-Bolotin, The University of British Columbia, Vancouver, Canada; marina.milner-bolotin@ubc.ca

Adriana Predoi-Cross, University of Lethbridge, Alberta
Li-Hong Xu, University of New Brunswick

Shohini Ghose, Wilfrid Laurier University
Roby Austin, St. Mary University, Nova Scotia

In Canada, education is part of a Provincial Mandate, thus every province has its own curricula in every school subject. All across the country, physical science is included as an important part of K-12 curricula. However, for the most part, elementary school teachers have very limited physical science knowledge. They are generalists and most of them have not taken physics beyond grade 11 and very few took introductory physics in college. This is especially troubling, since most of the students decide on their most and least favorite subjects in upper elementary school (grades 4-6). To combat this problem, the government, industry, and universities and colleges all across Canada have established a country-wide physics outreach effort. The poster will describe Canadian physics outreach activities in K-16 classrooms and their effectiveness.

PST1B09: 8–8:45 p.m. Conceptual vs. Numeric Problem Performance on the NY Regents Physics Exam

Poster - Luanna S. Gomez, SUNY Buffalo State College Physics, Buffalo, NY 14222; gomezls@buffalostate.edu

Dan L. MacIsaac, Kathleen A. Falconer, Joe L. Zawicki, SUNY Buffalo State

We review and discuss student performance ($1000 < N < 3000$) on selected items from the NYS Regents Physics standardized physics examinations offerings in the past five years. Student difficulty on conceptual items, traditional problem-solving exercises, and more challenging non-traditional problems are analyzed and compared.

Teacher Training/Enhancement

PST1C01: 8–8:45 p.m. Recruitment of High School STEM Teachers through the Robert Noyce Teacher Scholarship Program at Buffalo State College

Poster - Luanna S. Gomez, SUNY Buffalo State College Physics, Buffalo, NY 14222; gomezls@buffalostate.edu

Jane Cushman, Catherine Lange, Daniel MacIsaac, David Wilson

In January 2011, the National Science Foundation Robert Noyce Scholarship Program awarded up to $750,000 to the NSF-Noyce New Math and Science Teacher Partnership of Western New York at SUNY-Buffalo State College. The partnership builds on existing Science, Technology, Engineering and Mathematics (STEM) teacher preparation programs designed to address the shortage of math and physics teachers in New York's high needs schools by increasing the number of pre K-12 STEM teachers who are both certified and well-qualified. Noyce scholarships have been used to recruit and foster the development of new STEM teacher candidates through a variety of paths of entry into teaching. In return for receiving financial support, participants are committed to teach for two years in high needs districts for each year of scholarship support.

PST1C02: 8:45–9:30 p.m. Creating a Conceptual Understanding of the Wave Nature of Light

Poster - Andrew D. Boggs, Eastern Kentucky University, Richmond, KY 40475; andrew_boggs4@mymai.eku.edu

Jing Wang, Eastern Kentucky University

The Department of Physics and Astronomy at Eastern Kentucky University offers an inquiry physics course for middle and elementary pre-service teachers. This course uses procedures produced by Lillian C. McDermott and the Physics Education Group at the University of Washington, specifically the textbook *Physics by Inquiry*. Over the past decade, we have found it is particularly helpful to address some common misconceptions students hold at this level. We have adapted several units to fit the requirements of the Kentucky Core Content. One requirement at the middle school level is student understanding of the wave nature of light, which is not addressed by McDermott's textbook. Using techniques parallel to McDermott and her group's work we developed an inquiry unit for introducing this topic to pre-service teachers. In this unit, we are using affordable items to provide tools for future educators to present this material to their students.

PST1C03: 8–8:45 p.m. Examining High School Physics Teachers' Use of Resources

Poster - Matthew E. Hanselman, University of Northern Iowa, Cedar Falls, IA 50614-0150; bighans@uni.edu*

Lawrence T. Escalada, Jeffrey T. Morgan, and Emily M. Stumpff, University of Northern Iowa

The Iowa Physics Teacher Instruction and Resource (IPTIR) program is a three-year professional development program offered at the University of Northern Iowa. IPTIR's aim is to introduce physics teachers to a research-based inquiry style of teaching. In addition, teachers may use program credit to work toward a physics teaching endorsement. Two curriculum packages, Physics Resources and Instructional Strategies for Motivating Students (PRISMS) Plus [1] and Modeling Instruction[2], are used to teach both content and pedagogy. Participants are also given the opportunity to borrow computers and laboratory equipment, and are provided with additional resources that they can use to complement their teaching or to help analyze different aspects of student performance. We discuss the provided resources and the extent to which program participants utilized each and viewed its effectiveness.

*Sponsors: Lawrence Escalada and Jeffrey Morgan

1. http://www.uni.edu/prisms/
2. http://modeling.asu.edu/

PST1C04: 8:45–9:30 p.m. Using the RTOP to Gauge Implementation of IPTIR Program Goals

Poster - Jeremy B. Hulshizer, University of Northern Iowa, Cedar Falls, IA 50614-0150; jeremy.hulshizer@gmail.com*

Lawrence T. Escalada and Jeffrey T. Morgan, University of Northern Iowa

The Iowa Physics Teacher Instruction and Resources (IPTIR) program at the University of Northern Iowa trains physics teachers in research-based inquiry strategies; many out-of-field teachers also use the program to gain certification to teach physics. As part of their program activities, participants submit two video lessons each academic year, which the staff use to evaluate the degree to which participants are employing methods emphasized by the program. The Reformed Teaching Observation Protocol (1) is used to rate each submission. We discuss trends observed in examining the RTOP scores of program participants, as well as correlations between RTOP scores and student performance on various standardized conceptual assessments and other measures.

* Sponsor: Lawrence Escalada and Jeffrey Morgan.

1. 1. Sawada, Daiwo, et al. "Measuring Reform Practices in Science and Mathematics Classrooms: The Reformed Teaching Observation Protocol," *School Science and Mathematics* **102**(6), pp. 245-253.

PST1C05: 8–8:45 p.m. Content, Process, Affect, and Physics Courses for Future Teachers

Poster - Paul Hutchison, Grinnell College, Grinnell, IA 50112; hutchiso@grinnell.edu

A physics class must have some physics knowledge in it. This self-evident statement hides complexity worth examining. It is important to think about the role of physics knowledge and the role of students in relation to it. This study explores how different knowledge-student relationships interact with the multiple goals in physics courses aimed at pre-service elementary teachers, though the findings bear on any course for future teachers. I draw on analyses of existing curricula, scholarship from the science education and teacher education research communities, and data collected when I taught such courses. My study indicates different relationships between students and physics knowledge can create classroom environments that prize some goals over others. It's not clear this must necessarily be a zero-sum game, where the most important goal is identified and supported. I speculate how a physics course for teachers might be organized to simultaneously support multiple instructional goals.

PST1C06: 8:45–9:30 p.m. Science Education in Road Safety Education

Poster - Marisa Michelini, Research Unit in Physics Education, University of Udine, Italy; marisa.michelini@uniud.it

Alessandra Mossenta and Alberto Stefanel, University of Udine
Laura Tamburini, Friuli Venezia Giulia Regional Government, Italy

Physics in context fulfills the training and motivation task for a basic science education as a citizenship right. We therefore faced the challenge of designing curriculum materials for primary and junior high school teachers for an action-research project aimed at road safety education. Starting from motion and relative motions, with a conceptual grounding of the role of the frame of reference, trajectory and kinematics vectors, in a bi- and tri-dimensional space of the real environment, and its two-dimensional representation on a road map, we proposed an analysis of the safety distance, based on human reaction time and dynamic parameters of the motion on the road, such as momentum and sliding and rolling friction. Cameras and motion sensors, tape timer and paper and pencil games or trials on the track accompanied the planning of teachers, who through microsteps of experimentation proposed a more detailed analysis of the physics of collisions and the involved energy, of the rigid body motion and of the conservation of angular momentum. We proposed the curriculum and the teacher training model as an example of educational innovation development based on inquiry learning regarding physics in context, made possible by institutional collaboration.

PST1C07: 8–8:45 p.m. Investigative Science Learning Environment in the Pre-Service Teacher Science Classroom

Poster - Eric N. Rowley, Wright State University, Centerville, OH 45459; fizx_teacher@mac.com

Changes to the physics instruction for our pre-service middle level science teachers began in fall 2010. The core of these changes has been the Investigative Science Learning Environment (ISLE). This initial implementation of an ISLE-based curriculum provided an opportunity for qualitative investigation. Students were asked a complex question requiring multiple representations and higher order thinking on their end of the quarter exam. Approximately 75 student responses were analyzed for qualitative patterns. This poster will discuss the course, the question with student responses, and implications for further refinement of the use of ISLE in the pre-service teacher physics content courses.

PST1C08: 8:45–9:30 p.m. 2011 New Faculty Conference for Two-Year Colleges Physics Instructors

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

Todd Leif, Cloud County Communikty College

In March of 2011 Butler Community College hosted the New Faculty Conference for Two-Year College Physics Instructors. Twenty-nine new physics instructors attended the four day conference. This poster will present data on the the demographics of the participants, the content covered and the evaluation of conference.

PST1C09: 8–8:45 p.m. Streamline to Mastery Teacher-Driven Professional Development*

*Poster - Samson Sherman,** University of Colorado–Boulder, Boulder, CO 80309-0001; samson.sherman@colorado.edu*

Shelly Belleau, Susie Nicholson-Dykstra, Sara Severance, Emily Quinty

Streamline to Mastery is an NSF-funded learner-centered professional development program that seeks to capitalize on teachers' knowledge and experience to move newer physics teachers toward mastery. In this model, teacher participants choose their own goals and areas of growth and conduct research into their own teaching practices. Classroom research is conducted in close collaboration with pre-service teacher undergraduates, graduate researchers, and university faculty in a collaborative effort that benefits all partners in the pursuit of more effective and equitable K-12 physics education. Teachers will share their research findings, describe efforts to recruit and design professional development experiences for the next cohort of Streamline to Mastery teachers, and describe plans to scale this highly effective model of physics teacher education beyond the current funding structure.
*This research is partially funded by NSF grant #DUE 934921
**Sponsor: Valerie Otero

PST1C10: 8:45–9:30 p.m. Connecting Three Pivotal Concepts in K-12 Science State Standards and Maps of Conceptual Growth to Research in Physics Education

Poster - Chandralekha Singh, University of Pittsburgh, Pittsburgh, PA 15260; clsingh@pitt.edu

Christian Schunn, University of Pittsburgh

We discuss three conceptual areas in physics that are particularly important targets for educational interventions in K-12 science. These conceptual areas are force and motion, conservation of energy, and geometrical optics, which were prominent in the U.S. national and four state standards that we examined. The four state standards that were analyzed to explore the extent to which the K-12 science standards differ in different states were selected to include states in different geographic regions and of different sizes. The three conceptual areas that were common to all the four state standards are conceptual building blocks for other science concepts covered in the K-12 curriculum. We discuss the nature of difficulties in these areas along with pointers toward approaches that have met with some success in each conceptual area.

PST1C11: 8–8:45 p.m. Comparing Conceptual Understanding of Physics Teachers and Students

Poster - Emily M. Stumpff, University of Northern Iowa, Cedar Falls, IA 50614-0150; stumpffe@uni.edu*

Lawerence T. Escalada, Jeffrey T. Morgan, and Matthew E. Hanselman, University of Northern Iowa

The University of Northern Iowa's IPTIR (Iowa Physics Teacher Instruction and Resources) program introduces high school physics teachers, most of whom are out-of-field, to inquiry-based approaches to physics teaching. Numerous activities help develop participants' skills and track their progress in learning the content and the pedagogy emphasized in this program. All participants and their students complete various conceptual exams as pre-tests and post-tests. Three tests common to both populations are the Force Concept Inventory (1), the Test of Understanding Graphs - Kinematics (2), and the Classroom Test of Scientific Reasoning (3). Because instructors as well as their students take these exams, we can compare the raw scores and gains of the instructor during summer workshops and the raw scores and gains of their pupils during the academic year. We present the relationships between the knowledge of the teacher, as measured by these tests, and the learning gains of their students.
* Sponsor: Lawerence Escalada and Jeffrey Morgan.
1. D. Hestenes, M. Wells, and G. Swackhammer, Gregg, "Force concept inventory," *Phys. Teach.* **30**(3), pp. 141-158.
2. R. Beichner, "Testing student interpretation of kinematics graphs," *Am. J. Phys.* **62**(8), pp. 750-762.
3. A. Lawson, "The development and validation of a classroom test of formal reasoning," *J.of Research in Sci. Teach.* **15**(1), pp. 11-24.

PST1C12: 8:45–9:30 p.m. From Learning Assistant to Physics Teacher: Perspectives from Minority Students

Poster - Leanne M. Wells, Florida International University, Miami, FL 33173; lwells@fiu.edu

David Jones, Florida International University

Florida International University confers more bachelor and master degrees on Hispanic students than any other university in the country. It is also the main source of high school teachers for the country's fourth and sixth

largest school districts. For the first time in a decade, FIU will graduate physics teachers who have discipline-specific pedagogical training and field experiences. We explore the impact of FIU's Learning Assistant (LA) program, transformation of the science education program, Introductory Physics course reform, and Teacher-in-Residence presence on student views on studying science, attitudes toward teaching and learning, and the evolution of career choices. This presentation will focus on: (1) what LAs from underrepresented groups bring to the table when studying physics and start to think about teaching as a career and (2) how these students view and use the programs and support structures as they pass through the program and as they begin teaching.

PST1C13: 8–8:45 p.m. The Characteristics of a Thriving Secondary Physics Teacher Education Program

Poster - Courtney W. Willis, University of Northern Colorado, Greeley, CO 80631; courtney.willis@unco.edu

Cynthia Galovich, Matthew R. Semak, and Richard D. Dietz, University of Northern Colorado

The physics department of the University of Northern Colorado (UNC) typically graduates two to four secondary physics teachers each year. Since 2005 the UNC physics department has graduated 16 physics majors who have become teachers, and at present we have eight additional undergraduates who are planning on secondary teaching as a career. These are rather high numbers for any size university. Most universities have difficulties attracting physics majors into secondary teaching, which has led to the national shortage of qualified physics teachers. The exceptional productivity of our bachelor's-only program has been recognized by the American Institute of Physics. We examine possible causes for our success from the perspectives of both our faculty and our graduates.

Labs/Apparatus

PST1D01: 8–8:45 p.m. The Double Compound Pendulum

Poster - Joel C. Berlinghieri, The Citadel, Charleston, SC 29409; berlinghieri@citadel.edu

Erik T. Pratt and Erik Rooman, The Citadel

The double compound pendulum consists of two arms usually of uniform mass per unit length. The upper arm is attached to a rigid pivot by a frictionless bearing. One end of the lower arm is attached to the bottom end of the upper arm by a frictionless bearing. The bearings in our case are PASCO rotation sensors with the lower sensor using a Bluetooth wireless connection. DataStudio is used to record the initial angles and angular velocities and the subsequent angles, angular velocities, and angular accelerations of both arms. The motion of the arms is very sensitive to the initial conditions and is often chaotic. There are ranges of initial settings in which the lower arm will eventually flip over the top of its pivot. The motion is compared to models through numerical solutions. This experiment* is performed as part of the junior-level classical mechanics and numerical methods courses.

* Joel C. Berlinghieri, *Physics Laboratory Manual for Scientists and Engineers,* Tavenner Publishing Co., 2011, ISBN 978-1-930208-35-3

PST1D02: 8:45–9:30 p.m. Watching and Listening to the Coefficient of Restitution

Poster - 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. Students learning physics through video analysis projects show better data interpretation skills and gain deeper understanding on certain topics.[1,2] Most studies of video analysis have been focused on projects for introductory-level physics concepts. The benefit of using video analysis in upper-level physics courses is often neglected. To fill this gap, we used video analysis techniques to measure the coefficient of restitution of a ball. The results obtained compared favorably with more standard techniques, with the advantage of immediate visualization.

1. R 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).

PST1D03: 8–8:45 p.m. A Hands-On Introduction to Quantum Mechanics for Sophomore Physics Majors*

Poster - David P. Jackson, Dickinson College, Carlisle, PA 17013; jacksond@dickinson.edu

Brett J. Pearson, Dickinson College

The Physics Department at Dickinson College has re-designed its curriculum for physics majors to take advantage of recently developed single-photon experiments in quantum mechanics.* The ultimate goal is to bring students face to face with some of the fascinating and subtle features of quantum mechanics in a hands-on setting. This is mainly accomplished in a sophomore-level course titled "Introduction to Relativistic and Quantum Physics." Experiments include the behavior of a photon at a beam splitter--it "must" go one way or the other—and the behavior of a photon at a Mach-Zehnder Interferometer—it "must" go both ways. This poster will describe our curriculum changes and discuss some of the successes and difficulties we have experienced.

*This work was supported by NSF grant DUE-0737230.

PST1D04: 8:45–9:30 p.m. Wind Power Experiments Using an Electric Leaf Blower

Poster - Stephen Luzader, 59 Centennial St., Frostburg, MD 21532; sluzader@frostburg.edu

Hang Deng-Luzader and Samuel Akyea, Frostburg State University

Some simple experiments demonstrating basic principles of wind turbine operation can be carried out using an electric leaf blower in vacuum configuration as a wind source. A small DC hobby motor fitted with a model airplane propeller or a small fan blade serves as the generator, which is placed in front of the air intake of the leaf blower. The equipment required for quantitative experiments include a resistance box and voltmeter, some means of controlling the air speed, and an instrument to measure the air speed. Most departments will have resistors and voltmeters and probably a Variac for controlling the blower speed. The only special piece of equipment we purchased was a hot-wire anemometer to measure wind speed. Experiments suitable for a wide range of students will be described.

PST1D05: 8–8:45 p.m. A Systematic Error in a Boyle's Law Experiment

Poster - Richard P. McCall, St. Louis College of Pharmacy, St. Louis, MO 63110; rmccall@stlcop.edu

Systematic errors can cause measurements to deviate from the actual value of the quantity being measured. Using a meterstick that is not marked off correctly, using a balance to measure mass that has not been properly zeroed, or misinterpreting the range of a voltmeter are all examples. A simple Boyle's law experiment seeks to show that the pressure of a gas multiplied by its volume is a constant. A first attempt results in an experimental difference of about 5%. However, when the proper volume is taken into account, the difference reduces to about 1%. A discussion of how to measure the correct volume by indirect methods is presented.

PST1D06: 8:45–9:30 p.m. Spring, String, and Inclined Plane: A Lab on Newton's Laws

Poster - Carl E. Mungan, United States Naval Academy, Annapolis, MD 21402-1363; mungan@usna.edu

Students in an introductory physics course are typically presented with homework problems and lab work that separately involve strings (e.g. an Atwood's machine), inclined planes (e.g. conversion of gravitational to kinetic energy), and springs (e.g. oscillations of a mass hanging from a spring). But to fully develop student understanding of Newton's laws, it is important to combine elements to build up more complex situations. To this end, I propose tying together two blocks on an inclined plane and then attaching the upper block to a spring whose other end is fixed. Students can first be challenged to draw relevant free-body diagrams, initially ignoring drag. Next, if this setup is assembled in lab, even using low-friction motion carts instead of blocks, it is immediately observed that damping cannot be neglected. However, simple speed-independent friction fits the measurements well, so that analysis of the situation remains within student capabilities.

PST1D07: 8–8:45 p.m. You Can Build a Scanning Tunneling Microscope for Your Classroom!

Poster - Mark W. Plano Clark, Doane College, Crete, NE 68333; mark.planoclark@doane.edu

Paul Garcia, Doane College*
Axel Enders, University of Nebraska - Lincoln

Two years ago the authors proposed to produce a low-cost room-temperature atmospheric-pressure scanning tunneling microscope (STM) with atomic resolution -- to be accessible to high school and college teaching labs. Project costs are currently less than $200. The techniques to produce the STM require access to a basic machine shop and materials, and some skill in producing low-voltage (<20 V) amplifiers to drive the piezos. Each of the components make great student projects. Flat piezoceramic sheets are cut and then formed into rectangular structures to provide the x, y, and z scanning motions. We are using the open-source Gnome X Scanning Microscopy (GXSM) software and a commercial digital signal processing board but hope to produce a much cheaper digital signal processing board to further lower the cost.

*Paul Garcia is currently an engineering student at Washington University, St. Louis.

PST1D08: 8:45–9:30 p.m. Hubbert Peak and Radioactive Decay Activities Using Dice

Poster - Mark E. Rupright, Birmingham-Southern College, Birmingham, AL 35254; mruprigh@bsc.edu

Tyler Dart, Birmingham-Southern College

We will outline two laboratory activities for an introductory "Energy and the Environment" course that use dice to model random behavior. In the first, we model the growth, peak, and decline in production of a resource to produce a Hubbert-type curve. In the second, we relate the random decay of individual nuclei to the exponential decay of a radioactive sample. We also show how to extend the latter activity to more complex cases in which parent/daughter isotopes have different decay rates.

PST1D09: 8–8:45 p.m. Development, Implementation, and Assessment of Ultrasound Physics Laboratory

Poster - Karen A. Williams, East Central University, Ada OK 74820; kwillims@mac.com

This poster will explain how an advanced laboratory, PHYS 3611 Ultrasound Physics, was developed, implemented, and assessed at ECU. Details about each laboratory exercise will be shown. The course was created to provide more laboratory experience for our medical physics majors in response to surveys done to assess the physics major. To my surprise, the course as taught so far seems to be populated by students in medical physics, physical therapy, and premedical students. This might be a lab that would attract students in your program as well. Several students have been so interested in the ultrasound lab that they have gone one step further and done research projects in the field.

PST1D10: 8:45–9:30 p.m. What Is the Relevance of Physics Education Research to the Advanced Lab?

Poster - Benjamin M. Zwickl, University of Colorado–Boulder, Boulder, CO 80309; benjamin.zwickl@colorado.edu

Noah D. Finkelstein and Heather J. Lewandowski, University of Colorado

The University of Colorado–Boulder is in the early stages of a 2.5-year research-based redesign of our upper-division physics lab courses. There has been a nationwide resurgence of interest in advanced physics labs among instructors and faculty, but the PER community to date has focused on introductory and lecture-format classes. Little research has been conducted on these uniquely sophisticated and resource-rich learning environments in terms of goals, measurements of learning, and outcomes of modification. We are applying the existing research-base and methods of PER as a tool to make our labs better with the dual purpose of finding generalizable lessons about effective instruction in advanced lab courses. We will report preliminary outcomes that include our process of modification, learning goals, assessment frameworks, and a revised lab example.

Upper Division and Graduate

PST1E01: 8–8:45 p.m. Mentoring Graduate Students at a Hispanic Serving Institution

Poster - Eric Brewe, Florida International University, Miami, FL 33199; eric.brewe@fiu.edu

Laird H. Kramer and Renee Michelle Goertzen, Florida International Univ.

This poster describes the approaches we have taken to building a community of graduate students in Physics Education Research at Florida International University. Building a research group in the context of a Hispanic Serving Institution has unique features including an imperative to consider inclusive models of education. The current group of students includes students from the physics department and the College of Education. The primary approach to mentoring these students from diverse backgrounds has been to establish a learning community. We describe efforts toward building the learning community.

PST1E02: 8:45–9:30 p.m. Temperature Changes in Food: An Upper-Level Project

Poster - Michael Burns-Kaurin, Spelman College, Atlanta, GA 30314; mburns-k@spelman.edu

In the Advanced Experiments, Theory, and Modeling capstone course for physics majors at Spelman College, students work on projects that bring together principles and techniques from the intermediate-level theory and laboratory courses. In one of these projects, students measure the temperature change of a piece of food as a function of time and position as they heat or cool the food. They also work through the theory of the heat equation by looking at successively more complex situations to arrive at the full heat equation, solve the equation analytically, and create a computer simulation with parameters chosen to describe their data.

PST1E03: 8–8:45 p.m. Socratic Dialogs and Clicker Use in Upper-Division Mechanics Courses

Poster - Lincoln D. Carr, Colorado School of Mines, Golden, CO 80401; lcarr@mines.edu

Vincent H. Kuo, Patrick B. Kohl, Colorado School of Mines
Noah Finkelstein, University of Colorado–Boulder

The general problem of effectively using interactive engagement in non-introductory physics courses remains open. We present a three-year study comparing different approaches to lecturing in an intermediate mechanics course at the Colorado School of Mines. In the first two years, the lectures were modified to include Socratic dialogs between the instructor and students. In the third year, the instructor used clickers and Peer Instruction. All other course materials were nearly identical to an established traditional lecture course. We present results from exams, course evaluations, the CLASS attitude survey, and a new conceptual survey. We observe little change in student exam performance as lecture techniques varied, though students consistently stated clickers were "the best part of the course" from which they "learned the most." Indeed, when using clickers in this course, students were considerably more likely to become engaged than students in CSM introductory courses using the same methods.

PST1E04: 8:45–9:30 p.m. Teaching Creativity and Innovation to Physicists Using Tablet PCs

Poster - Patrick B. Kohl, Colorado School of Mines, Golden, CO 80401; pkohl@mines.edu

Vincent H. Kuo, Frank Kowalski, and Susan Kowalksi, Colorado School of Mines

As the rest of the world catches up to the U.S. in industrial output and technological sophistication, our continued economic prosperity will depend on strengthening our historical success in generating new ideas. While there are limited efforts to foster creativity and innovation through formal and informal instruction in the business world, few efforts exist in science or engineering education. To address this, the Colorado School of Mines has recently created a dedicated Tablet PC classroom where we hold an elective physics course for the purpose of improving creativity in our students. In this poster, we report on the structure of the course and the technologies used. The latter include pedagogical implementations of Ink-Survey, a free web-based software package that enables detailed, real-time interactions with the instructor. We assess student progress via the Torrance Test of Creative Thinking, and discuss early work towards developing a physics-specific instrument for measuring creativity.

PST1E05: 8–8:45 p.m. Stages of Participation as Stages of Expertise

Poster - Idaykis Rodriguez, Florida International University, Miami, FL 33199; irodr020@fiu.edu

Eric Brewe and Laird H. Kramer, Florida International University

Expertise research in physics has focused heavily on differences between experts and novices. In an effort to extend the scope of expertise research, we are engaged in an ongoing study of the development of expertise in a physics research group.[1] To capture the features of the development of expertise in physics, we present an ethnographic, qualitative study within a physics research group. We utilize video recordings of the physics research group's weekly research meeting and guided interviews with each of eight participants in the group. These data are analyzed using Lave and Wenger's[2] perspective of learning as legitimate peripheral participation within a community of practice. We present data from this study to characterize stages of expertise and posit a trajectory novices take toward expertise.

1. Supported by NSF Award # PHY-0802184
2. J. Lave and E. Wegner, *Situated learning: Legitimate peripheral participation*, New York. Cambridge University Press (1991).

PST1E06: 8:45–9:30 p.m. The Third Semester – Advantages of a Dedicated Waves/Fourier Course

Poster - David H Kaplan, Southern Illinois University Edwardsville, Edwardsville, IL 62026;dkaplan@siue.edu

Keeping physics majors is a national priority today. Yet, many are currently lost in a transition for which they are not adequately prepared - that from first-year physics, for which the main mathematical and physical prerequisites are well defined, to modern physics and other intermediate and upper-division courses in which students are expected, with rapid on-the-fly "coverage," to quickly become proficient with properties of wave equations, wave superposition, concepts of Fourier analysis, Fourier integrals, the bandwidth theorem and more. All too often, the result has been memorization, frustration and exodus. The introduction of a third-semester dedicated course on waves and Fourier analysis as a prelude to modern physics and quantum mechanics helps in this. In this presentation we describe some of the distinct advantages of such a course for retention of physics majors and aspects of the curriculum for such a course that we have developed.

Physics Education Research

PST1F01: 8–8:45 p.m. Determining the Accuracy of an Ultrasonic Motion Detector Velocity Calculation

Poster - Dan Beeker, Indiana University, Bloomington, IN 47408; debeeker@indiana.edu

Alexei Krainev, Indiana University

Although the ultrasonic motion detector is ubiquitous in the first year physics labs, only rarely is the accuracy of this device examined. A simple method for determining the accuracy of motion detector velocity calculations using photogates and a Mindstorm robot is demonstrated. In addition to providing a simple way to determine the accuracy of an important parameter, the Mindstorm robot introduces a very high "play factor" to the activity.

PST1F02: 8:45–9:30 p.m. Correlation Between Students' Performance on Free-Response and Multiple-Choice Questions

Poster - ShihYin Lin, University of Pittsburgh, Pittsburgh, PA 15260; hellosilpn@gmail.com

Chandralekha Singh, University of Pittsburgh

When it comes to assessing students' learning in physics, there is always concern about the format of the assessment tool. While a multiple-choice test provides an efficient tool for assessment because it is easy to grade, some instructors are concerned that a free-response format facilitates a more accurate understanding of students' thought processes. In addition, free-response questions allow students to get partial credit for displaying different extent of understanding of the subject tested. Here, we discuss a study in which two carefully designed research-based multiple-choice questions were transformed into free-response format and implemented on an exam in a calculus-based introductory physics course. Students' performance on the free-response questions was graded twice, first by using a rubric, and second by converting the answers back to one of the choices in the original multiple-choice format (which was not provided to the students). We found that there was an excellent match between the different free-response answers and the original choices in the multiple-choice questions. The strong correlation between the two scores graded using different methods suggests that carefully designed multiple-choice assessments can mirror the relative performance on the free-response questions while maintaining the benefits of grading and ease of quantitative analysis. This work was supported by NSF.

PST1F03: 8–8:45 p.m. Using Analogical Problem Solving to Learn about Friction

Poster - ShihYin Lin, University of Pittsburgh, Pittsburgh, PA 15260; hellosilpn@gmail.com

Chandralekha Singh, University of Pittsburgh

Research suggests many students have the notion that the magnitude of the static frictional force is always equal to its maximum value. In this study, we examine introductory students' ability to learn from analogical problem solving between two problems that are similar in the application of physics principle (Newton's second law) but one problem involves friction which often triggers the misleading notion. Students from algebra- and calculus-based introductory physics courses were asked in a quiz to take advantage of what they learned from a solved problem provided, which was about tension in a rope, to solve another problem involving friction. To help students process through the analogy deeply and contemplate the applicability of associating the frictional force with its maximum value, students in different recitation classrooms received different scaffolding. We will discuss the types of scaffolding support that were effective in helping students learn these concepts. Supported by NSF.

PST1F04: 8:45–9:30 p.m. Uniform Circular Motion Lab Apparatus with Persistence of Vision Display

Poster - Zengqiang Liu, St. Cloud State University, St. Cloud, MN 56301; zliu@stcloudstate.edu

Jing Chen, ShunJie Yong, and Steve Zinsli, St. Cloud State University

In uniform circular motion, if angular speed doubles then centripetal acceleration quadruples. A physics lab apparatus and demonstration has been constructed to demonstrate and accurately prove the above relation in an elegant and creative way. The apparatus measures angular speed and centripetal acceleration simultaneously and reports the results using a persistence of vision (POV) display. A POV display eliminates the need for wireless communication or complicated mechanical contacts between the rotating apparatus and a data collection system. Hall Effect switches are used to sense angular speed while an accelerometer is used to sense acceleration. The POV display is constructed with light-emitting diodes. The entire system is controlled by an Arduino microcontroller. Detailed measurements with the apparatus proved its accuracy. The POV display appealed to lots of younger children when it was presented at various campus activities, making it a point of attraction for future physics public outreach activities.

PST1F05: 8–8:45 p.m. Gender Matters: The Gender Gap at the University of Michigan

Poster - Kate E Miller, University of Michigan, Ann Arbor, MI 48104; katemi@umich.edu

Timothy McKay, University of Michigan

While we expect that some background factors, such as prior test scores and academic preparation, should influence student success, we are concerned about inappropriate impact of uncontrollable factors, such as gender, socio-economic status, and race. In particular, there is a nationally recognized gender disparity in introductory physics performance. We describe analysis of data for 48,579 students who have taken introductory physics at the University of Michigan over 14 years. We clearly detect the presence and persistence of a gendered performance gap in all courses and in all terms considered. We find that differing mathematical preparation as reflected in SAT Math scores accounts for some of this gender gap, especially in the female dominated life science sequence. The physical science and engineering sequence, which is substantially male dominated, shows a strong gender difference even after differing mathematical preparation is accounted for.

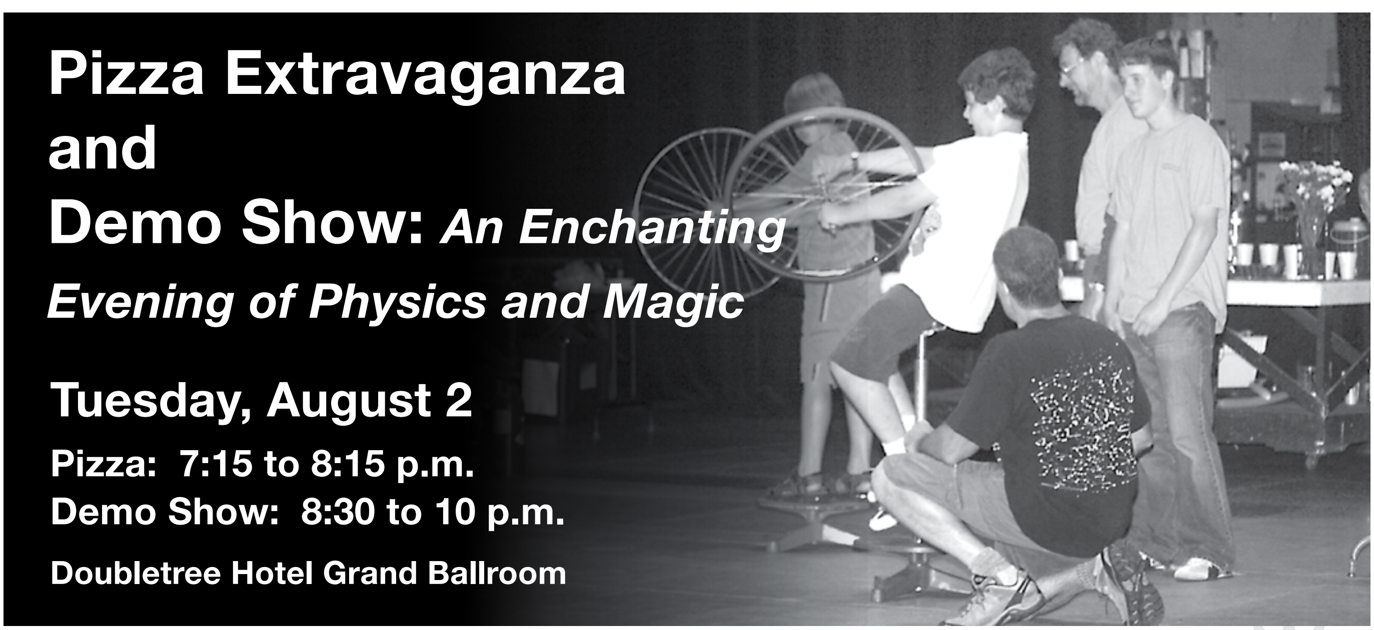
PST1F06: 8:45–9:30 p.m. Using Low-friction Carts to Measure Viscosity*

Poster - Mark E. Reeves, George Washington University, Washington, DC 20052; eevesme@gwu.edu

Deepa Raghu, George Washington University

The subject of continuum mechanics is often avoided in the IPLS class, as is a meaningful discussion of nonconservative forces. This is unfortunate since viscosity is essential to understanding the physical aspects of cellular motion and heart disease. I will describe a lab in which students determine viscosity from measurements of the velocity vs. time for metal balls dropped in liquids of various viscosities from air to glycerin, and measure kinematics of the balls falling under the influence of gravity. The balls pull low-friction carts, which allows for a very small driving force and also to measure the position and velocity of the ball continuously. The students observe a variety of behaviors ranging from free fall to reaching terminal velocity. Students measure the position of the cart by an ultrasonic transducer or a photogated pulley, as the weight pulls it down the track. There are a number of non-ideal experimental aspects such as viscous drag on the string and the short drop that doesn't allow attainment of terminal velocity in less viscous liquids. These allow the students to think more deeply about the physics of realistic conditions and make use of Taylor series for their data analysis, should this be desired.

* This research is supported by the NSF/CCLI program. More information can be found at http://www.phys.gwu.edu/iplswiki/index.php/Laboratories



Tuesday, August 2

AAPT Fun Run/Walk	6:30–7:30 a.m.	13th and Douglas
Millikan Medal	10:30 a.m.	HC Auditorium
Exhibit Hall	10 a.m.–4 p.m.	HC Ballroom
Pizza and Demo Show	7:15 p.m.	Doubletree

Session DA: Interactive Lecture Demonstrations: Physics Suite Materials that Enhance Learning in Lecture

Location: Harper Center 3027
Sponsor: Educational Technologies Committee
Co-Sponsor: Research in Physics Education Committee
Date: Tuesday, August 2
Time: 8:30–9:40 a.m.

Presider: Priscilla Laws

DA01: 8:30–9 a.m. Interactive Lecture Demonstrations: Active Learning in Lecture

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 and Interactive Lecture Demonstrations (ILDs).[2] The demonstrations will be drawn from second semester topics.

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).

DA02: 9–9:30 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 in teaching physics concepts has been studied using physics education research-based, multiple-choice conceptual evaluations.[1] Results of such studies will be presented. These results should be encouraging to those who wish to improve conceptual learning in lecture.

1. D. R. Sokoloff and R. K. Thornton, "Using interactive lecture demonstrations to create an active learning environment," *Phys. Teach.* **35**, 340 (1997).

DA03: 9:30–9:40 a.m. Circular Motions

Cheng Ting, Houston Community College, Southeast, Houston, TX 77087; cheng.ting@hccs.edu

Camcorders can help students to observe simple circular motions of a bicycle wheel and a simple pendulum. Video analysis will be used to study the circular motions, and allow students to build up concepts of vectors involved in the kinematics of circular motions, such as angular velocity and angular momentum. How to build the mathematical formula for students based on their observation will be discussed.

Session DB: Adjunct Faculty Issues

Location: Harper Center 3028
Sponsor: Physics in Two-Year Colleges Committee
Date: Tuesday, August 2
Time: 8:30–10 a.m.

Presider: Dennis Gilbert

The widespread use of part-time physics positions in community colleges raises important concerns about the quality of life and community in the physics teaching profession, the sustainability and pace of innovation, consequences beyond the physics curriculum, the use of economic considerations to drive an over-use of part-time positions, the necessary and appropriate use of part-time positions, integrating and supporting adjunct colleagues, and the resources and allies of the physics community to reach optimum permanent/adjunct staffing levels. The goal of this session will be raising awareness and the level of discussion on these concerns.

DB01: 8:30–9 a.m. Use of Contingent Faculty and the Effect on Student Success

Invited - Vann Priest, Rio Hondo College, Whittier, CA 90601; vpriest@riohondo.edu

On average, contingent (part-time) faculty teach nearly half of the courses at community colleges. The effect of this on student retention, success, and graduation rates is either assumed to be negative or remains unknown to most faculty and college officials. In this presentation, I will review the latest research on the effects that extensive use of part-time faculty has on student success, retention, transfer rates, and graduation rates.

DB02: 9–9:30 a.m. Part-Time Faculty, Student Success, and Public Policy

Invited - Rep. Michael E. Dembrow, Oregon Legislature, Portland, OR 97212; michaeldembrow@gmail.com

This talk will review significant public policy issues regarding the over-use of part-time positions generally and in physics in particular in higher education. Along with the negative effects on individual faculty and on departments, these include a number of negative impacts on students: on retention and degree completion, on efforts to prepare students for success in meeting STEM education goals, and on initiatives to move college physics pedagogy in a more student-focused direction. Finally, the talk will review and explore legislative approaches to this growing problem.

DB03: 9:30–10 a.m. Structural Consequences of the Over Use of Part-Time Positions

Invited - Maria Knudtson, University of Nebraska at Omaha

The widespread use of part-time positions has serious structural implications for faculty, departments, and the overall health of higher education. The discussion will cover several broad issues including the effects on faculty infrastructure, equity, academic democracy, and academic freedom, as well as model approaches for correcting dependence on contingent faculty. The pervasiveness of part-time positions provides physics faculty members with allies in addressing this issue as well as promising approaches based on the broad and diverse faculty experience.

Session DC: Digital Textbooks: Possibilities and Perils

Location: Harper Center 3029
Sponsor: Educational Technologies Committee
Date: Tuesday, August 2
Time: 8:30–9:30 a.m.

Presider: Harold Stokes

The use of digital textbooks is on the rise. How will publishers react to these changes? What advantages and disadvantages do digital textbooks give students and instructors? How will this change the way we teach physics?

DC01: 8:30–9 a.m. Why Not Make Physics Textbooks Free?

Invited - Justin B. Peatross, Brigham Young University, Provo, UT 84602; peat@byu.edu

Michael J. Ware, Brigham Young University

We have authored an upper-division optics textbook that is freely available at www.optics.byu.edu. We call on physicists everywhere to join the Internet age and share their knowledge without charge. Electronic tools make it easy to produce and distribute a professional product. The small royalty from traditional publishing comes with a huge overhead that makes your work pricy for students. Why not forego it?

*Sponsor: Harold Stokes

DC02: 9–9:30 a.m. The Future of the Introductory Physics Textbook

Invited - Stuart Johnson, John Wiley & Sons, Inc., 111 River St., Hoboken, NJ 07030; sjohnson@wiley.com

The format of today's introductory physics textbook has been in place for over 100 years, but there are many indications that this format may be approaching the end of its useful life. This paper will explore the reasons why change is imminent and what the next generation of "textbooks" might look like.

Session DD: Astronomical Image Processing

Location: Skutt Student Center Ballroom DE
Sponsor: Space Science and Astronomy Committee
Date: Tuesday, August 2
Time: 8:30–10 a.m.

Presider: David Klassen

In this session we will share ideas and techniques on processing and using astronomical images both in the classroom and for community outreach. Topics range from best practices for creating images, through how to process images to make good display pieces, all the way to making them usable for scientific study. The session will focus on digital images and manipulation using a variety of software packages.

DD01: 8:30–9 a.m. Observational Astronomy: Adverse Conditions and Teachable Moments

Invited - Eddie J. Guerra, Rowan University, Glassboro, NJ 08028; guerra@rowan.edu

This presentation describes the efforts to operate an observatory atop a science building, on the suburban Rowan University campus, in the northeastern portion of the country. An outline of adverse conditions arising due to the placement of the observatory will be presented. Imaging techniques and strategies to mitigate these conditions will be presented. A gallery of images produced by college students will be displayed. The Rowan University course "Observational Astronomy" will be detailed, including its audience of both science and non-science majors. Also, the prospects for research in photometry and outreach to high schools at this and similar sites will be discussed.

DD02: 9–9:30 a.m. Chandra X-ray Astronomy Data Analysis in Educational Settings

Invited - Terry A. Matilsky, Rutgers University, Piscataway, NJ 08854; matilsky@physics.rutgers.edu

How can we provide an authentic research experience to students who want to find out what science is REALLY about? We couple DS9 imaging software, a user-friendly, fun-to-explore environment with a "virtual observatory" that allows analysis to be done remotely on UNIX-based computers, regardless of the platform employed by the user. All of NASA's archived satellite observations can be accessed by any interested student. Furthermore, by adapting VNC (Virtual Network Computer) software, we can enhance this flexibility enormously and allow instructors to view, comment on, and debug any analysis task in real-time, from anywhere in the world, and across all computing platforms. This makes these programs especially useful in distance learning environments.

DD03: 9:30–9:40 a.m. An Undergraduate Astronomy Research Class at the High School Level

Eric G. Hintz, Brigham Young University, Provo, UT 84602; doctor@tardis.byu.edu

Heather P. Jones, Mt. San Antonio College

For over 10 years now we have taught an observational astronomy class at an advanced undergraduate level. This class teaches the methods of data acquisition, data processing, data analysis, and writing for publication, using optical data obtained on a CCD camera. The class is designed around teaching students the skills used for professional astronomical research, including the use of the IRAF reduction package developed at NOAO. The question then arises, can we train a younger group of students to perform full astronomical reductions? Over the last year we have begun development of a workshop for local high school teachers, or teachers from small colleges, to give them the tools to fully reduce astronomical data. We also had a local high school student come to us as an intern. He became our first test subject. We will report on our experiences.

DD04: 9:40–9:50 a.m. Using Science Images to Make Pretty Pictures for the Classroom*

*Michael D. Joner,** Brigham Young University, Provo, UT 84602; jonerm@forty-two.byu.edu*

Robert Gendler and David Laney, Brigham Young University

We have demonstrated that research images from the BYU West Mountain Observatory can often be combined to produce images that are suitable for classroom use. This process can usually be completed with little or no effort being made to secure additional image data after the completion of a research project. Results will be shown for images processed from frames obtained for science investigations and compared with images where the data were obtained specifically to produce an instructional image. We also present two amimations where the data frames are from nightly monitoring projects. Images can be previewed at the website in the abstract footnote.

*WMO Image Gallery - http://wmo.byu.edu/gallery/
**Sponsor: Eric G. Hintz

DD05: 9:50–10 a.m. MircoObservatory Image: Astronomical Image Processing for the Public (free software)

Patricia A. Sievert, Northern Illinois University, DeKalb, IL 60115; psievert@niu.edu

We teach families to use the free software, MicroObservatory Image, to process images that they request online from NASA's MicroObservatory.* The software is freely available online and the learning curve is relatively easy, making it an ideal introduction to astronomical image processing for outreach. I'll present a quick overview of the program's features and locations for additional resources.

* www.niu.edu/stem

Session DE: The Big Bang Effect: Representation of Physicists in Popular Culture

Location: Skutt Student Center Ballroom ABC
Sponsor: Women in Physics Committee
Co-Sponsor: Physics in Pre-High School Education
Date: Tuesday, August 2
Time: 8:30–10:10 a.m.

Presider: Jacob Clark Blickenstaff

While physicists are rarely portrayed in popular TV shows or movies, The Big Bang Theory has been on CBS for four seasons and even won an Emmy in 2010. How does the representation of physicists in this show compare to real working scientists? How do media representations encourage or discourage interest in physics (or physics teaching) as a career?

DE01: 8:30–9 a.m. Evil Geniuses: The Portrayal of Scientists as Villains

Invited - Rebecca C. Thompson, American Physical Society, College Park, MD 20740; thompson@aps.org

From Doctor Octopus from Spiderman to Maggie Walsh of Buffy the Vampire Slayer season 4, scientists are often portrayed as evil geniuses intent on using their high IQs to take over the world. Does this affect how the public views scientists? Science in general and physics specifically is so often thought of as "scary." Misconceptions about talking robots and world eating black holes can turn people against physics and the "evil genius" scientists that will destroy the world, either by accident or on purpose.

DE02: 9–9:30 a.m. Speaking of Physics: The Art of Science Communication

Invited - Stephanie V. Chasteen, University of Colorado–Boulder, Boulder, CO 80309; stephanie.chasteen@colorado.edu

Why leave it up to the "experts" (i.e., the media) to portray physics accurately and positively? Speak for yourself, without the need for a translator who may "or may not" get it right. As a scientist, you can talk about what your work means and why it's important with an authority that a science writer doesn't bring to the table. While we can't all be Brian Greene, you can have control over how your work, and physics in general, is presented to the public. In this talk, I'll share some best practices of science communication, gleaned during my time as a science reporter at NPR and elsewhere.* These simple tips can take a lifetime to master, but can help you get your message across, to the public, the media, and even Aunt Mabel.

* See Dr. Chasteen's popular publications and podcasts at http://sciencegeekgirl.com/publications.html. More tips on communication at http://communicatingscience.aaas.org.

DE03: 9:30–10 a.m. The Big Bang Theory Effect Conjecture

Invited - Jacob Clark Blickenstaff, 505 Court St., Hattiesburg, MS 39401; Jclarkblickenstaff@gmail.com

It could be argued that physics and physicists have not had such popular exemplars as Sheldon and Leonard (the main characters on CBS' "Big Bang Theory") since the death of Albert Einstein. Dr. David Salzberg consults on the physics shown on white boards in the show so that material is trustworthy. But how "true" is the representation of physics and physicists that Sheldon and Leonard present to the general public on television every week? How about the female scientists who show up in recurring (though generally not starring) roles? Does it really matter if a TV comedy re-enforces stereotypes about science and scientists? What effect could this show have on students? Interest in learning physics in high school or college? As a physics educator I am concerned that this show and others like it will exacerbate the trend of undergraduates moving away from the physics major.

DE04: 10–10:10 a.m. 'Physicists and Scientists' on TV....Is THAT Really US?

Karen A. Williams, East Central University, Ada, OK 74820; kwillims@mac.com

Most of us have watched the "Big Bang Theory" on television and thought at times, this reminds me of Dr. X or Dr. Y. Other scenes make us think that isn't true of physicists we know….or is it? Are these depictions characteristic of us? Greater discussion of physics and science from my students seems to come from "Mythbusters" and some other science shows on television now hosted by real physicists. How do TV shows portray scientists? This will examine how various groups (physics majors, nonmajors, etc.) perceive physics/science (i.e. the endeavor) based upon watching physicists/scientists on television. How do they perceive those that do science? Is this perception negative so that it might persuade a high school student to change his mind about becoming a physicist? Is this perception positive for male students? For female students?

Session DF: Research-based Pedagogy in the High School

Location: Skutt Student Center 105
Sponsor: Physics in High Schools Committee
Co-Sponsor: Research in Physics Education Committee
Date: Tuesday, August 2
Time: 8:30–10 a.m.

Presider: Daniel Crowe

Several high school pedagogies based on physics education research will be described. The intended audience is high school physics teachers with little or no familiarity with such pedagogies.

DF01: 8:30–9 a.m. Modeling Instruction in the High Schools: A Research-based Curriculum

Invited - Dwain M. Desbien, Estrella Mountain CC, Avondale, AZ 85392; dwain.desbien@emcmail.maricopa.edu

This talk will focus on the Modeling Theory of Physics as developed by the modeling group at ASU (led by David Hestenes). I will discuss the research underpinnings of the curriculum, the curriculum itself, and the models used in the curriculum. Discussion of the workshops where teachers can learn the modeling technique will be discussed and information on how to apply will be given. Finally some results from the modeling workshop project on student learning will be given.

DF02: 9–9:30 a.m. PRISMS PLUS – A High School Physics Curriculum

Invited - Lawrence T. Escalada, University of Northern Iowa, Cedar Falls, IA 50614-0150; Lawrence.Escalada@uni.edu

Physics Resources and Instructional Strategies for Motivation Students (PRISMS) is a high school physics curriculum that utilizes a learning cycle pedagogy. PRISMS originated in 1982 as a collection of 130 high-interest activities related to real-life student experiences. PRISMS was revised and enhanced with funding from the National Science Foundation and made available as PRISMS PLUS. PRISMS PLUS is based on physics education research and the recommendations of national science education initiatives. Students are guided through high-interest activities that engage them in exploring patterns and relationships; formulating concepts based on evidence; and applying these concepts to new phenomena, using the concepts to predict the behavior of physical phenomena. PRISMS PLUS includes more than 40 complete learning cycles with conceptual support materials to help students develop conceptual understanding of the basic physics ideas introduced. PRISMS provides the pedagogy for many of the UNI Physics preparation and professional development programs for science teachers.

DF03: 9:30–10 a.m. Helping Your Students Learn Physics and Think Like Scientists

Invited - Eugenia Etkina, Rutgers University, New Brunswick, NJ 08901; eugenia.etkina@gse.rutgers.edu

We often spend the first week of classes teaching our students how science works and then switch to our traditional delivery mode telling them what the laws of physics are and how to use them to solve back-of-the-chapter problems. Is it possible for our students to learn physics concepts and laws by actually practicing science? What does it mean to practice science in a high school classroom? In this talk I will describe two curricula, "Investigative Science Learning Environment" (ISLE) and Physics Union Mathematics (PUM), that engage your students in the processes mirroring scientific practice when learning physics. These curricula help them experience physics first hand as their own creation. They engage the students in data collection and analysis, help them learn how to devise their own explanations, how to test them with new experiments, and how to make meaningful connections to mathematics.

Session DG: New AP B Where Are You?

Location: Harper Center 3048
Sponsor: Physics in High Schools Committee
Co-Sponsor: Teacher Preparation Committee
Date: Tuesday, August 2
Time: 8:30–9:30 a.m.

Presider: Martha Lietz

This session will address the upcoming changes to the AP Physics B curriculum and exam. It will conclude with a Q&A session featuring members of the AP CDA Committee Bob Morse, Eugenia Etkina, Connie Wells, and Gay Stewart.

DG01: 8:30–9 a.m. Part I. The New AP Physics B Curriculum

Invited - Gay B. Stewart, University of Arkansas, Fayetteville, AR 72701; gstewart@uark.edu

The latest information released by College Board in regard to the new AP Physics B courses—Physics 1 and Physics 2 will be presented, including an overview of the curriculum framework along with the division of content between Physics 1 and Physics 2. Currently, Physics B is supposed to follow a preparatory course. Now, the material is divided up and deepened to make each year a stand-alone, rigorous, conceptual and problem-solving course. These courses can be placed flexibly into a school's curriculum; examples, alignment of the courses with college courses and possible ramifications for college credit will be discussed.

DG02: 9–9:30 a.m. Part II. Teaching the New AP Physics B

Invited - Connie J. Wells, Pembroke Hill School, Kansas City, MO 64112; cwells@pembrokehill.org

The conceptual level for the newly designed course will be significantly deeper, thereby allowing teachers more time for inquiry-based, student-centered learning. Suggested approaches to the incorporation of elements of the redesigned courses into current AP Physics courses will be offered as teachers plan during the interim between now and first year of implementation of the new curriculum. New teachers will discover an approach to physics teaching that merges conceptual development with scientific practice. Experienced teachers will see how their current practices merge with the goals of Physics 1 and Physics 2. Participants will gain insight into what impact these changes may have on their current teaching practices. Participants will be given examples of how these new courses can be placed flexibly into a school's curriculum, and the teacher support materials that will accompany both courses will also be discussed.

Session DH: Research on Learning Assistants and TAs

Location: Skutt Student Center 104
Sponsor: Teacher Preparation Committee
Date: Tuesday, August 2
Time: 8:30–9:50 a.m.

Presider: Gary White

DH01: 8:30–8:40 a.m. Teaching Assistants' Reasons for the Design of Problem Solutions for Introductory Physics: Rationale and Methodology

William Mamudi, Western Michigan University, Kalamazoo, MI 49008-5444; william.o.mamudi@wmich.edu

Charles Henderson, Western Michigan University
Shih-Yin Lin and Chandralekha Singh, University of Pittsburgh
Edit Yerushalmi, Weizmann Institute of Science, Israel

As part of a larger study to understand how instructors make teaching decisions, we investigated how graduate teaching assistants (TAs) perceive features of written problem solutions. TA are an important population to understand; they often provide significant instruction and they also represent the pool of future physics faculty. This talk will focus on the methodology used to study TAs enrolled in a training course. Data were collected via a series of tasks related to concrete instructional artifacts (solutions to the same physics problem that vary in their representation of expert problem solving as well as in their instructional approach). Important aspects of the design were a) using artifacts from a previous study of faculty to allow for comparison of results, b) developing a written questionnaire that requires respondents to explicitly connect problem features with preferences and reasons, and c) documenting respondent ideas both pre- and post-discussion within their training course.

DH02: 8:40–8:50 a.m. Teaching Assistants' Reasons for the Design of Problem Solutions for Introductory Physics: Findings

Shih-Yin Lin, University of Pittsburgh, Pittsburgh, PA 15213; hellosilpn@gmail.com

Chandralekha Singh, University of Pittsburgh
William Mamudi and Charles Henderson, Western Michigan University
Edit Yerushalmi, Weizmann Institute of Science, Israel

As part of a larger study to understand how instructors make teaching decisions, we investigated how graduate teaching assistants (TA's) perceive features of written problem solutions. TA's are an important population to understand; they often provide significant instruction and they also represent the pool of future physics faculty. Twenty-four first-year graduate TA's enrolled in a training course were provided with different instructor solutions for the same physics problem and asked to discuss their preferences for prominent solution features. Preliminary findings reveal that providing a schematic visualization of the problem, listing knowns/unknowns, and explaining reasoning in explicit words were the most valued features. Preferences for different features were sometimes in conflict with each other. For example, while the TA's valued solutions where reasoning was explicitly explained, they also valued concise solution. We'll present the reasons behind these preferences and discuss the implications for the professional development of physics TA's.

DH03: 8:50–9 a.m. Assessing Reflective Practice through Learning Assistant Reflections*

Geraldine L. Cochran, Florida International University, Miami, FL 33199; gcoch001@fiu.edu

Laird H. Kramer and Eric Brewe, Florida International University

We have analyzed reflections from our chemistry, mathematics, and physics undergraduate learning assistants (LAs) seminar to examine their development of reflective teaching practices. One goal of Florida International University's (FIU) LA seminar is to help our participants develop as reflective practitioners. We endeavor to reach this goal by means of classroom activities, classroom discussion, and reflective homework assignments. Weekly reflective papers on course readings and teaching experiences are assigned to help our students reach higher levels of reflection. To assess our LAs' level of reflection, we analyzed reflections using Hatton and Smith's (1995) [[1]] "criteria for the recognition of evidence for different types of reflective writing." The three discipline-based LA programs at FIU utilizing the LA seminar are structurally different and include different kinds of teaching experiences. Thus, we have also investigated whether or not participation in the various programs may result in different levels of reflection for the LAs.

1. N, Hatton, D. Smith, "Reflection in teacher education: towards definition and implementation," *Teaching and Teacher Education* **11**, 33-49 (1995) *Work supported by PhysTEC and NSF PHY-0802184

DH04: 9–9:10 a.m. Engaging Instructors in Discussing Student Difficulties: A Model for Preparation

Benjamin T. Spike, University of Colorado–Boulder, Boulder, CO 80309-0390; spike@colorado.edu

Noah D. Finkelstein, University of Colorado–Boulder

We report on the results of a recent effort to modify graduate Teaching Assistant (TA) preparation for the Tutorials in Introductory Physics by focusing instructor attention on potential student difficulties rather than simply the mastery of content. We track shifts in instructor awareness of student difficulties with Tutorials as a result of a simple intervention during TA preparation sessions. We share findings from this semester-long effort, and conclude by discussing broader implications for teacher preparation in both traditional and transformed environments.

DH05: 9:10–9:20 a.m. Effects of the Learning Assistant 'Treatment' on In-Service Teachers' Practices*

Kara E. Gray, School of Education, University of Colorado–Boulder, Boulder, CO 80309-0390; kara.gray@colorado.edu

David C. Webb and Valerie K. Otero, University of Colorado–Boulder

The Colorado Learning Assistant (LA) Program serves as a content-specific supplement to standard teacher preparation programs. In addition to transforming undergraduate STEM courses, it recruits and prepares math and science majors for teaching careers by involving university STEM faculty. The research reported here compares the teaching practices of in-service teachers who had the LA "treatment" as undergraduates to colleagues who did not participate in the LA program as undergraduates but were certified through the same program. We report on teachers' views of assessments, their views of learning, and differences in their teaching practices. This analysis is based on interviews with approximately 30 teachers and observations of their classrooms throughout their induction years of teaching. This work considers how the LA program may help improve current teacher preparation models.

* This work is partially funded by NSF grant #ESI-0554616.

DH06: 9:20–9:30 a.m. Comparing Learning Assistants' Classroom Practices to Colleagues Using Artifact Methodology*

Stephanie A. Barr, University of Colorado–Boulder, Boulder, CO 80309-0390; stephanie.barr@colorado.edu

Valerie K. Otero, University of Colorado–Boulder

The Scoop notebook[1] is an instructional artifact package developed to assess teachers' use of reform classroom practices. It is one of the tools used by University of Colorado's LA-Test research group to characterize differences in the classroom practices between former Learning Assistants (LA's) teaching at the secondary level, and their colleagues. Analysis of these artifacts indicate significant differences between LA and non-LA groups. Other data sources corroborate these findings.[2] We will discuss the implications of this study and make inferences about the role of the LA experience in teacher preparation. We will also describe the method of using artifact packages to study classroom practice, discussing the pros and cons of this type of data.

1. H. Borko, B.M. Stecher, A.C. Alonzo, S. Moncure, and S. McClam, *Educational Assessment* **10**, 73-104 (2005).
2. K. Gray, D. Webb, V. Otero, "Are Learning Assistants Better K-12 Science Teachers?" in C. Henderson, M. Sabella, C. Singh (Eds.) *2009 Physics Education Research Conference Proceedings*. Melville, NY: AIP Press. (2010).

* This work is partially funded by NSF grant # ESI ? 00554616.

DH07: 9:30–9:40 a.m. Case Studies of Increasing Participation in a Physics Learning Community

Renee Michelle Goertzen, Florida International University, Miami, FL 33199; rgoertze@fiu.edu

Eric Brewe and Laird Kramer, Florida International University

We present a case study of two introductory undergraduate physics students' increasing participation in the physics learning community at Florida International University (FIU). An implicit goal in the reforms implemented by the Physics Education Research Group at FIU has been the establishment of multiple opportunities for entry into and participation in a community of physics learners. These opportunities include classes using research-based curricula (Modeling Instruction and Investigative Science Learning Environment), a Learning Assistant program, and a growing cohort of physics majors. Using interviews conducted across a year of introductory physics, we explore the trajectories of two students who have successfully increased their participation in a physics learning community.

DH08: 9:40–9:50 a.m. Assessing Laboratories through Pre- and Post-testing: Optics*

*Drew Baigrie,** Texas Tech University, Lubbock, TX 79409; drew.baigrie@ttu.edu*

Beth Thacker, Keith West, Mark Ellermann, and Mahmoud Yaqoub

We present the results of written pre- and post-tests administered in large algebra-based and calculus-based introductory physics laboratories and a small inquiry-based, laboratory-based, algebra-based course. We also examine student performance as a function of TA teaching style, which is ranked using the RTOP assessment.

*This project is supported by the NIH grant 5RC1GM090897-02.

**Sponsor: Beth Thacker

Tuesday morning

Session DI: PER: Student Reasoning II

Location: Harper Center 3023 & 3023A
Sponsor: Research in Physics Education Committee
Date: Tuesday, August 2
Time: 8:30–9:50 a.m.

Presider: Taha Mzoughi

DI01: 8:30–8:40 a.m. Intuitive Ontologies for Energy in Physics*

Rachel E. Scherr, Seattle Pacific University, Seattle, WA 98119, rescherr@gmail.com

Sarah B. McKagan and Hunter G. Close, Seattle Pacific University
Matthew J. Jones, Tillicum Middle School

The nature of energy is not typically an explicit topic of physics instruction. Nonetheless, participants in physics courses that involve energy are constantly saying what kind of thing they think energy is, both verbally and nonverbally. The premise of an embodied-cognition theoretical perspective is that we understand the kinds of things that may exist in the world (ontology) in terms of sensorimotor experiences such as object permanence and movement.[1] We offer examples of intuitive ontologies for energy that we have observed in classroom contexts, including energy as a quasi-material substance; as a means of activation; as a fuel; and as an ineffable quantity which is not subject to further analysis. In the classroom, multiple and overlapping metaphors for energy complement one another in complex representations of physical phenomena.[2]

1. G. Lakoff, M. Johnson, *Philosophy in the flesh: The embodied mind and its challenge to Western thought*, New York, Basic Books, (1999).
2. A. Gupta, D. Hammer, E.F. Redish, "The case for dynamic models of learners' ontologies in physics," *J. Learn. Sci.* **19**(3), 285-321, (2010); D. Hammer, A. Gupta, E.F. Redish, "On static and dynamic intuitive ontologies," *J. Learn. Sci.* **20**(1), 163-168, (2011).

*Supported in part by by the National Science Foundation (DRL 0822342).

DI02: 8:40–8:50 a.m. 'Productive Disciplinary Engagement' in the Context of Energy*

Warren M. Christensen, North Dakota State University, Fargo, ND 58102; Warren.Christensen@ndsu.edu

Rachel E. Scherr, Hunter G. Close, Sarah B. McKagan, and Eleanor W. Close, Seattle Pacific University

The concept of "productive disciplinary engagement"[1] (PDE) provides a layered method for describing experiences in which learners are interacting with one another. The four principles of PDE align with much of the Physics Education Research community's effort in instructional design: 1) Problematizing Content, 2) Giving Students Authority, 3) Holding Students Accountable to Others and Disciplinary Norms, and 4) Providing Relevant Resources. Authentic experiences of this kind are not common in most classrooms and significant challenges arise when attempting to create them. We present examples of PDE from a summer Professional Development course on energy at Seattle Pacific University and consider both the observational criteria by which PDE is identified and the features of the instruction that contributed to making it possible.

1. R.A. Engle, F.R. Conant, "Guiding principles for fostering productive disciplinary engagement: Explaining an emergent argument in a community of learners classroom," *Cog & Inst.* **20** (4) (2002).

*Supported in part by NSF DRL 0822342.

DI03: 8:50–9 a.m. Two Right Answers: The Difficulty of Reconciling Competing Physics Commitments*

Benedikt W. Harrer, University of Maine, Orono, ME 04469; benedikt.harrer@maine.edu

Rachel E. Scherr and Hunter G. Close, Seattle Pacific University
Michael C. Wittmann and Brian W. Frank, University of Maine

In group settings, we sometimes see learners commit to arguments that, although seemingly contradictory, are both correct and appropriate. Groups may have difficulties reconciling these competing commitments. In a professional development course at SPU, secondary teachers are discussing the energy flow in a refrigerator to find out how refrigerators work. While one teacher shows commitment to the idea that refrigerators move heat from a relatively cold compartment to a hotter environment, two others appear committed to the second law of thermodynamics which states that heat flows from hot to cold. Video records of the discussion show that the teachers recognize the disparity of their commitments but do not spontaneously reconcile the contradiction. Our analysis shows why all group members are right to believe in their respective commitments, points out difficulties they have reconciling the contradicting commitments, and explores possible causes for these difficulties.

*Supported in part by NSF DRL 0822342.

DI04: 9–9:10 a.m. Understanding Forms of Energy through Testing Novel Cases*

Stamatis Vokos, Seattle Pacific University, Seattle, WA 98119; vokos@spu.edu

Warren Christensen, North Dakota State University
Eleanor Close, Sarah McKagan, Rachel Scherr, and Lane Seeley, SPU

National and state standards often list forms of energy that students should know, including gravitational, kinetic, potential, etc. Form can be a useful shorthand for describing the state of the system, or it can be a meaningless label to be memorized. Most physics instruction does not emphasize a deep understanding of the physical meaning of form. Are there ways that our instruction could more effectively help students gain an understanding of form? One way to develop and test understanding of forms of energy is to ask the question, "What must be considered when deciding whether a new form is legitimate?" We present case studies of students struggling with the legitimacy of forms of energy not listed in the standards, some of which they deem to be legitimate and some of which they do not. Finally, we suggest instructional methods to take advantage of this struggle.

* Supported in part by NSF DRL 0822342

DI05: 9:10–9:20 a.m. Conservation of Energy vs. Conservation of Value in Energy*

Sarah McKagan, McKagan Enterprises, 2436 S, Irving St., Seattle, WA 98144; sam.mckagan@gmail.com

Lezlie DeWater, Rachel Scherr, Lane Seeley, and Stamatis Vokos, SPU

When teaching about energy in physics class, an important learning goal for students is an understanding of conservation of energy. Outside of physics class, the word "conservation" is often used with an entirely different meaning: In the real world, we care about "conserving" a finite and expendable resource. This resource is often referred to as "energy," but in the more precise language of physics we would call it "useful energy" or "value" in energy. We present results from a collaboration in which SPU visual communication majors, after extensive discussions with members of the physics department, produced posters to depict various energy concepts and to communicate their understanding. Many of these posters explicitly highlight the distinction between "energy" and "value," Illustrating how nonscientists struggle with this issue. We discuss how this struggle may play out for students in physics classes, and suggest a method for redirecting students' useful intuitions about value.

*Supported in part by NSF DRL 0822342

DI06: 9:20–9:30 a.m. Interpretations of P.E. Diagrams by Introductory Students While Learning QM

Brian M. Stephanik, University of Washington, Seattle, WA 98195-1560; bsteph@u.washington.edu

Peter S. Shaffer and Lillian C. McDermott, University of Washington

In order for students to relate quantum and classical mechanics they must have a sufficiently strong foundation of some basic concepts in classical physics. We have found that students in introductory courses who are learning quantum mechanics sometimes struggle with these classical concepts in ways that can inhibit their ability to connect these two regimes. Examples of our findings in the context of potential energy diagrams, as well as preliminary attempts to address student difficulties, will be presented.

DI07: **9:30–9:40 a.m.** **Characterizing Student and Teacher Descriptions of Pressure***

Amy D. Robertson, University of Washington, Seattle, WA 98195-1560; awrob@uw.edu

Peter S. Shaffer and Lillian C. McDermott, University of Washington

A basic assumption of kinetic-molecular theory is that the pressure of a gas is generated by collisions of gas particles with the walls of the container. This assumption is often used to derive an expression that relates the pressure of a gas to the kinetic energy of the gas particles and ultimately connects the microscopic model for pressure to the ideal gas law. In a series of questions that were developed to elicit microscopic descriptions of pressure, student and teacher explanations revealed a variety of macroscopic and microscopic descriptions of pressure that had no obvious connection to collisions of gas particles with the container walls. Examples will be presented, together with a brief discussion of possible implications for instruction in physics and chemistry courses.

*This work has been supported under a National Science Foundation Graduate Research Fellowship.

DI08: **9:40–9:50 a.m.** **Pulling a Spring Taut Affects Students' Talk about Wave Propagation**

Michael C. Wittmann, University of Maine, Orono, ME 04469-5709; mwittmann@maine.edu

Evan Chase, University of Maine

Students' responses to questions about wave propagation along a taut spring indicate that many believe the effort exerted by the hand making a wavepulse affects the speed with which it moves.[1] We have previously suggested that these responses may depend on how the students imagine the physical scenario—is the hand creating a wavepulse on an already taut spring, or is the spring first pulled taut and then the wavepulse is created?[2] In the latter situation, we expect students to be more inclined to correctly think of the tension on the spring affecting the wave speed. We created two interview tasks to investigate our prediction. Evidence shows that students who pull the spring taut before creating a wavepulse do not answer questions about wave speed by discussing "the force imparted to the wave."

1. M.C. Wittmann, R.N. Steinberg, E.F. Redish, *The Phys. Teach.* **37** 15–21. (1999).
2. M.C. Wittmann, *Proceedings of the 9th International Conference of the Learning Sciences* (ICLS 2010) - Vol. 1, Full Papers, 659-666. (2010).

Session DJ: Upper Division Undergraduate

Location: Harper Center 3040
Sponsor: Physics in Undergraduate Education Committee
Date: Tuesday, August 2
Time: 8:30–9:40 a.m.

Presider: Paul Dolan

DJ01: **8:30–8:40 a.m.** **Percolating the Classroom: Using Mathematica to Introduce Percolation Concepts**

Timothy D. Hooper, Penn State Altoona, Altoona, PA 16601-3760; tdh16@psu.edu

Gary J. Weisel and Darin T. Zimmerman, Penn State Altoona

More than 12,000 articles have been published on the physics of percolation, yet only a handful have attempted to teach the concept to undergraduate students. However, with increases in computing power and widely available software packages, getting started on the study of percolation is a much simpler task today than it was 30 years ago. In this presentation, we show how undergraduate science and engineering students can use a standard desktop computer running Mathematica to perform sophisticated investigations of two-dimensional lattices. In a special topics research course, second-year students learned how to simulate percolation in various lattice geometries, calculate cluster statistics, and extract critical exponents from the simulation data. These students made fundamental connections between the mathematics and physics of percolating systems and reached an understanding of a fundamental physical process that unfortunately, is not often part of a typical undergraduate curriculum.

DJ02: **8:40–8:50 a.m.** **Displaying Sounds with Real-Time Frequency Analyzers**

David Keeports, Mills College, Oakland, CA 94613; dave@mills.edu

Real-time frequency analyzers (RTFAs) are available as free online downloads, and they are incorporated even in entry-level music production programs such as Apple's GarageBand. Outputting the sound of a drawbar organ though an RTFA clearly shows the analyzer's function. I will present some ways in which this software can be used to display spectral subtleties of sounds that single instantaneous Fourier transforms cannot reveal. When a string is plucked, harmonics initially decay at different rates. Real-time spectral analysis of speech exposes difficulties in representing vowel and consonant sounds as Fourier series. An RTFA provides a useful tool for showing how "resonance box beating" extends to the beating of harmonic waves. Additionally, an RTFA explains why the sound of harmonic waves beating resembles sound processed by a musical phase shifter.

DJ03: 8:50–9 a.m. Magnetic Resonance (MR) Analogy for a Charged Particle Dynamics in a Magnetic Field

Michael B. Partensky, Brandeis University, Waltham, MA 02453-2700; partensky@gmail.com

Valery P. Putyrsky, Ural Federal University, Yekaterinburg, Russia

An analogy between the Bloch Equations (BE) of the MR theory (MRT) and the dynamics equations (DE) for a charged particle in a magnetic field allows for a unified description of two different groups of electromagnetic phenomena. In a static magnetic field B0, BE for magnetization M and DE for the velocity V, are formally equivalent. Hence, V(t) performs Larmor precession around the direction of B0, resulting in a familiar helical trajectory. With oscillating magnetic field, this analogy still holds under certain conditions, e.g., if the Lorenz force due to the induced electric field can be neglected. This bridges the MRT and the particle dynamics. The resonant behaviors of V are described in the rotating reference frame.[1] The particle trajectories are discussed and compared with the solutions accounting for the effects of the induced electric field.

1. I.I. Rabi, N.F. Ramsay, J. Schwinger, *Rev. Mod. Phys*., **64**, 167 (1954)

DJ04: 9–9:10 a.m. Stages of Participation as Stages of Expertise

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

Eric Brewe and Laird H. Kramer, Florida International University

Expertise research in physics has focused heavily on differences between experts and novices. In an effort to extend the scope of expertise research, we are engaged in an ongoing study of the development of expertise in a physics research group. To capture the features of the development of expertise in physics, we present an ethnographic, qualitative study within a physics research group. We utilize video recordings of the physics research group's weekly research meeting and guided interviews with each of eight participants in the group. These data are analyzed using Lave and Wenger's[2] perspective of learning as legitimate peripheral participation within a community of practice. We present data from this study to characterize stages of expertise and posit a trajectory novices take toward expertise.

1. Supported by NSF Award # PHY-0802184
2. J. Lave, E. Wegner, *Situated learning: Legitimate peripheral participation,* New York, Cambridge University Press (1991).

DJ05: 9:10–9:20 p.m. Graduate Students' Perceptions of Scientific Collaborations after Researching in China

Anne W. Collins, University of California, Santa Barbara, Santa Barbara, CA; anne.wrigley@gmail.com*

Anne E. Emerson, Danielle B. Harlow, and Julie A. Bianchini, University of California, Santa Barbara

Scientific practice is increasingly a collaborative endeavor, especially as the world becomes more global (Katsouyanni, 2008).[1] While research thrives on scientific partnerships, few studies look beyond publication counts and, instead, investigate what constitutes such an alliance (Lee & Bozeman, 2005).[2] Although publications certainly motivate collaboration, studies that measure collaborative networks solely by counting publications are limited since they do not provide a comprehensive picture of the collaborative process. With this in mind, we examined U.S. and Chinese graduate students' motivations and perceptions of collaboration as a result of participation in a research-abroad program in the fields of electron chemistry, catalysis, and electron microscopy. Our findings provide insight into what motivates science partnerships and the features of successful collaborations. Our study has implications for those looking to develop and foster international collaborations.

1. K. Katsouyanni, "Collaborative research: accomplishments and potential," *Environmental Health,* **7**(3), 1-7. (2008).
2. S. Lee, B. Bozeman, "The impact of research collaboration on scientific productivity," *Social Studies of Science*, **35**(5), 673-702. (2005).

*Sponsor: Danielle B. Harlow

DJ06: 9:20–9:30 a.m. Socratic Dialogs and Clicker Use in Upper-Division Mechanics Courses

Lincoln D. Carr, Colorado School of Mines, Golden, CO 80401; lcarr@mines.edu

Vincent H. Kuo and Patrick B. Kohl, Colorado School of Mines
Noah Finkelstein, University of Colorado Boulder

The general problem of effectively using interactive engagement in non-introductory physics courses remains open. We present a three-year study comparing different approaches to lecturing in an intermediate mechanics course at the Colorado School of Mines. In the first two years, the lectures were modified to include Socratic dialogs between the instructor and students. In the third year, the instructor used clickers and Peer Instruction. All other course materials were nearly identical to an established traditional lecture course. We present results from exams, course evaluations, the CLASS attitude survey, and a new conceptual survey. We observe little change in student exam performance as lecture techniques varied, though students consistently stated clickers were "the best part of the course" from which they "learned the most." Indeed, when using clickers in this course, students were considerably more likely to become engaged than students in CSM introductory courses using the same methods.

DJ07: 9:30–9:40 a.m. Light Reflection from a Uniformly Moving Mirror, a General Principle

J. Ronald Galli, Weber State University, Ogden, UT 84408-2508; jrgalli@weber.edu

When light is reflected from a uniformly moving mirror, the reflected and incident angles are equal only for special cases. Reasons for this will be presented and a more basic principle of reflection will be suggested.

AAPT Awards: Robert A. Millikan Medal Teaching Awards

Location: Harper Center Hixson-Lied Auditorium
Date: Tuesday, August 2
Time: 10:30 a.m.–12:15 p.m.

Presider: David Cook

Brian Jones

Robert A. Millikan Medal Awarded to Brian Jones

All I Really Need to Know about Physics Education I Learned in Kindergarten

Brian Jones, Colorado State University, Physics Department, Fort Collins, CO

We learn by doing. To learn physics, our students must be active, perform investigations, solve problems, and communicate with their peers. The same is true of teaching. We learn by doing, and my work with the Little Shop of Physics program has given me invaluable practice as a physics teacher. For 20 years I have worked with a team of undergraduate students and fellow educators to present this unique hands-on science program to over 250,000 K-12 students. We have worked with students of all ages and all backgrounds, in schools all over the region and the world. Along the way, we have developed effective tools to teach scientific concepts and we have learned useful techniques to engage students. We have traded ideas and insights with thousands of teachers. Going on the road with the Little Shop of Physics takes me out of my classroom, and I return a much better teacher for it. I will share some techniques, some insights, and (of course) some demonstrations that I have developed with my Little Shop colleagues over the past 20 years.

Stacy McCormack

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

Blond Girls Can't Learn Physics

Stacy McCormack, Penn High School, Mishawaka, IN

At the age of six, Stacy McCormack told her entire family that one day she would become a science teacher. Trained as a high school chemistry teacher, she was fearful of making the transition to teaching physics because of her own fear of physics—but the pleading of her students convinced her to make the switch. As she worked toward her graduate degree, one professor in particular made it especially awkward when he remarked "I'll tell you right now, because you're a girl and have blond hair, you'll never understand physics." Stacy designed a guided-inquiry style high school physics class at Penn High School in Mishawaka, IN, that is lab-driven, student-centered, and uses numerous formative assessments to guide student learning. Now the 2011 Indiana State Teacher of the Year and an online adjunct instructor of Astronomy, Physics, and Physical Science classes for Ivy Tech Community College in South Bend, IN, Stacy shares her inexpensively created labs in a book for physics teachers titled *Teacher Friendly Physics.* Amazingly, each year hundreds of high school students now find success in physics under the guidance of a blond girl.

Edward Prather

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

Teaching Space Science: A STEM Transformation Vehicle that Really Works

Edward Prather, University of Arizona, Department of Astronomy, Tucson, AZ

From assembly line worker to tenured faculty member—a struggle and journey that has made me hungry to help. Over the past decade I have worked closely with hundreds of college instructors, postdocs, graduate students, and undergrads in collaborative projects designed to understand issues of teaching and learning in college-level general education space science courses. The research results from these collaborations have been used to transform classrooms all over the country. We are creating learning environments that can significantly impact learners' science literacy and engagement in STEM for the 250,000 students that take these courses each year. By moving students along the continuum from non-science major, to peer instructor, to degree seeking student, we are creating the next generation's Ambassadors of Science.

Crkrbrl 2: Crackerbarrel on Professional Concerns of PER Solo Faculty

Location: Harper Center 3029
Sponsor: Research in Physics Education Committee
Co-Sponsor: Professional Concerns Committee
Date: Tuesday, August 2
Time: 12:15–1:15 p.m.

Presider: Steven 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.

Crkrbrl 3: Crackerbarrel on Adjunct Issues

Location: Harper Center 3028
Sponsor: Physics in Two-Year Colleges Committee
Date: Tuesday, August 2
Time: 12:15–1:15 p.m.

Presider: Paul Williams

Adjunct faculty play a significant role in two-year college physics programs. A large number of issues specific to adjunct faculty such as appropriate staffing, pay, professional development, curriculum development, the relationship to full-time faculty, among others exist. Come join this freewheeling discussion about adjunct faculty issues in two-year colleges.

Crkrbrl 4: Using Simulations Interactively in the Classroom

Location: Harper Center 3027
Sponsor: Space Science and Astronomy Committee
Co-Sponsor: Educational Technologies Committee
Date: Tuesday, August 2
Time: 12:15–1:15 p.m.

Presider: Kevin Lee

Computer simulations can be powerful tools in the classroom. However, it is necessary that they be used interactively to truly get students engaged. This crackerbarrel will look at several techniques to engage students with simulations—question and answer dialogs, peer discussions, recording predictions on worksheets, and others. Participants will then brainstorm in groups on how to best apply these techniques.

Crkrbrl 5: New Methods of Teacher Evaluations

Location: Harper Center 3023 & 2032A
Sponsor: Physics in High Schools Committee
Co-Sponsor: Teacher Preparation Committee
Date: Tuesday, August 2
Time: 12:15–1:15 p.m.

Presider: Jan Mader

The days of an administrator sitting in the back of a classroom and completing a check sheet as a teacher lectures to the classroom have been replaced by a myriad of evaluations techniques. We will discuss peer evaluation, portfolios, 5-minute walk throughs, STEP, LEARN, TEACH methods of providing evaluations that provide definite descriptions of teaching practices.

Session EA: *Panel:* Impact of New K-12 Standards on Teachers and Teacher Training

Location: Skutt Student Center Ballroom ABC
Sponsor: Professional Concerns Committee
Co-Sponsor: Physics in High Schools Committee
Date: Tuesday, August 2
Time: 1:15–2:15 p.m.

Presider: Elaine Gwynn

With No Child Left Behind and the push for standardized exit exams and criterion referenced testing from kindergarten through high school, how are teachers being equipped to be "highly qualified."

EA01: 1:15–2:15 p.m. Getting Ready for the New Generation of K-12 Physics Standards

Panel - Patricia Heller, University of Minnesota, Department of Curriculum and Instruction, Minneapolis, MN 55455; helle002@umn.edu

Compared to the current K-12 science standards, the new research-based physics standards: (a) have more explicit statements of the physics principles and concepts students should understand; (b) require more application of these principles and concepts to real world situations; (c) require increasing intellectual sophistication and higher levels of abstraction as grade levels progress from elementary to middle school to high school, and (d) reflect a current (modern) view of physics. These differences will impact how we prepare future teachers. This presentation outlines how the new standards will affect the physics content of courses for teachers.

EA02: 1:15–2:15 p.m. Impact of National Science Standards on Teachers and Teacher Training

Panel - Jim Woodland, Nebraska Department of Education, Lincoln, NE 68509; jim.woodland@nebraska.gov

A perspective from a state department of education on the impact of state science standards on classroom instruction, curriculum, assessment, and teacher preparation.

EA03: 1:15–2:15 p.m. New Physics Standards in Texas

Panel - Jill Marshall, University of Texas, Austin, TX 78712; marshall@mail.utexas.edu

As of 2009 Texas physics teachers are teaching under a revised set of standards for what students should be able to do, the revised Texas Essential Knowledge and Skills or TEKS for physics. Although changes to the TEKS were "evolutionary not revolutionary," a new structure organizing the topics was imposed and a new emphasis was placed on conceptual understanding. New standards relating to optics and nuclear physics were added.

Session EB: PER: Topical Understanding and Attitudes

Location: Harper Center 3023 & 3023A
Sponsor: Research in Physics Education Committee
Date: Tuesday, August 2
Time: 1:15–3:15 p.m.

Presider: Eric Brewe

EB01: 1:15–1:25 p.m. Analysis of Multiple-Choice Problems in Terms of Conditions in National Test on Force and Energy

Hyeon-Suk Choi, Korea National University of Education, Chung-Buk, 363-791, KOREA; eovnddl@hotmail.com

Jung bok Kim, Korea National University of Education

Multiple-choice tests are widely used and their importance seems likely to grow, due to their inherent suitability. Many diagnostic instruments have been developed often in the form of multiple-choice tests. This study was to survey setting up conditional terms on the choice items of the Force and Energy section in a high school physics test by Korea Institute of Curriculum & Evaluation (KICE). A total of 78 items were analyzed by a framework representing the conditional terms—23 among 78 items contained connotative conditional terms. Expressed conditional terms presented 69 of the 78 items. On the other hand, nine of 78 items did not contain both connotative and expressed conditional terms. We were able to group conditional terms into preventing correct dispute, conditional terms of scientific error, or unnecessary conditional terms to get the correct answer to items.

EB02: 1:25–1:35 p.m. Using Online Homework Data to Assess Student Confidence

Andrew Pawl, University of Wisconsin-Platteville, Platteville, WI 53818; pawla@uwplatt.edu

Joseph D. Peterson, University of Wisconsin-Platteville

A popular type of question in online homework involves a set of several true/false statements where students must submit their answer to all the statements at once. This discourages random guessing because although one true/false statement has only two possible answers, a question containing N such statements has two raised to the Nth power possible answers. We have studied student response patterns to a number of these questions with the goal of determining which of the individual true/false statements exhibit a large proportion of response switches (i.e. from true to false or from false to true) and which statements exhibit largely consistent responses. The tendency of students to change their answer to a statement or to remain consistent is one indication of student confidence in the knowledge tested.

EB03: 1:35–1:45 p.m. Students' Views of Macroscopic and Microscopic Energy in Physics and Biology

Benjamin W. Dreyfus, University of Maryland, College Park, MD 20742-4111; dreyfus@umd.edu

Edward F. Redish and Jessica Watkins, University of Maryland–College Park

Energy concepts are fundamental across the sciences, yet these concepts can be fragmented along disciplinary boundaries, rather than integrated into a coherent whole. To teach physics effectively to biology students, we need to understand students' disciplinary perspectives. We present interview data from an undergraduate student who displays multiple stances toward the concept of energy. At times he views energy in macroscopic contexts as a separate entity from energy in microscopic (particularly biological) contexts, while at other times he uses macroscopic physics phenomena as productive analogies for understanding energy in the microscopic biological context, and he reasons about energy transformations between the microscopic and macroscopic scales. This case study displays preliminary evidence for the context dependence of students' ability to translate energy concepts across scientific disciplines. This points to challenges that must be taken into account in developing curricula for biology students that integrate physics and biology concepts.

EB04: 1:45–1:55 p.m. Comparing Students, Individual, and Group Work in an Electronics Lab*

Nasser M. Juma, Kansas State University, Manhattan, KS 66506-2601; mhuninas@phys.ksu.edu

N. Sanjay Rebello, Kristan L. Corwin, and Brian R. Washburn, Kansas State University

We observed students as they worked on lab experiments in an upper-division electronics and instrumentation laboratory course. In the first half of the course the students learned about various analog and digital electronic components through mini-lectures and laboratory activities. They built various electronic circuits using their knowledge of these electronic components. In the second half of the course students teamed up to work on an open-ended capstone project that required them to use their knowledge of electronics learned in the first half of the course to improve the measurements done on a physics experiment they have worked on in a previous semester. As a group, the students thought of ideas to improve the measurement design and then built circuitry to implement this improved design. We describe findings from this study and highlight how the students' group work during the capstone project compares with their individual work before the capstone project.

* This work is supported in part by NSF grant DUE-0736897.

EB05: 1:55–2:05 p.m. Improving Students' Understanding of Coulomb's Law and Gauss's Law

Jing Li, University of Pittsburgh, Pittsburgh, PA15232; fairylee86@gmail.com

Chandralekha Singh, University of Pittsburgh

We discuss the development and evaluation of five research-based tutorials on Coulomb's law, Gauss's law, and the superposition principle to help students in the calculus-based introductory physics courses learn these concepts. The tutorials were developed based upon research on students' difficulties on relevant topics. We discuss the performance of students on the pre-/post-tests given before and after the tutorials, respectively, in four calculus-based introductory physics courses. We also compare the performance of students who used the tutorials with those who did not use them. We find that students performed significantly better in classes in which tutorials were used than in the classes where students learned the material via traditional lecture only. We also found that the students who worked on the tutorials and performed differently in the pre-test all have improvement in the post-test.

EB06: 2:05–2:15 p.m. Student Understanding of the Approach to Thermal Equilibrium*

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

This paper describes work that is part of an ongoing collaboration to study student learning of thermal physics and develop curricular materials suitable for upper-division courses. The current work describes research on student understanding of the approach to thermal equilibrium. In the hybrid "thermal physics" approach, thermal equilibrium is examined on the macroscopic level but also as a statistical phenomenon. We examine student understanding of these different treatments in the context of two interacting solids, and discuss implications for instruction.

* Supported in part by NSF grant DUE 0817335. Any opinions and findings are the work of the author and do not necessarily represent the view of the National Science Foundation.

EB07: 2:15–2:25 p.m. Students' Perceptions of the Pathway Active Learning Environment*

Sytil K. Murphy, Kansas State University, Manhattan, KS 66506; smurphy@phys.ksu.edu

Christopher M. Nakamura and Dean A. Zollman, Kansas State University
Michael Christel and Scott Stevens, Carnegie Mellon University

The Pathway Active Learning Environment (PALE) features a synthetic tutor that provides pre-recorded video responses to questions about physics. Additional multimedia in the form of images or video clips is used to supplement the synthetic tutors' video responses. As a context for interactions with the tutor, students working with the PALE complete online lesson activities organized in three-stage learning cycles. The activities focus on video observation and measurement. To evaluate the system, 22 students were interviewed. Complete participation consisted of three interviews over three weeks in the fall of 2010. Each interview was approximately 1.5 hours long. During the first hour the student worked through one of the lessons. In the last half hour, a researcher interviewed the student to explore the student's thoughts and opinions of the system and to probe their relevant physics knowledge. Themes emerging from a preliminary analysis of the interviews will be discussed.

* This work is supported by the U.S. National Science Foundation under grant numbers REC-0632587 and REC-0632657.

EB08: 2:25–2:35 p.m. Towards the Measurement of Undergraduate Students' Physics Identity

Geoff Potvin, Clemson University, Clemson SC 29634; gpotvin@clemson.edu

Carrie Beattie and Kylie Paige, Clemson University

Prior research has found that students' attitudes toward physics, as embodied in their "physics identity," may play a strong role in their choices toward future physics course-taking and the likelihood of their choosing physics as a college major. Theoretical work in this area has identified several domains that constitute and influence physics identity; however, to date, quantitative research in this direction has not been based in an appropriate theoretical framework while establishing valid and reliable measures of relevant constructs. In the current work, we report on progress toward the establishment of a rigorously tested, theoretically grounded instrument to measure physics identity and its related subconstructs. Evidence for the reliability and validity of this instrument, including exploratory factor analyses, is provided using pilot data taken from 300 college students enrolled in one of two courses: introductory physics for physical science or life science majors.

EB09: 2:35–2:45 p.m. A Qualitative Investigation of Opportunities to Influence Self-Efficacy

Vashti Sawtelle, Florida International University, Miami, FL 33199; vashti.sawtelle@gmail.com

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

Considerable research has shown a connection between self-efficacy and success in science fields. The qualitative analysis we present in this talk focuses on the development of self-efficacy, and in particular on what types of activities provide opportunities for self-efficacy to develop. We focus this discussion on the qualitative analysis of three Modeling Instruction students in a single problem-solving session and the self-efficacy experience opportunities (SEOs) that were apparent in this session. After providing evidence that SEOs are abundant throughout the problem solving session, we also qualitatively analyze a post-hoc interview with one of the students from the session. The combination of these two sessions provides evidence that the opportunities to influence self-efficacy that we have characterized are in fact sometimes taken up by some students, and have a direct influence on their self-efficacy.

EB10: 2:45–2:55 p.m. Student Difficulties with a Taylor Series Expansion in Statistical Mechanics

Trevor I. Smith, University of Maine, Orono, ME 04469; Trevor.I.Smith@umit.maine.edu

John R. Thompson and Donald B. Mountcastle, University of Maine

One goal of physics instruction is to have students learn to make physical meaning of specific mathematical ideas, concepts, and procedures, in different physical settings. We have reported on student difficulties with these connections in the contexts of integrals, total differentials, and partial derivatives in upper-division thermal and statistical physics. As part of research investigating student understanding and use of the Boltzmann factor, we are developing materials that guide students through a derivation of the Boltzmann factor that includes a Taylor series expansion of entropy. Using results from written surveys, classroom observations, and individual think-aloud and teaching interviews, we present evidence that while some students can recognize familiar expressions as Taylor expansions, students lack fluency with Taylor expansions at the level one might expect of advanced undergraduates, despite previous exposure to Taylor series expansions in both calculus and physics courses.

EB11: 2:55–3:05 p.m. What College Students Don't Know about Density

DJ Wagner, Grove City College, Grove City, PA 16127; djwagner@gcc.edu

Sam Cohen, Adam Moyer, and Elizabeth Carbone, Grove City College

As part of the development of a fluid statics assessment, our research group conducted clinical interviews with students in both conceptual physics and calculus-based introductory physics courses. What were intended as "basic" questions about density quickly became a significant focus of those interviews, as only one of the eight students interviewed demonstrated a confident understanding of mass density. Questions were quickly added to the diagnostic exam given at the end of the semester, and the results confirm that many students have a poor grasp of density. In this talk, I will summarize our preliminary data and discuss future plans for the assessment and our instruction.

EB12: 3:05–3:15 p.m. Relationship between Students' Predicted Score and Actual Score on Class Exams

N. Sanjay Rebello, Kansas State University, Manhattan, KS 66506-2601; srebello@phys.ksu.edu

It has long been known that students' self efficacy can influence their performance of assessments. I conducted a study to investigate the relationship between students' predicted performance and actual performance on five exams in a second-semester calculus-based physics class. After completion of each of the five exams during the semester, students in the class were given about 72 hours to predict their individual and class mean score on the exam. As incentive, students were offered extra credit worth 1% of the exam points for each predicted score that was correct within 1% of the actual score. I compared students' individual and mean score predictions with the actual scores to investigate the relationship between prediction accuracies and exam performance of the students. I also examined trends in the prediction accuracies of students over the five exams. I report on the results and possible implications of this study.

Session EC: *Panel*: Educating the Larger Public about Science – Lessons from Public Institutions

Location: Harper Center 3027
Sponsor: Physics in High Schools Committee
Co-Sponsor: Educational Technologies Committee
Date: Tuesday, August 2
Time: 1:15–3:15 p.m.

Presider: Paul Nienaber

A number of public scientific institutions (national laboratories, museums, planetariums, etc.) make extraordinary contributions to improving the science literacy of members of the citizenry at large. This session focuses on some of the successes achieved (and challenges faced) by people doing science outreach in these settings, and the present relationship between more traditional forms of science education and what happens in these public venues.

EC01: 1:15–3:15 p.m. Attracting the Public: Lessons from the Magnet Lab

Panel - Jose Sanchez, Center for Integrating Research & Learning, National High Magnetic Field Laboratory, Tallahassee, FL 32310-3706; sanchez@magnet.fsu.edu

The Magnet Lab and other facilities, large and small, can provide the infrastructure that translates science research for students, teachers, and the general public. In addition, an educational programs group with science educators as staff, provides support for scientists as they expand their involvement with science outreach. CIRL addresses this mission by providing a broad range of programs at traditional and nontraditional venues: For example, K12 outreach to schools, middle school mentorships, high school internships, internships for undergraduates, internships for teachers, teacher professional development, Science Café, Barnes & Noble Science Nights, and Chick Fil A Family Nights. CIRL educators take any and all opportunities to help teachers bring real-world research into classrooms.

EC02: 1:15–3:15 p.m. Discovery to Understanding: The National Superconducting Cyclotron Laboratory

Panel - Michael Thoennessen, National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, MI 48824-1321; thoennessen@nscl.msu.edu

The National Superconducting Cyclotron Laboratory (NSCL) is a world leader in rare isotope research and education. Broadening the impact of scientific discovery and enhancing the public understanding of science are among the main objectives of the laboratory. Every year more than 4000 visitors participate in tours of the facility and we developed hands-on demonstrations for open houses and science fairs. For example, the Marble Nuclei Project offers a hands-on approach to learning about matter on the atomic and subatomic scale by comparing and contrasting different isotopes. This project helps visitors and students understand the various types of decay associated with different isotopes, and become aware of the goals of nuclear science and how it is applied in everyday situations.

EC03: 1:15–3:15 p.m. Physics for the Public

Panel - Marge Bardeen, Education Office, Fermi National Accelerator Laboratory, Batavia, IL 60510; mbardeen@fnal.gov

We probably all agree that the public should know something about the nature and value of scientific research. Through outreach and education activities, scientists can communicate understandings of the natural world and how we come to those understandings. The setting could be a library, lecture hall, museum floor, or even a book store. The experience should build understandings and relationships. The approach should involve engagement and when possible exploration. We discuss several activities for the general public from the particle physics community.

EC04: 1:15–3:15 p.m. Outreach from a Small Observatory

Panel - James Conwell, Eastern Illinois University, Charleston, IL 61920; jconwell@eiu.edu

In the fall of 2004 the Eastern Illinois University Physics Department dedicated its new observatory. Built with student help and private donations, it has been central to the department's community outreach through its monthly open houses. More than 1600 visitors came in the year 2010 alone. Community support in 2009, during the UN International Year of Astronomy, allowed us to have a year-long celebration, centering on a lecture series, an observatory blog (EIU Astro at 240,000 visitors), and in cooperation with the art department, a museum exhibit on Art and Archeo-astronomy.

Session ED: What Do We Know about Web 2.0?

Location: Harper Center 3048
Sponsor: Educational Technologies Committee
Co-Sponsor: Research in Physics Education Committee
Date: Tuesday, August 2
Time: 2:15–3:15 p.m.

Presider: Robert Steiner

The rise of Web 2.0—including user-generated content, social networking and virtual worlds—provides a new array of potential opportunities in physics education. For students, teachers, and the general public, these opportunities may include heightened engagement, deeper understanding of physics, improvements in skills, and changes in attitude toward science. But what do we really know about the educational effectiveness of Web 2.0, particularly in the realm of physics education?

ED01: 2:15–2:25 p.m. Enhancing Introductory Student Motivation with a Major-Managed Course Blog*

W. Brian Lane, Jacksonville University, Jacksonville, FL 32211; wlane@ju.edu

Students typically begin an introductory physics course without the important motivational factors of relevance and confidence, such that many students do not fully engage with learning activities. Instructional technology can provide a venue for developing student motivation by extending the classroom discussion and incorporating into the learning community outsiders at different stages along the novice-to-expert journey. To leverage these benefits, we implemented an instructional strategy that used a course blog to create a community of learners made of upper-level physics seminar students (who wrote a variety of articles for the blog) and non-major introductory physics students (who read and commented on the articles). Using various surveys (including the CLASS) and post-instruction interviews, we examine the impact of this strategy on the introductory students' senses of relevance and confidence and propose further developments of this instructional strategy.

* Supported by the Marilyn Repsher Center for Teaching and Learning.

ED02: 2:25–2:35 p.m. Combining JiTT with Wikis in Physics Classrooms

Hashini E. Mohottala, University of Hartford, West Hartford, CT 06117; mohottala@hartford.edu

I report the combined use of Just in Time teaching (JiTT) and Wikispace (wikis) in an introductory-level physics class. Wikis help students, instructors and technology to interact with one another. A core element of JiTT is interactive lectures. Although these teaching tools have been used separately in physics classrooms over the years, the combination will be a new experience for both physics instructors and students. During this exercise, I carefully picked relevant physics problems and posted them on the Wiki page weekly, using it as a platform for students to meet online and discuss problem solving strategies. The students were supposed to discuss and find the methods to solve the problems and not get the final answer in numerical forms. This activity helped students enhance their critical thinking abilities and as the Wiki page administrator, I was able to track all the write-ups, edits and allocate the necessary grades.

ED03: 2:35–2:45 p.m. Automated Analysis of Students' Responses to Short-Answer Physics Questions*

Christopher M. Nakamura, Kansas State University, Manhattan, KS 66506 cnakamur@phys.ksu.edu

Sytil K. Murphy and Dean A. Zollman, Kansas State University
Michael Christel and Scott Stevens, Carnegie Mellon University

Online learning environments and synthetic tutoring systems are of interest as potential resources in physics education. These systems may allow many students to study physics in interactive ways at times and in locations of their choice. To effectively promote authentic learning, these environments must be able to present students with open-ended, conceptual questions, as a tutor would. The ability to interpret and respond automatically to students' responses would increase the interactivity of these systems considerably. It would also present a powerful analysis tool to address the large data sets these systems can generate. Vector-space based methods of text indexing and lexical network approaches to text analysis may be useful for this purpose. Here we discuss work exploring these types of approaches to interpreting student responses to short-answer questions. In particular we investigate the combination of qualitative coding methods with computerized text analysis to provide robust automated interpretation of responses.

* This work is supported by the U.S. National Science Foundation under grant numbers REC-0632587 and REC-0632657.

ED04: 2:45–2:55 p.m. Collaborative Problem Solving in the Presence of an Expert Tutor

Brett D. van de Sande, Arizona State University, CIDSE, Tempe, AZ 85287-8809; bvds@asu.edu

We know that, in the right circumstances, pairs of problem solvers can work more effectively than a student working alone. In a previous lab study, we found that pairs of students, working under the direction of an expert (computer) tutor, was a particularly effective combination. We have embarked on a project to develop technology that extends this paradigm to pairs of students working remotely from one another. We discuss the status of the project and the prospects for education experiments using this new tool.

ED05: 2:55–3:05 p.m. Online Homework: Identifying Problem-solving Strategies and Misconceptions for Contextualized Problems

Aaron D. Wangberg, Winona State University, Winona, MN 55987; awangberg@winona.edu

Nicole Engelke, California State University–Fullerton
Gulden Karakok, University of Northern Colorado

Students who struggle to solve problems often utilize a variety of creative solution strategies that go beyond mimicking previously worked examples. These strategies are sometimes incorrect generalizations of a particular example or invented based on superficial properties of the problem. Recently, advances in the open-source online homework system WeBWorK have allowed us to capture not only the final answer that students provide but also the work, including incorrect attempts, used to complete the problem. We will share how we have used the system to better understand and characterize how calculus students with weak understandings of function composition attempt to solve contextualized, e.g. extreme value and rate, problems in the course. In addition, we will share how we are using this information and technology to provide interactive interventions focused on these students' weaknesses.

Session EE: Upper Division Laboratories: Ideas, Equipment and Techniques

Location: Skutt Student Center 105
Sponsor: Laboratories Committee
Co-Sponsor: Apparatus Committee
Date: Tuesday, August 2
Time: 1:15–2:45 p.m.

Presider: Eric Ayars

This session will focus on practical aspects of upper-division physics lab courses. Topics include a broad range of lab-related subjects such as novel experimental techniques, hardware or software advances, and curricular developments.

EE01: 1:15–1:45 p.m. Teaching Scientific Writing – What I Learned from a New Approach

Invited - Brian Houser, Eastern Washington University, Cheney, WA 99004; bhouser@mail.ewu.edu

In my most recent running of our Advanced Laboratory, I set the writing of scientific reports as a principal objective. My new approach included a class discussion of two actual papers (one published and one rejected), student comments on each others' work, and a requirement that the third and final report be subject to the refereeing process before resubmission for a grade. Though the writing abilities of the students varied widely, all showed improvement. This talk will give an overview of the course and present how students progressed in writing abstracts, procedures, and analysis sections of their papers. I will also include problems I encountered and improvements that can be made for the next offering.

EE02: 1:45–2:15 p.m. ALPhA's Laboratory Immersions Program – Plunging into New Experiments

Invited - Lowell McCann, University of Wisconsin - River Falls, River Falls, WI 54022; lowell.mccann@uwrf.edu

In this talk, I will report on the first two years of the Advanced Laboratory Physics Association's (ALPhA) Laboratory Immersion program. ALPhA initiated this program to help faculty and teaching staff learn new instructional-physics experiments. Each Laboratory Immersion is two to three days in length, with the entire time devoted to learning one experiment well enough to teach it confidently. I will discuss the first round of Immersions, which took place during summer 2010, and the impact these offerings have had on the participants based on the results of our preliminary evaluation. The slate of upcoming Immersions for summer 2011 will also be presented.

EE03: 2:15–2:25 p.m. Electron Mobility in Silicon: Surprising

A. James Mallmann, Milwaukee School of Engineering, Milwaukee, WI 53202-3109; mallmann@msoe.edu

The mobilities of the current-carrying free charges in transistors influence switching speeds, the operating temperatures, and the rate of battery drain for laptop computers and other portable electronic devices. After a brief discussion of the scattering of electrons by lattice vibrations, I will describe a simple, inexpensive experiment to determine how the mobility of free electrons in lightly doped n-type silicon depends on temperature.

EE04: 2:25–2:35 p.m. The Radio Astronomy Laboratory: Another Way to Learn Physics and Astronomy

Victor Migenes, Brigham Young University, Provo, UT 84602; vmigenes@byu.edu

Daniel Blakley, Brigham Young University

The field of Radio Astronomy was founded essentially by unemployed military radar engineers after World War II. Radar research had left unanswered questions and unsolved problems. The 1950-60s saw a big growth in the design and construction of radio antennas by universities and private laboratories. In the 1970-80s new developments in the area of interferometric radio astronomy and synthesis arrays created instruments that increased the spatial resolution and sensitivity of the observations. National Laboratories was born. The 1990s radio interferometry added baselines to a radio antenna in Earth orbit. New exciting instruments and opportunities will be available in 2015-2020 such as ALMA and SKA. Radio Astronomy is an interesting and exciting way to teach physics and astronomy concepts to intermediate and upper-level undergraduate students and even graduate students. Setting up a small Radio Astronomy laboratory is n easy and cheap way to expose K-12 students to physics and astronomy, and research work. We present our efforts, so far, in establishing a Radio Astronomy Laboratory at Brigham Young University and involving undergraduate and graduate students in class and research work.

EE05: 2:35–2:45 p.m. Relativistic Electron Experiment for the Advanced Laboratory

Michael F. Vineyard, Union College, Schenectady, NY 12308; vineyarm@union.edu

We have developed an advanced laboratory experiment at Union College to make independent measurements of the momentum and kinetic energy of relativistic electrons from a beta source. The momentum measurements are made with a magnetic spectrometer and a silicon surface-barrier detector is used to measure the kinetic energy. A plot of the kinetic energy as a function of momentum compared to the classical and relativistic predictions clearly shows the relativistic nature of the electrons. Accurate values for the rest mass of the electron and the speed of light are also extracted from the data. I will describe the experimental apparatus, discuss the analysis, and present some results.

Session EF: Reforming the Introductory Physics Course for Life Science Majors V

Location: Skutt Student Center 104
Sponsor: Physics in Undergraduate Education Committee
Date: Tuesday, August 2
Time: 1:15–3:15 p.m.

Presider: Juan Burciaga

The physics community has been asked to reform and rethink the introductory physics sequence for the life sciences. This session will feature speakers who will talk about the need for reform from the perspective of these organizations and some of the responses being shaped by the physics community.

EF01: 1:15–1:35 p.m. Taking a Biologist to Lunch

Invited - Dawn C. Meredith, University of New Hampshire, Durham, NH 03824; dawn.meredith@unh.edu

Jessica A. Bolker and Christopher W. Shubert, University of New Hampshire
James Vesenka, University of New England
Gertrud L. Kraut, Southern Virginia University

It is often suggested that instructors of algebra-based introductory physics courses take a biologist to lunch, with the goal of finding out what a practicing biologist needs to know about physics. We sat down with faculty from several different life sciences at our institution to find out what physics their students need: a microbiologist, a zoologist, a kinesiologist, a physiologist, and a geneticist. We will share what we learned from these articulation cross-disciplinary conversations. One need expressed by biology faculty was for physics problems that have significant biology context and content; we have developed problems to address this need. A second need is for lecture modules from our IPLS course that biology instructors can use to refresh students' memories of specific physics content. This enables the students to apply those physics principles in specific biological contexts and build upon what they learned in the IPLS course.

EF02: 1:35–1:55 p.m. Reforming Physics for Biologists and Pre-Meds: Disciplinary Barriers

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

Todd J. Cooke, Wolfang Losert, and Karen Carleton, University of Maryland

The calls from the biology and medical communities for reform of undergraduate biology education[1] requests that support courses be reformed as well. At the University of Maryland, the Physics and Biology Education Research Groups[2] have been discussing these issues and interviewing students in physics and biology classes. We find that adapting physics classes for biology students and including physics in biology classes is going to be harder than it appears on the surface. There are epistemological differences in the way both students and professionals in biology and physics think about their science, differences in the way they use math, and differences in the way they think about fundamental concepts. These differences create barriers to reform. Additional barriers arise when chemists and mathematicians are included. Bridging these disciplinary barriers to create effective reform is going to require creativity, open minds, and a willingness to communicate.

1. http://umdberg.pbworks.com/w/page/27519347/Documents-on-Biology-Education-Reform
2. http://www.physics.umd.edu/perg/; http://umdberg.pbworks.com/w/page/8039417/FrontPage

EF03: 1:55–2:15 p.m. Introductory Physics for the Life Sciences and the Revised MCAT

Invited - Robert C. Hilborn, University of Texas at Dallas, Richardson, TX 75080-3021; rhilborn@utdallas.edu

The Association of American Medical Colleges is in the process of reviewing and revising the Medical College Admissions Test (MCAT) with the expectation that the new exam will go "live" in 2014 or 2015. At the same time, the AAMC Committee on Admissions has recommended that medical schools drop the traditional course requirements and replace them with a list of competencies: what entering medical students should know and be able to do, particularly in the natural and mathematical sciences. I will review the current status of the MCAT revision and discuss how changes in the MCAT and in admissions requirements for medical schools may affect introductory physics courses for the life sciences.

EF04: 2:15–3:15 p.m. IPLS at Appalachian State University

Poster - Patricia E. Allen, Appalachian State University, Boone, NC 28608; allenpe@appstate.edu

At Appalachian State University, a new IPLS (Introductory Physics for the Life Sciences) course is currently being piloted with 21 students. In consultation with various on-campus pre-professional health-care programs, the author attempts to integrate the BIO2010 and SFFP recommendations with existing departmental resources to generate a course appropriate for future health-care professionals. For example, the overarching topic for the first semester course is ultrasound imaging, diathermy, and surgery, while defibrillators and diagnostic imaging (MRI, CT, etc) are used for the second semester. The roles of physics, physiology, and materials are introduced into the course as they are needed. The presentation will include course topics (including the order of coverage), resources for lecture and lab, and preliminary student performance for the pilot course. In addition, some of the issues associated with scaling up this type of course will be discussed.

EF05: 2:15–3:15 p.m. Project-based Learning of Biomechanics

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

Life and health science students taking the first semester of the algebra-based introductory physics course at Mercy College learn mechanics in the context of biomechanics through a semester-long project analyzing a human or animal motion of their choice. As each topic is explored in class, students apply that topic to their analysis. Kinematics, Newton's laws, rotation and torque, momentum, energy, heat and temperature, elasticity, and fluids are applied at different levels depending on the project. Students take data from force plates, goniometers, accelerometers, force sensors, motion sensors, and video analysis, to incorporate into their projects. Students are required to post updates to their projects online and to comment on each other's work in progress. Guidelines, rubrics, and student examples will be shown.

EF06: 2:15–3:15 p.m. Using Biology to Teach Physics

Poster - Konstantin Bogdanov, Lyceum 1586, Moscow 119330, Russia; kbogdanov1@yandex.ru

Today, physics teachers have turned to real-world examples in order to motivate physics learners. Connections to biological issues have been viewed as opportunities to make physics relevant. We are describing how a biological theme can be incorporated into the high school physics course for life science majors. Changes to the course to make physics more relevant to biological issues were incorporated into most aspects of the course. For example, the concepts of elasticity are explored using the context of composite structure of skeletal bone and blood vessel wall. Basic concepts in electricity are covered with examples like resting potential, nerve impulse propagation, electrocardiography and electrical cardioversion. Thermodynamics is taught in the context of body mass-lifestyle-relationships and the role of surface tension in breathing. Most biological examples were taken from author's book (Konstantin Bogdanov, *Biology in Physics*, 2000, Elsevier Inc.).

EF07: 2:15–3:15 p.m. A Hybrid Lecture-Studio Implementation at Boston University

Poster - Andrew Duffy, Boston University, Boston, MA 02215; aduffy@bu.edu

Manher Jariwala, Boston University

Boston University has a new internal grant, sponsored by the provost, called RULE - Reforming the Undergraduate Learning Experience. The Department of Physics has received a RULE grant, and is using the funds to implement an experimental studio section of our algebra-based introductory physics class that is taken primarily by life science majors. That section will begin in a new 63-student classroom in fall 2010. To prepare for this implementation, in May and June 2010, the summer version of the course was taught in a hybrid lecture-studio format, with the lecture component having a number of interactive engagement features. In this poster, we will report on our experience with the hybrid format.

EF08: 2:15–3:15 p.m. Introduction to Medical Physics for Physics Majors and Biophysics Minors

Poster - Michael G. Nichols, Creighton University, Omaha, NE 68178; mnichols@creighton.edu

This course was developed for undergraduate students interested in the life sciences who would otherwise take only the required two-semester general physics sequence. The primary goal of this writing-intensive course is to develop a functional understanding of the physical principles on which many medical techniques and technologies are based. This includes radioactivity, the interaction of ionizing and non-ionizing radiation with living tissue, the physical mechanisms whereby radiation induces cell damage, biophysical cell survival models, and the principles of radiation treatment. In addition to this, students are introduced to medical imaging technologies including X-ray CT, SPECT, PET, MRI and Ultrasound. This is done both in the classroom and through tours of local hospitals. Altogether, these applications encourage students to extend and deepen their understanding of physics while illustrating how a little interdisciplinary ingenuity can lead to the development of medical technologies that can profoundly improve the quality of life.

EF09: 2:15–3:15 p.m. From Brownian Motion to Random Walks: Diffusion in the IPLS Class*

Poster - Mark Reeves, George Washington University, Washington, DC 20052; reevesme@gwu.edu

Carl Pearson, Rahul Simha, and Robert Donaldson, GW 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. 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. The class discussions and simulations are complemented by laboratories in which diffusion, Brownian motion, and laser trapping are directly observed and quantitatively measured. From the measurements and in-class discussions, the connection is made between the microscopic model/observation and its macroscopic realization. The same line of argument is used to establish the equipartition theorem in terms of observations of laser trapping and this is then extended to discussions of protein folding and membrane formation.

* This research is supported by the NSF/CCLI program. More information can be found at http://www.phys.gwu.edu/iplswiki/index.php/Example_Courses

EF10: 2:15–3:15 p.m. Teaching Introductory Physics with Biomedical Applications

Poster - Natalia Schkolnikov, Hampton University, Hampton, VA 23668; natalia.schkolnikov@hamptonu.edu

Often students from underrepresented groups in the biomedical sciences feel disconnected from physics. We report on some of our experiences teaching the introductory physics sequence for biology and pharmacy students at Hampton University. Since fundamental concepts of physics are central to an understanding of biomedical sciences, we include biomedical applications in most topics of the courses. In particular, the biological and medical fields are an ideal source of physics problems. We discuss how fast an animal can walk or run, how long a cardiac pacemaker can work, and how electrical signals travel along neurons. We cover various methods that are used to "look inside the body" such as ultrasound, MRI, and X-ray imaging. Encouraged by the opening of the Hampton University Proton Therapy Institute in 2010, we discuss how energetic protons could provide an efficient cancer treatment. My experience shows that students find all these discussions stimulating and helpful.

EF11: 2:15–3:15 p.m. Concept Mapping to Clarify Interdisciplinary Themes: An Example Using Osmosis

Poster - Ji Shen, University of Georgia, Athens, GA 30602; ji.shen1221@gmail.com*

Craig C. Wiegert, Shannon Sung, and Georgia Hodges, University of Georgia

Boundaries between traditional academic disciplines often hinder students from integrating "big ideas" across subjects. In response to the growing need for college-level interdisciplinary education, we have assembled a diverse team of educators and education researchers (in physics, biology, physiology, and other STEM subjects) to investigate student understanding of interdisciplinary science topics. Important early steps in this project include identifying the pivotal concepts associated with a given topic, and developing a common understanding of the discipline-specific explanations of these concepts. We illustrate these steps applied to the topic of osmosis, a phenomenon often poorly understood by students and educators alike. We share our results in creating several iterations of an "expert" group concept map for osmosis. This collaborative process highlights different and often imprecise use of terminology; the challenges of developing an accurate common model; and several problems in understanding and communicating the underlying physical mechanism of selective diffusion.

* Sponsor: Craig Wiegert

EF12: 2:15–3:15 p.m. What Do We Want Our Life Science Majors to Learn?

Poster - Guofen Yu, The University of Findlay, Findlay, OH 45840; yu@findlay.edu

The majority of students in my Introductory Physics Lecture course lack the interest in physics and the learning skills for science courses. Both my students and I struggled in the course when I first started teaching life science majors after years of teaching engineering students. Through this experience, I have come to realize that it is extremely important to set up appropriate overarching course goals (such as the skills I want students to develop) and make content objectives for each chapter to maximize life science applications. My pedagogical methods, topic selections, depth of discussions on each topic, class examples, homework assignments, and assessments are all built upon the course goals and chapter objectives. A list of my course goals and the pedagogical reforms in my course will be reported as part of this session. Data of students' performance and comments from online anonymous surveys over several semesters will also be presented.

EF13: 2:15–3:15 p.m. Making Physics Lab Relevant to the Life Science Major

Poster - Rona Ramos, Yale University, New Haven, CT 06511; rona.ramos@yale.edu

Sidney Cahn and Stephen Irons, Yale University

In current biological and biomedical research, the connections between the life sciences and the physical sciences are deepening. Increasingly, the methods of research and analysis in these fields depend on sophisticated instruments with strong roots in the physical sciences. However, many premedical and life science students feel their undergraduate physics courses are irrelevant to their chosen field. The Yale Physics Department has responded to these concerns by making major changes to the introductory laboratory courses for life science and premedical students. This talk will highlight some of the innovative demos and instructional laboratory experiments that have been developed to address this issue. Other changes include presenting lab experiments in the context of current biomedical and biophysical applications. Preliminary feedback suggests that students are more engaged and feel the laboratory course is more appropriate to the training of future life scientists and physicians.

Session EG: The Art and Science of Teaching

Location: Harper Center 3029
Sponsor: Physics in Undergraduate Education Committee
Date: Tuesday, August 2
Time: 1:15–2:45 p.m.

Presider: Ray A. Burnstein

EG01: 1:15–1:45 p.m. Doing Your Best with the Class You're Given: Efforts to Intellectually Engage General Education Science Students in a Mega-Course

Invited - Edward Prather, Center for Astronomy Education - University of Arizona, Tucson, AZ 85721; eprather@as.arizona.edu

At the University of Arizona, members of the Center for Astronomy Education (CAE) are working to create effective interactive learning environments in general education Earth and Space Science courses with enrollments as large as 1200 students. Which research-validated instructional strategies still work in these mega courses? What educational resources are needed and how do you facilitate learning? These are two of the questions that are driving our group of educators and researchers to explore the boundaries of the "Art and Science of Teaching." Examples of interactive learning strategies we use, the pedagogical issues we face, and the results on the effectiveness of these courses will be presented.[1,2]

1. E.E. Prather, A.L. Rudolph, & G. Brissenden, "Teaching and learning astronomy in the 21st century," *Physics Today* **62**(10) (2009).
2. This work is supported by the National Science Foundation under Grant No. 0715517, a CCLI Phase III Grant for the Collaboration of Astronomy Teaching Scholars (CATS)

EG02: 1:45–2:15 p.m. Teaching Physics Using and Misusing Groups

Invited - Kenneth Heller, University of Minnesota, Minneapolis, MN 55455; heller@physics.umn.edu

Teaching physics has always involved students working in groups. In labs students traditionally worked together, usually in groups of two. Students often formed study groups outside of class to do difficult assignments or study for high-stakes tests. Today, many research-validated modes of teaching depend on students working together. There is even a continuing pressure from employers to graduate students who have the skills to collaborate productively. Nevertheless, many teachers and students do not have beneficial experiences when classes involve group work. This talk will outline the utility of group work based on research-backed learning theory and discuss some common practices that can enhance or destroy that utility.

EG03: 2:15–2:45 p.m. Responsive Teaching and the Beginnings of Energy Ideas in Third Grade[1]

Invited - Fred Goldberg, San Diego State University, San Diego, CA 92120; fgoldberg@sciences.sdsu.edu

As part of a project aimed at describing children's progress in their science inquiry and in their development of energy (and other) ideas we have been working with grade 3-6 teachers to help them change their teaching from focusing on achieving specific district or state standards to focusing on responding to their students' ideas and reasoning. This change in focus has coincided with teachers seeing science inquiry as a pursuit of coherent, mechanistic accounts of phenomena.[2] In this talk I will use some examples from third-grade classrooms to illustrate how this new focus has promoted the emergence of energy ideas.

1. Supported in part by NSF Grant Number 0732233– Learning Progressions for Scientific Inquiry: A Model Implementation in the Context of Energy.
2. D. Hammer, R. Russ, R.E. Scherr, & J. Mikeska, "Identifying inquiry and conceptualizing students' abilities," in R.A. Duschl & R.E. Grandy (Eds.), *Teaching scientific inquiry: Recommendations for research and Implementation* (pp. 138-156). Rotterdam, NL: Sense Publishers. (2008).

Session EH: Research on Student Learning of Energy

Location: Skutt Student Center Ballroom DE
Sponsor: Research in Physics Education Committee
Date: Tuesday, August 2
Time: 1:15–3:15 p.m.

Presider: Paula Heron

EH01: 1:15–1:45 p.m. Speciation of Energy Concepts through Speech and Gesture in Interaction

Invited - Hunter G. Close, Seattle Pacific University, Seattle, WA 98119; hclose@spu.edu

Rachel E. Scherr, Seattle Pacific University,

When energy is added to a liquid to evaporate it, what is the form of energy in the gas? Is it thermal energy, which is indicated by temperature? Is it chemical energy, which is indicated by chemical composition of a substance?[1] Maybe something else? In a summer professional development course in the Energy Project[2] at Seattle Pacific University, secondary teachers posed this question while cooperating in Energy Theater[3] in order to figure out the energy transfers and transformations in a real refrigerator. Their negotiation of the name of this form of energy boiled down to a discussion of the difference between kinetic and potential energy. We show how the speech and gesture that mediated the negotiation display different levels of distinction of energy concepts among the teachers, and we suggest how dynamic refinement, or "speciation," of these concepts might be promoted strategically in instruction.

1. http://www.project2061.org/publications/bsl/online/index.php
2. Supported in part by NSF DRL 0822342.
3. R.E. Scherr, H.G. Close, S.B. McKagan, & E.W. Close,"'Energy Theater': Using the body symbolically to understand energy," in C. Singh, M. Sabella, & S. Rebello (Eds.) *2010 Physics Education Research Conference Proceedings,* Melville, NY: AIP Press.

EH02: 1:45–2:15 p.m. Cultivating Energy Conceptual Resources for Productive Reasoning

Invited - Eric Brewe, Florida International University, Miami, FL 33199; eric.brewe@fiu.edu

The conceptual resources related to energy in the typical introductory physics curriculum are inadequate for robust analysis of energy. In this talk, I describe the implementation, in the context of a Modeling Instruction university physics course, of a curricular framework designed to promote the development and use of conceptual resources for analyzing physical phenomena. The curricular framework involves both a reorganization of the content of introductory physics as well as a renewed focus on energy. Reorganizing includes treating energy early and spiraling back to energy treatments. The refocusing includes emphasizing energy's role in modeling phenomena and attending to the tools for representing energy conservation, storage, and transfer. Qualitative evidence is presented showing student use of energy conceptual resources that are promoted in the curricular implementation.

EH03: 2:15–2:45 p.m. A Teaching Proposal about Energy for Students Aged 11-14

Invited - Nikos Papadouris, Learning in Science Group, University of Cyprus, Nicosia, Cyprus; npapa@ucy.ac.cy*

Costas P. Constantinou, Learning in Science Group, University of Cyprus

Teaching about energy is an inherently complex and challenging task, especially in the elementary and middle school. We briefly discuss the epistemological barriers that tend to perplex attempts to introduce energy and we propose an alternative teaching approach, for students aged 11-14, that seeks to provide a means for bypassing or overcoming those obstacles. This approach rests on the premise that the elaboration of energy could be more usefully framed in an epistemologically oriented, rather than a conceptually oriented, context. The emphasis in this approach is placed on (a) helping students appreciate that, in science, we invent theories in order to account for observations and (b) guiding them to elaborate energy as a theoretical framework for interpreting changes in physical systems. In the concluding part, we discuss the potential effectiveness of this teaching approach on the basis of empirical data on students' learning gains, collected through implementation in three sixth-grade classes.

* Sponsor: Paula Heron

EH04: 2:45–3:15 p.m. The Problem with Systems: Factors Underlying Student Difficulties with Energy

Invited - Beth A. Lindsey, Penn State Greater Allegheny, McKeesport, PA 15132; bal23@psu.edu

The first law of thermodynamics states that doing work on an otherwise isolated system will cause its energy to change. A set of curricular materials1 has been developed, designed to help students interpret and apply the relation between work and energy, but many difficulties persist even after targeted instruction. This persistence may be related to a failure to choose an appropriate system of interest and identify the interactions of that system with its environment. I will present data on student thinking about systems, and the connection to student thinking about energy in contexts from introductory mechanics and beyond. Data presented will be from pre-tests, post-tests, and video recordings of classroom interactions and one-on-one interviews at three institutions of differing sizes and student populations.

1. Lillian C. McDermott, Peter S. Shaffer, and the Physics Education Group *Tutorials in Introductory Physics*, Preliminary Second Edition, Pearson Education, Inc. (2009).

Session EI: Physics Education Research Around the World II

Location: Harper Center 3028
Sponsor: International Physics Education Committee
Co-Sponsor: Research in Physics Education Committee
Date: Tuesday, August 2
Time: 1:15–2:15 p.m.

Presider: Genaro Zavala

EI01: 1:15–1:45 p.m. High School Students Formalize the Quantum Concepts

Invited - Alberto Stefanel, University of Udine, 33100 Italy; alberto.stefanel@uniud.it

Marisa Michelini and Lorenzo Santi, University of Udine

Almost a century after its formulation, whether and how to teach quantum mechanics in high schools is still open. Focusing on the construction of theoretical thinking, we built an educational proposal following a Dirac approach. The polarized light phenomenology is the context for the foundation of the superposition principle and its main consequences. Extensive literature shows that the main learning knots are just these basic concepts and the probabilistic interpretation of its formal representation. Several studies have been conducted on students' learning processes during research-based experimentations in 14 classes with 340 high school students. A case study, carried out by means of tutorials, audio-recordings, tests, and data acquisition, aimed at analyzing students' approach to the formalism. We individuated three ways to consider formalism: physical, when it acquired meaning through a link to physical processes; geometrical, when a geometrical lecture is given; and conceptual/descriptive, when it is translated in words/sentences.

EI02: 1:45–2:15 p.m. Physics Education Research in Canada

Invited - Tetyana Antimirova, Ryerson University, Toronto, ON M5B 2K3; antimiro@ryerson.ca

One may ask why there are only a few Physics Education Research groups in Canada, unlike in the U.S., Europe, Australia, or Latin America, where PER has blossomed. The main reason is the virtual absence of PER funding at the national and provincial levels. As a result, graduate programs in PER cannot be established. Another problem that hinders the development of PER in Canada is a deep disconnect between the Physics Departments and Faculties of Education. Almost all PER initiatives in Canada today happen despite the lack of sustainable PER funding. These efforts are initiated by the individuals, small groups, and some universities, resulting in a patchwork of short-term PER research projects. I will provide a few case studies of recent successful PER-related initiatives in Canada. Despite the difficulties we face, PER movement in Canada is building slowly from the ground up. However, the long-term future of PER in Canada remains uncertain.

Session EJ: Recruiting Students to High School Physics

Location: Skutt Student Center Ballroom F
Sponsor: Teacher Preparation Committee
Co-Sponsor: Women in Physics Committee
Date: Tuesday, August 2
Time: 1:15–3:05 p.m.

Presider: Gary White

High school physics enrollments have been increasing in recent years, but two thirds of the nation's students still graduate high school without taking a physics course. The reasons for this include misconceptions about physics on the part of students, parents, and counselors, as well as graduation and testing schemes that do not require physics. This session will feature several high school teachers who have significantly increased physics enrollments at their schools through innovative methods.

EJ01: 1:15–1:45 p.m. Recruiting Strategies for H.S. Physics

Invited - Mike Kennedy, Neuqua Valley High School/U.S. Department of Energy, Arlington, VA 22201;mike_kennedy@ipsd.org

There is a need to increase the number of students that take physics in high school, especially when you consider the President's national goal of preparing all students in the STEM (science, technology, engineering, and mathematics) subjects. The success of students in the 21st century workforce will depend on students' education in the STEM fields and in many cases their exposure to physics. While at Neuqua Valley High School in Naperville, IL, I have helped to create a large interest in the physics courses. When I started at Neuqua Valley 10 years ago, I only had nine students in one section of AP Physics. This year there are five full sections of AP Physics that are taught by three teachers. To meet the student demand for physics courses at all levels, we have doubled our physics teaching staff from five teachers to 10 teachers during my tenure at Neuqua Valley. Come learn some strategies that will help you recruit students to your physics classes.

EJ02: 1:45–2:15 p.m. Why Am I Here? The Development of a Physics Identity through Meaningful High School Physics Experiences

Invited - Zahra Hazari, Clemson University, Department of Engineering & Science Education, Clemson, SCC 95864; zahra@clemson.edu

This talk addresses the ways in which high school physics experiences shape students' physics identities and their subsequent persistence, particularly for females and underrepresented minorities. The framework for this work is based upon the concept of a physics identity that is shaped by individuals' performance, competence, interest, and recognition by others. The talk will include results from multiple research studies, including a large national survey study and focused case studies of successful physics teachers (NSF Grant No. 0952460 and 0624444). In particular, the discussion will examine the link between physics identity and physics-related career choices, identify high school physics experiences that quantitatively predict physics identity development, and examine qualitatively what these strategies look like in the classrooms of successful high school physics teachers.

EJ03: 2:15–2:25 p.m. One Mad Man's Campus Campaigns*

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

In good times you should advertise, in bad times you must. As the son of an advertiser and a marketer, I have always valued advertising as a recruitment tool. As a high school physics teacher, I have been motivated to maintain or increase my "market share" each year. I have used "dog and pony shows," personalized direct mail campaigns, and a variety of flyer and poster designs. I will detail the relative efficacy of the various campaigns and share specific designs and slogans I have used over the years.

* http://homepage.mac.com/phyzman/NTW/flyers.html

EJ04: 2:25–2:35 p.m. Can Math Oriented Physics Classes Really Increase Your Number of Students?

Donald G. Franklin, Retired, 39 West Main St., Hampton, GA 30228; dgfrank1@aol.com

With 27 years of high school physics experience in five states, which includes eight years of private school, I have a lot of information with which to build my model. Using math as the major emphasis can only work if there is constant review. This can be done by using a textbook or online homework. Here is where they differ: Online homework does away with copying down someone's answers as they are not yours. The teacher becomes a conceptual teacher so that students can solve their problems. Getting the students to follow the problem solving format is the hardest part. Constant review: Giving the same problems to the entire class and then testing them on the new material and review material every week to two weeks allows for students to make up for their mistakes, which they feel they can show that they have learned the material rather than cramming material for the test.

EJ05: 2:35–2:45 p.m. The Peer Pressure of Student Physics Commercials

Elizabeth (Tommi) C. Holsenbeck, Alabama State University, Montgomery, AL 36101; eholsenbeck@alasu.edu

The Alabama Section of AAPT is attempting to have current high school physics students influence their younger peers with an advertising campaign. The First Annual Physics Commercial Competition will be held in the fall of 2011. It is funded by the Alabama Section of AAPT, Huntingdon College, and small donations from members and other interested parties. AMSTI (Alabama Math, Science and Technology Initiative)/ Science in Motion Physics Specialists developed the contest and will take the leadership role in administering it. An added dimension comes from a co-sponsor, Huntingdon College. Their college physics students will create sample commercials to use as a guide and be in teachers' hands by spring 2011. A unique perspective will come from these college students as they look in hindsight at their high school physics experience or non-experience. The hope for Alabama public schools is physics classes' enrollment will increase in 2012-13.

EJ06: 2:45–2:55 p.m. The Amazing World of Physics (and Science), Demonstrated to Students by Students

Stacia M. Kelly, 1638 Fayette Ave., Lawton, IA 51030; kellys@lawton-bronson.k12.ia.us

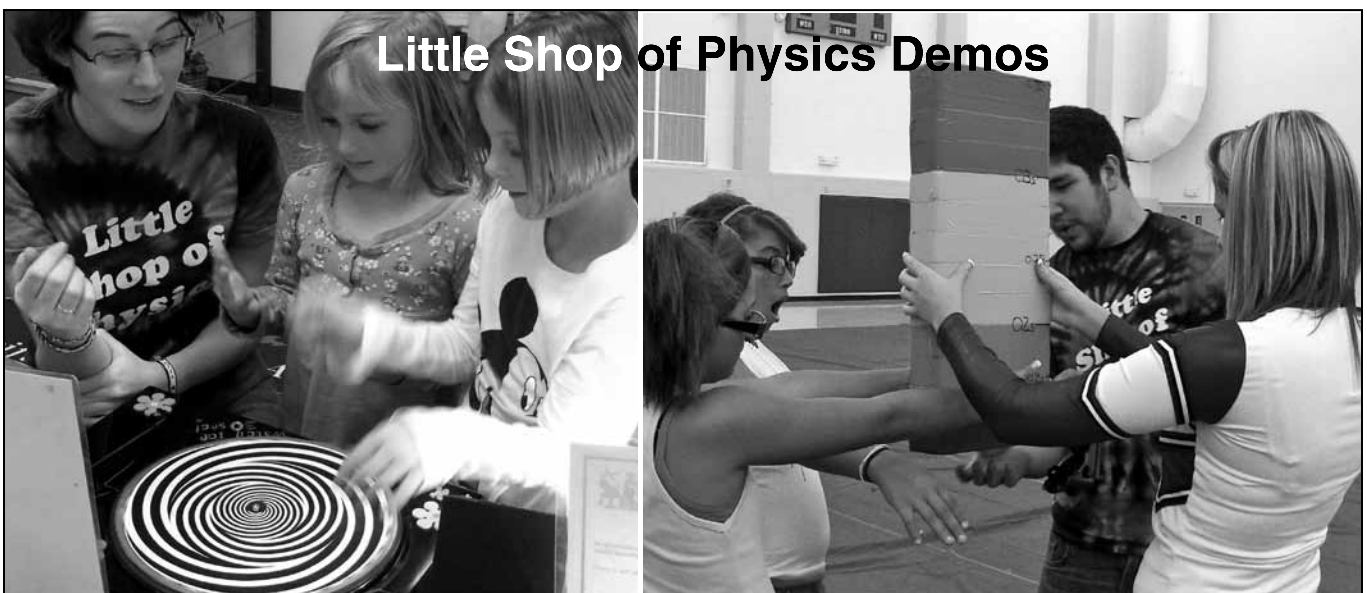
This year marks the fifth Annual Physics Show hosted by students in my high school course. Originally implemented as an alternative summative assessment tool, the Physics Show has become an anticipated event for our district's fifth and sixth grade students. Physics students collaborate as teams in and out of class, abiding by specific guidelines and predetermined timelines, to generate and perform a Physics "Magic" Show at the end of the academic year. The show is judged by faculty members based upon several criteria, including the Physics students' ability to clarify phenomena in an age-appropriate, yet accurate explanation. Examples of guidelines, judging rubrics and student demonstrations will be provided.

EJ07: 2:55–3:05 p.m. Campaign for Recruiting Students to High School Physics

Melissa A. Lapps, AAPT, College Park, MD 20740; mlapps@aapt.org

Gabe Popkin, APS
Marilyn Gardner, AAPT

The Why Physics? campaign is a joint effort between AAPT, the American Physical Society and the Society of Physics Students to help high school physics teachers recruit students, and to inform students, parents, and guidance counselors about the many benefits of taking a physics course. The campaign includes the "Why Physics?" poster and the "7 Myths About High School Physics" brochure. In addition, we are designing a large part of our campaign around enlisting and empowering physics teachers to be strong advocates for physics in their schools. In this talk I will briefly describe our campaign, and share some of the strategies for success that we have learned from teachers around the country.



Harper Center 3023B • Tuesday, August 2 • 3:45–5:15 p.m.

PST2: Poster Session 2

Location: Kiewit Fitness Center Courts
Date: Tuesday, August 2
Time: 5:15–6:45 p.m.

Odd number poster authors will be present 5:15–6 p.m.
Even number poster authors will be present 6–6:45 p.m.
(Posters should be set up by 9 a.m. Monday and taken down by 7 p.m. Tuesday)

Lecture/Classroom

PST2A01: 5:15–6 p.m. Students' Retention and Transfer of Problem Solving through Modeling Activities

Poster - Bijaya Aryal, University of Minnesota-Rochester, Rochester, MN 55904; baryal@umn.edu

The development of students' problem solving skills has been considered one of the major challenges in physics instruction. This study examined the effect of modeling activities on retention and transfer of problem solving skills. An instructional method was designed to help students make connections among ideas learned from various areas to solve physics problems. The method used plan-search-execute (PSE) as three stages of problem solving strategy. The students were expected to represent complex physics problems with simple physical models. The problem solving activity was integrated with abstractly related hands-on activities. Finally, to assess whether or not the students retained and transferred the desired skills, they were asked to solve new sets of related contextual physics problems individually. The results showed a positive influence of modeling activities on student retention of problem solving. The transfer was noticeable only when the modeling activities and related hands-on activities were appropriately sequenced.

PST2A02: 6–6:45 p.m. Physics Education in Russian Schools

Poster - Konstantin Yu. Bogdanov, Lyceum 1586, Moscow 119330; kbogdanov1@yandex.ru

In Russia, physics is taught in middle (seventh-ninth grades) and high (10th-11th grades) schools. Middle school class stresses conceptual discussions rather than the mathematical aspect of the subject. Later, in high school the students will be advanced enough in math to fully grasp the physics concepts. Students take two to four physics classes every week for 45 minutes per meeting in middle school and two to five classes every week for 45 minutes per meeting in high school. The number of students per physics class is about 20. In Russia, everyone has to take physics in high school, but only 20% take an exam covering a wide range of topics. The topic outline and examples of multiple-choice and free-response questions will be presented in the report. A textbook written by the author and used in Russian schools together with animated cartoons helping to teach physics will be also demonstrated.

PST2A03: 5:15–6 p.m. Measurements of Students' Performance on Computational Exercises in Introductory Mechanics

Poster - Marcos D. Caballero, Georgia Institute of Technology Atlanta, GA 30332; caballero@gatech.edu

Matthew A. Kohlmyer, North Carolina State University
Michael F. Schatz, Georgia Institute of Technology

The impact of laboratory and homework exercises on the development of computational thinking is evaluated using a proctored end-of-course computational exercise. We present the motivation for and development of this proctored assignment, an analysis of erroneous student code, and the implications for teaching computation to introductory physics students.

PST2A04: 6–6:45 p.m. Turning the Tables: Letting Middle Schoolers Teach College Students Science

Poster - Jon D. H. Gaffney, University of Kentucky, Lexington, KY 40504; jon.gaffney@uky.edu

Paul Broderson. Winburn Middle School

Seventh graders at a local, low-income serving middle school developed instructional presentations for simple natural phenomena such as acid/base reactions and crushing soft drink cans. Typically, they share these interactive lessons with elementary school students. However, I invited them to turn the tables on my students, elementary education majors enrolled in a required physics course during the spring of 2011. The 7th graders taught their lessons to the future teachers, demonstrating an energizing confidence and enthusiasm. The activities encouraged the pre-service teachers to think about science in new ways, and many even reported the visit as being their favorite day of class. Hopefully, we will be able to capture and build upon that enthusiasm. In the future, we intend more reciprocal visits, where the middle school students get to both teach and learn physics lessons from the university students.

PST2A05: 5:15–6 p.m. Verification of the Gravitational Equivalence Principles Using Video Modeling

Poster - Carolina Galvis, Grupo de Física / Gimnasio La Montaña, Bogotá 09002 Colombia; grupofisica@glm.edu.co

Mauricio Mendivelso-Villaquirán, Grupo de Física / Gimnasio La Montaña

Some gravitational experiments need special conditions that are not available in the classroom (i.e. low friction, low air drag force or absence of gravitational field). Following video analysis by Persson and Hagen (Phys. Educ. 46,12) we verify the weak equivalence principle in our classroom. In addition, we verify the strong equivalence principle using the same technique and a low-cost experimental setup.

PST2A06: 6–6:45 p.m. What Is a Quantum?

Poster - Art Hobson, University of Arkansas, Fayetteville, AR 72701-3256; ahobson@uark.edu

Electrons, photons, etc., are field quanta, yet we continue to teach students that they are particles, thus making quantum physics into a topic that's not only difficult but, much worse, logically inconsistent. An elementary field quantum is a discrete, spatially extended, highly unified, bundle of field energy. Quantum field theorists understand that "particles" are quanta of various fields. The Schroedinger equation describes nonrelativistic material field quanta. But this understanding has not seeped through to most teachers and so students are stuck with all sorts of wave-particle paradoxes. How can particles exhibit all these extended, non-local effects? Not only these paradoxes, but such vacuum phenomena as the Lamb shift and Casimir effect, testify to the primacy of a field picture. This poster presents a simple method of teaching these fundamentals, along with supporting statements by Maxwell, Einstein, Weinberg, and Robert Mills.

PST2A07: 5:15–6 p.m. Engaging Non-STEM Majors in Authentic Problem Solving

Author: Poster - Daniel Loranz, Truckee Meadows Community College, Reno, NV 89512; dloranz@gmail.com

"PHYS 117: Intro to Space Science and Engineering" is a new course at Truckee Meadows Community College developed specifically to engage non-STEM majors in authentic problem solving. In this course, students earn science credits by completing hands-on projects in high-altitude ballooning, lighter-than-air vehicles, rocketry, and robotics. All course projects pose legitimate and unsolved problems that require students to balance multiple competing constraints in the search for optimal solutions. And each project takes students through a complete cycle of i) Design/Build, ii) Deploy/Evaluate, and iii) Reflect/Report.

PST2A08: 6–6:45 p.m. Assessing Learning Beyond Content*

*Poster - Gina Merys,** Creighton University, Omaha, NE 68178; gmm89957@creighton.edu*

Jay Leighter, Theresa Edmonds, Michael Cherney, Creighton University

Introductory undergraduate education in physics frequently involves large classroom instruction and the assessment of student learning using content- and skill-based tests. This is not the case in certain other disciplines. (It is also not the case in workshop-type courses or in physics research experiences.) The development of an interdisciplinary program in Energy Studies created the need for non-traditional evaluation techniques that could be used in a project-based curriculum. These assessment methods draw on the best practices in English, Communication Studies, Engineering and Physics. The methods developed have applicability to the measurement of life-long learning skills, teamwork skills, and innovation ability as well as for the assessment of content knowledge and problem solving skills.

* This work is supported by the United States Department of Energy.

** Sponsor: Michael Cherney

PST2A09: 5:15–6 p.m. Student Use and Perception of Tablet PCs; Are They Helpful?

Poster - Charles A. Parker, Colorado School of Mines, Golden, CO 80401; cparker@mines.edu*

Zachary T. Boerner, Vincent H. Kuo, Susan E. Kowalksi, Frank V. Kowalski

Research shows that learning is more effective when students are actively interacting with the professor and each other. To facilitate these interactions, the Technology in the Classroom Committee (TICC) at the Colorado School of Mines provides Tablet PCs to physics students in selected courses each semester. These Tablet PCs are used in conjunction with the InkSurvey tool, which allows for real-time feedback in the classroom. The Tablet PCs also allow for sophisticated student collaboration using notetaking software, providing a means for note sharing. In our poster, we explore how the Tablet PCs have been used in the physics classrooms at CSM and present preliminary data on student perceptions of having the Tablet PCs.

* Sponsor: Vincent H. Kuo

PST2A10: 6–6:45 p.m. Concept-Mapping Mechanics

Poster - Andrew Pawl, University of Wisconsin-Platteville, Platteville, WI 53818: pawla@uwplatt.edu

One reason that introductory mechanics is a required course in many disciplines is that it has a very narrow focus but a very rich conceptual structure. Students of mechanics are expected to see the flexibility that is gained by developing many different descriptions for the same physical process (e.g. the motion of an object under the influence of gravity). Unfortunately, physics education research suggests that most students fail to appreciate this central aspect of the curriculum and instead view kinematics, momentum, and energy as completely separate ideas. Used properly, a concept map can be an ideal means of communicating the structure of physics to students. In this poster, we present a novel approach to designing a concept map for mechanics and indicate how student use of this tool can be tracked and studied.

PST2A11: 5:15–6 p.m. Fostering Computational Thinking: Computer Modeling Homework in Intro. Mechanics

Poster - Michael F. Schatz, Georgia Institute of Technology, Atlanta, GA 30332; michael.schatz@physics.gatech.edu

Marcos D. Caballero, Georgia Institute of Technology
John B. Burk, The Westminster Schools
Matthew A. Kohlmyer, North Carolina State University

Introductory physics courses typically fail to provide students with significant opportunities to use a computer to solve science and engineering problems. We present an overview of recent work to develop laboratory and homework exercises on numerical modeling, simulation, and visualization for students in introductory mechanics in both high school and large enrollment university courses.

PST2A12: 6–6:45 p.m. Why Should I Learn This? Addressing Student Motivation with Relevant Professional Examples

Poster - Laura Tucker, Harvard University, Cambridge, MA 02138; ltucker@seas.harvard.edu*

Eric Mazur, Harvard University

Student learning hinges on motivation.[1] However, many students don't enter our classrooms knowing why learning physics has value, often asking, "Why should I learn this?" As instructors, we can help our students develop motivation. However, effectively conveying the power of physics principles and thinking is challenging, especially when directed at non-physics majors. Specific examples may not be readily available, and take time to research. Furthermore, testimonies from many individuals working in fields relevant to students can have more power than words from the instructor alone. Addressing this need, we have created a series of slides to be projected before lecture or used as handouts. These materials include profiles of professionals explaining how studying physics has helped them in their diverse careers. We hope to demonstrate relevance beyond the classroom of studying physics by providing answers from many relevant figures to the students? Questions about why learning physics is useful.

1. Susan Ambrose, et. al. *How Learning Works, 7 Research-Based Principles for Smart Teaching* (2010).

*Sponsor: Eric Mazur

PST2A13: 5:15–6 p.m. Regularities in Real World Complex Trajectories Using Video Modeling

Poster - Arturo Velasquez, Grupo de Física / Gimnasio La Montaña, Bogotá, 09002, Colombia; grupofisica@glm.edu.co*

Fernando Huertas, Grupo de Física / Gimnasio La Montaña

Regular high school kinematics courses use rectilinear, projectile, and circular paths to introduce the idea of composite path. However, it is possible to introduce the same notion using real-world trajectories in the classroom: motion of a tennis raquet grip during free fall and motion of selected points on a spinning ballerina are analyzed with video modeling and detailed here.

*Sponsor: Mauricio Mendivelso Villaquirán

PST2A14: 6–6:45 p.m. Learning from/with Physics 'Sniglets': Classroom Neologisms in College Physics

Poster - Richard Zajac, Kansas State University at Salina, Salina, KS 67401; rzajac@sal.ksu.edu

The words introductory students want to use don't always exist, but why should that stop them? A look at students' top wish list of useful "physics sniglets" provides some insight into their conceptual development. New contributions are also welcome.

Technologies

PST2B01: 5:15–6 p.m. Open-source Electronic Education Tools Using Tablet PCs

Poster - Zachary T. Boerner, Colorado School of Mines, Golden, CO 80401; zboerner@mines.edu*

Charley A. Parker, Vincent H. Kuo, Susan E. Kowalski, Frank V. Kowalski

The Technology in the Classroom Committee (TICC) at the Colorado School of Mines provides and manages a number of electronic education tools available for anyone to access. These include the InkSurvey tool, a wiki for information on the software used by TICC, and a forum for users to discuss Tablet PCs and the classes in which they are enrolled. InkSurvey, in a manner similar to clickers, provides instructors with the means to pose open-format questions. Combined with the use of Tablet PCs, this allows the instructor to perform a real-time formative assessment of students' problem solving abilities. This poster will explore the utility of each of these tools and suggest how institutions outside of the Colorado School of Mines may use them to further their own educational programs.

* Sponsor: Vincent H. Kuo

PST2B02: 6–6:45 p.m. Item Response Theory Analysis of the Mechanics Baseline Test

Poster - Carolin N. Cardamone, MIT, Cambridge, MA 02139; cnc@mit.edu

Saif Rayyan, Daniel Seaton, Albert Wu, Dave Pritchard, MIT

Item Response Theory (IRT) algorithms are being developed to better assess student performance in our Integrated Learning Environment for Mechanics (ILEM; [1]). A student's skill, as determined by IRT, provides more information than the traditional student score because it takes into account universally calibrated problem difficulties. Importantly, it allows determination of skill on a universal scale independent of which questions the student answers. Our approaches seek to dynamically update student and class skill level in ILEM throughout the course based on their performance, rather than relying primarily on the gain from pre/post testing. We present results comparing IRT and pre/post gain analysis of the Mechanics Baseline Inventory Test, including discussion of item parameters for the 26 questions on the MBT exam.

1. R. Teodorescu, A. Pawl, S. Rayyan, A. Barrantes, D. E. Pritchard, "Toward an Integrated Online Environment," *2010 Physics Education Research Conference Proceedings*, edited by S. Rebello, M. Sabella and C. Singh

PST2B03: 5:15–6 p.m. MAPS: Augmenting Attitudes and Transfer of Problem-solving Skills

Poster - Carolin Cardamone, MIT, Cambridge, MA 02139; cnc@mit.edu

Analia Barrantes, Saif Rayyan, and Dave Pritchard, MIT
Andrew Pawl, University of Wisconsin–Platteville

We present the ongoing implementation and assessment of our Modeling Applied to Problem Solving (MAPS) Pedagogy.[1,2] MAPS helps students develop expert-like problem solving skills. In particular, strategic skill is imparted by specifying the relevant systems and interactions as a guide to selecting the appropriate physical model for solving the problem. After taking a review course in mechanics using the MAPS pedagogy, students show significant improvement in three major categories: 1) problem solving ability measured by a calibrated final exam, 2) attitudes toward science in general (and specifically toward problem solving) measured by the CLASS,[3] 3) transfer of problem solving skills to following courses, measured by enhanced exam performance in the subsequent Electricity and Magnetism course. We are expanding the implementation of MAPS in introductory courses inside and outside MIT, and looking for collaborators.

1. A. E. Pawl, A. Barrantes and D. E. Pritchard, "Modeling applied to problem solving," in *Proceedings of the 2009 Physics Education Research Conference*, Ann Arbor, MI, 2009.
2. S. Rayyan, A. E Pawl, , A. Barrantes, R. Teodorescu, and D. E. Pritchard, "Improved student performance in electricity and magnetism following prior MAPS instruction in mechanics," *2010 Physics Education Research Conference Proceedings*, edited by S. Rebello, M. Sabella, and C. Singh.
3. W. K. Adams, K.K., Perkins, N., Podolefsky, M., Dubson, N., Finkelstein, and C. E. Weiman, "A new instrument for measuring student beliefs about physics and learning physics: the Colorado Learning Attitudes about Science Survey." *Physical Review Special Topics: Physics Education Research* **2**(1), 010101, 2006.

PST2B04: 6–6:45 p.m. Learning about Teaching Physics: New Podcast on Education Research Results

Poster - Stephanie V. Chasteen, University of Colorado–Boulder, Boulder, CO 80309; stephanie.chasteen@colorado.edu

Michael Fuchs, Boulder High School

Want to get the inside scoop on the latest research on teaching and learning? Curious about physics education research results, but don't have the time to keep up with the journals? Now you can keep up with the literature during your daily commute or trip to the gym with a new audio podcast, "Learning About Teaching Physics."[1] Each short, well-produced podcast pairs education researchers and teachers to talk about an interesting result from the field, such as research on lecture demos, new research on the use of clickers, and whether tests can help students learn. What do these results mean? How does it relate to classroom practices? What challenges might a teacher face in trying to use such an idea? Stop by the poster to learn about the project, talk about the need to communicate between PER and practicing teachings, and to pick up a CD with the podcasts.

1. "Learning About Teaching Physics" can be found on Compadre.org and at my blog, http://blog.sciencegeekgirl.com.

PST2B05: 5:15–6 p.m. An Inside Look: Practical Strategies for Personal Response Systems ('clickers')*

Poster - Stephanie V. Chasteen, University of Colorado–Boulder, Boulder, CO 80309; stephanie.chasteen@colorado.edu

Katherine K. Perkins, University of Colorado–Boulder
Carl E. Wieman, Past director, Science Education Initiative

I never would have understood how clickers could be used to transform classroom teaching if I hadn't watched them in the hands of experienced instructors. Not every teacher has that opportunity. This poster will give you an overview of some of the resources we have created on clickers: Get a glimpse inside our classes at the University of Colorado with short videos, grab a copy of our instructor handbook, and come discuss any challenges you've had in implementing this powerful technique.[1] I'll share ideas and strategies for success with clickers, from writing questions to facilitating discussion. In many ways, clickers help us support student achievement of higher order thinking skills, which are the hallmark of deeper learning.

1. All clicker videos and resources are at http://STEMclickers.colorado.edu, and the University of Colorado's clicker question collection is at http://www.colorado.edu/physics/EducationIssues/cts/.

*This work was funded by CU's Science Education Initiative and the National Science Foundation Grant No. 0737118.

PST2B06: 6–6:45 p.m. Thermo-economics Optimization and Ecological Tax*

Poster - Eduardo Chávez Lima, Escuela Superior de Computo - Instituto Politécnico Nacional, D.F, C.P. 07738, Mexico; echavezl@ipn.mx

Today, thermodynamics allows modeling processes that are innovative, added to this, the development of economic processes allows us to create links to the explanation of formulations in a different social, ethical, and historic context. So the relationship between thermodynamics and economics tries to solve conditions on the border of both sciences, proposing thermo-economics as a new branch of knowledge like econophysics, sociophysics, or quantum computing. In this work, we will determine the economically optimal operating point to models of power plants, using different energy transfer laws, similar to Curzon-Ahlborn, through the study of several operation regimes (optimization criteria) such as maximum power out, maximum ecological function, and maximum efficiency.

*Work supported by COFAA -IPN.

PST2B07: 5:15–6 p.m. Using Virtual Experiments to Help Student Reasoning in Physics

Poster - Jiawu Fan, Beijing Normal University; wojiaofjw@yahoo.com.cn

Shaona Zhou, South China Normal University
Chunhui Du, Jing Han, Lei Bao, Ohio State University

We develop a computer virtual reality (VR) platform that supports interactive physics activities. We use the platform to help students conduct guided explorations to learning physics concepts and reasoning. A teaching experiment with two random selected groups of students was conducted. Students were asked to complete a one-hour exploration on one dimensional motion (1D motion) and circular motion. Using a cross-controlled design, we find that students doing virtual experiments outperform their peers doing paper-based problem solving. Show specific cases --One group of students did the 1D motion task in problem solving form and the circular motion task in VR form, and the other group did the 1D motion in VR form and the circular motion in problem solving form. Students in both groups liked the VR form more than problem solving form and perform better in VR form.

PST2B08: 6–6:45 p.m. Open Source Physics in the Amusement Park

Poster - Michael R. Gallis, Penn State Schuylkill, Schuylkill Haven, PA 17972; mrg3@psu.edu

There are a variety of tools from the Open Source Physics project appropriate for use in typical amusement park physics activities. The Tracker Video Analysis tool can be used to extract data from video clips that can be taken with almost any modern digital camera. The Easy Java Simulations tool allows users to easily build simulations of varying levels of complexity. This poster presents the use of these tools for "High School Physics Day" activities at local amusement parks and in a special topics course offered to advanced local high school students in a dual enrollment special topics course.

PST2B09: 5:15–6 p.m. Going Beyond End of Chapter Problems in LON-CAPA

Poster - Boris Korsunsky, Weston High School, Weston, MA 02493; korsunskyb@mail.weston.org

Raluca Teodorescu, Carolin Cardamone, Saif Rayyan, David Pritchard, MIT

We describe the open-source library of physics problems we are collecting in LON-CAPA (http://loncapa.mit.edu). Currently, the library features both traditional and research-based problems intended to expose students to various contexts, problem features, knowledge and cognitive processes. We are adding conceptual questions and challenge problems that require out of the box thinking. The conceptual questions are developed at Ohio State University and MIT. The challenge problems are inspired by various tasks published in *The Physics Teacher.* [1-3] We are planning to evaluate the difficulty and pedagogical effectiveness of those problems using Item Response Theory (IRT). This permits determination of a student's skill independent of which problems they do. We welcome collaborators willing to add their problems to our library.

1. B. Korsunsky, "Ready, SET, Go! A research-based approach to problem solving," *Phys. Teach.* **42**, 493-497 (2004).
2. B. Korsunsky, B. "Physics Challenges for Teachers and Students (a monthly column), " *Phys. Teach.* (2001-present). The library of past Challenges is online at http://tpt.aapt.org/features/physics_challenge_solutions
3. B. Korsunsky, 'Braintwisters for physics students," *Phys. Teach.* **33**, 550-553 (1995).

PST2B10: 6–6:45 p.m. Harnessing Technology to Help Students Learn

Poster - Taha Mzoughi, Kennesaw State University, Kennesaw, GA 30144-5591; tmzoughi@kennesaw.edu

In an attempt to improve student learning in introductory physics courses, we have used active learning methods focused on the use of technology. The courses follow a hybrid format where most of the learning occurs outside of class. Lecture time is used to answer and discuss questions and to explore the topics students find interesting. The technologies used include computer-mediated and hands-on activities. Instead of lectures, students complete online multimedia quizzes, embedding both lecture type recording segments and simulations. The quiz is intended to help students focus on the intricacies of the topic covered. Homework is also completed online. It includes both traditional end of the chapter questions and simulation mediated questions. Hands-on laboratory activities are preceded by prelaboratory simulation-mediated activities. We will describe the methods used and preliminary results on the effectiveness of the approach.

PST2B11: 5:15–6 p.m. PhET: An Expanding Resource of Free Online Interactive Simulations

Poster - Noah Podolefsky, University of Colorado–Boulder, Boulder, CO 80309; Noah.Podolefsky@colorado.edu

Katherine K. Perkins, PhET Team

The PhET Interactive Simulations* project is expanding in new directions. We are building new connections to our teacher-user community—get the latest news by following our new blog, joining us on Facebook, or receiving Twitter updates. We're also making sims for middle school science—adapting existing sims, creating new ones, and partnering with teachers to investigate their use in classrooms. We now have more than 100 simulations of physical phenomena that create animated, interactive, game-like environments in which students learn through scientist-like exploration. Our simulations emphasize the connections between real-life phenomena and the underlying science, make the invisible visible, and include the visual models used by expert scientists. New sims include: Gravity and Orbits, Capacitor Lab, Density, Buoyancy, Bending Light, Fluid Pressure and Flow, and Resonance Lab, along with a growing collection of chemistry simulations. Visit http://phet.colorado.edu.

* The PhET Project is funded by the Hewlett Foundation, NSF CCLI Grant #0817582, NSF DRK12 Grant #1020362, the O?Donnell Foundation, JILA, and University of Colorado–Boulder.

PST2B12: 6–6:45 p.m. Teaching Physics Across Grades with Sustainable Energies via Digital Technologies

Poster - David Rosengrant, Kennesaw State University, Kennesaw, GA 30144-5591; drosengr@kennesaw.edu

Matthew Laposata, Kennesaw State University

Many college and high school students do not understand the basic physics behind sustainable energies. As a result of this, students have erroneous beliefs about sustainable energies. Thus, the "Sustainable Homes: Building 'Smarter' Houses Today for a Better Tomorrow" project aims to combine physics with environmental science so that students can better understand both sciences. We have updated our website (http://ihome21.kennesaw.edu/) with new activities and videos in the past year. Through these exercises, students will: see detailed descriptions of sustainable housing technologies and how they differ from conventional systems; use data from actual sustainable homes, including the "Weatherford Place" development in Roswell, GA, to critically analyze the performance of these technologies; and conduct hands-on activities that demonstrate how these sustainable technologies operate on a smaller scale. We also report on how teachers in our professional development sessions have utilized these resources.

PST2B13: 5:15–6 p.m. First Assessment of the Integrated Learning Environment for Mechanics

Poster - Raluca E. Teodorescu, Massachusetts Institute of Technology, Cambridge, MA 02139; rteodore@mit.edu

Analia Barrantes, Saif Rayyan, and David Pritchard, MIT
Sara Julin, Whatcom Community College

We present the first evaluation of our open-source Integrated Learning Environment for Mechanics (ILEM) [1] – http://loncapa.mit.edu. The centerpiece of this environment is a collection of multi-level research-based homework sets organized by topic and cognitive complexity, whose design helps students learn physics problem solving. These sets are associated with learning modules that contain short expositions of the content supplemented by integrated open-access videos, worked examples, simulations, and tutorials. In our evaluation of homework problems, we analyze student attempts, preferences and performance on different types of problems (e.g. representation, ranking and strategy writing problems). In our evaluation of content, we analyze observations generated by student comments in the discussion boards and during critical thinking activities. We continue to expand and improve the content and we welcome users and collaborators.

1. R. Teodorescu, A. Pawl, S. Rayyan, A. Barrantes and D. E. Pritchard, "Toward an Integrated Online Environment," *2010 Physics Education Research Conference Proceedings*, edited by S. Rebello, M. Sabella and C. Singh

PST2B14: 6–6:45 p.m. A Meteorological Network Using Open Source Hardware and Software

Poster - Sergio Trujillo, Grupo de Física / Gimnasio La Montaña, Bogotá 09002, Colombia; grupofisica@glm.edu.co*

Juan P. Villamil, Simon Vargas, Juan F. Ceron, Fabian Martinez, Grupo de

Física / Gimnasio La Montaña

We design a weather monitoring network in Bogotá, Colombia, using semiconductor devices, Arduino platform, and plotting software developed with open source software processing. Using some open license schematics, teams of high school physics teachers and students build Arduino-based interfaces and plotting/data storage software to install and set up meteorological stations at several schools along the city. We obtain temperature, wind velocity, humidity, barometric pressure and precipitation vs. time plots over variable time intervals to study weather behavior in our city.

*Sponsor: Mauricio Mendivelso Villaquirán

PST2B15: 5:15–6 p.m. Ready for Classroom Use? Assessment of the Andes Homework System

Poster - Brett van de Sande, Arizona State University, CIDSE, Tempe, AZ 85287-8809; bvds@asu.edu

The Andes intelligent tutor homework system has been used in the classroom at the U.S. Naval Academy and elsewhere since 2000. It now contains more than 500 problems covering most of the topics in a standard introductory physics course. During the last few years, we have developed a new version of Andes that runs in a web browser. We describe new data-mining techniques for automatically detecting, and correcting, errors and weakness in the tutor system. Also, we present evidence from both laboratory and classroom studies that new web-based Andes is ready for classroom use.

PST2B16: 6–6:45 p.m. The Studies in Motion Videodisc: New Uses for Old Media

Poster - Christopher D. Wentworth, Doane College, Crete, NE 68333; chris.wentworth@doane.edu

Amy E. Craig, Doane College
Robert G. Fuller, University of Nebraska, Lincoln

"The Studies in Motion" videodisc was an early example of interactive multimedia produced by the Corporation for Public Broadcasting and The Annenberg School of Communications for educational use in an introductory college lab setting. While videodisc technology is obsolete, the media produced for this videodisc remains a rich source of material for introductory physics students to explore and analyze. We present several examples of using digitized clips from the original videodisc for introductory physics activities using modern digital video analysis software such VideoPoint and Tracker. All of the original video media and suggested activities are available on the web at the Humanized Physics Project website.*

* http://physics.doane.edu/hpp/Resources/SIMLD/SIMLDHome.htm.

PST2B17: 5:15–6 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. 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.

Physics Education Research

PST2C01: 5:15–6 p.m. Influence of Sequencing Individual and Group Activities on Student Learning

Poster - Bijaya Aryal, University of Minnesota-Rochester, Rochester, MN 55904; baryal@umn.edu

Previous research findings have documented the positive impact of group interaction on student learning. Much of the previous work has focused on the use of group activities and assignments. However, it is equally important for students to develop the skills to make decisions individually, which suggests the necessity of individual activities and assignments in the learning space. I have integrated individual and group learning activities in the design of a three-stage learning sequence. The learning sequence involves two individual assignments and one group assignment. As a part of the assessment of this instructional strategy, the correlation between the sequence of the individual and group assignments and enhanced student learning will be evaluated. This presentation describes the learning activity sequence with some examples. In addition, preliminary results of the effects of variations in the sequence of group and individual activities on student learning is presented.

PST2C02: 6–6:45 p.m. Student Reasoning about Graphical Representations of Definite Integrals

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

John R. Thompson, Thomas Thomas Wemyss, University of Maine

Physics students are expected to apply the mathematics learned in their mathematics courses to physics concepts and problems. Few PER studies have distinguished between difficulties students have with physics concepts and those they have with mathematics concepts, application of those concepts, or the representations used to connect the math and the physics. We are conducting empirical studies of student responses to mathematics questions dealing with graphical representations of (single-variable) integration. Reasoning in written responses could be put into roughly three major categories related to particular features of the graphs: area under the curve, position of the function, and shape of the curve. In subsequent individual interviews, we varied representational features to explore the depth and breadth of the contextual nature of student reasoning, with an emphasis on negative integrals. Results suggest an incomplete understanding of the criteria that determine the sign of a definite integral.

PST2C03: 5:15–6 p.m. Assessing Student Affect in Learning Computation in Introductory Mechanics

Poster - Marcos D. Caballero, Georgia Institute of Technology, Atlanta, GA 30332; caballero@gatech.edu

Matthew A. Kohlmyer, North Carolina State University
Michael F. Schatz, Georgia Institute of Technology

An introductory physics course at Georgia Tech requires students to learn numerical computation for describing physical phenomenon that are not amenable to being solved using analytic methods. Students' motivation to learn computation and anxiety about solving computational exercises varies greatly. The attitudes, interests, and values that students exhibit when learning a subject can play a role in their motivation to and anxiety about learning the subject. We present a brief overview of the development of a new tool, the Computation Modeling in Physics Attitudinal Student Survey (COMPASS), aimed at helping to characterize students' attitudes about, interests in, and values concerning computation, as well as preliminary measurements derived from this instrument.

PST2C04: 6–6:45 p.m. Teaching Assistants' Reasons for the Design of Problem Solutions for Introductory Physics: Rationale and Methodology

Poster - William Mamudi, Western Michigan University, Kalamazoo, MI 49008-5444; william.o.mamudi@wmich.edu

Charles Henderson, Western Michigan University
Shih-Yin Lin, Chandralekha Singh, University of Pittsburgh
Edit Yerushalmi, Weizmann Institute of Science, Israel

As part of a larger study to understand how instructors make teaching decisions, we investigated how graduate teaching assistants (TAs) perceive features of written problem solutions. TAs are an important population to understand; they often provide significant instruction and they also represent the pool of future physics faculty. This talk will focus on the methodology used to study TAs enrolled in a training course. Data were collected via a series of tasks related to concrete instructional artifacts (solutions to the same physics problem that vary in their representation of expert problem solving as well as in their instructional approach). Important aspects of the design were a) using artifacts from a previous study of faculty to allow for comparison of results, b) developing a written questionnaire that requires respondents to explicitly connect problem features with preferences and reasons, and c) documenting respondent ideas both pre- and post-discussion within their training course.

PST2C05: 5:15–6 p.m. An Optics Concepts Test

Poster - Alex Chediak, California Baptist University, Riverside, CA 92504; achediak@calbaptist.edu

A series of conceptual tests exist that allow educators to compare their normalized gains to those of other educators, and together determine best practices (e.g., FCI, MBT, FMCE, ECCE, CSEM, and DIRECT). But a standard conceptual test for optics is a seeming omission in the PER literature--this in spite of the common observation, by physics educator and students alike, that optics is perhaps one of the most conceptually challenging areas of undergraduate physics. The math is often simple (a few equations, no vector algebra), but the concepts easy to confuse. This poster presents a multi-choice question optics conceptual test, consisting of 20 questions, each having five choices. Topics covered include reflection, refraction, mirrors, lenses, interference, cameras, human eye maladies, and optical corrections. I seek partners to join me in using these questions on pre- and post-tests with their students.

PST2C06: 6–6:45 p.m. Concentration Analysis and Item Response Theory*

Poster - Li Chen, School of Electronic Science and Engineering, Southeast University, Nanjing 210096, China; chenli.seu@163.com

Yan Tu, Southeast University
Jing Han, Chunhui Du, Lei Bao, Ohio State University

Both Concentration Analysis and Item Response Theory (IRT) are useful tools in education assessment. In concentration analysis, the concentration factor gives a scaled value describing how students' answers to individual questions are concentrated. Perfectly concentrated responses will produce a concentration value of 1 while random responses will produce 0. In IRT, an estimated parameter, the guessing parameter, also describes the chance of guessing in response to a question. Then it is meaningful to find out if these two factors are related. Based on the college students' FCI data collected at The Ohio State University, the concentration factor and guessing parameters for all 30 FCI questions are calculated. The results show a weak correlation between these two measures (Sig.=0.222). After comparing the algorithms, we find that concentration factor focus on all of the choices, while in IRT only the binary score (right or wrong) are used. The implications of the differences will be discussed with suggestions on revisions of the algorithms.

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

PST2C07: 5:15–6 p.m. Evaluation of Student Exam Note Sheets in Introductory General Physics

Poster - Fredrick M. DeArmond, Portland State University, Portland, OR 97207; fmd@pdx.edu

Chris Sheaffer, Ralf Widenhorn, Portland State University

An ongoing study is being performed involving the collection and evaluation of note sheets prepared by students for use on exams in a first-year algebra-based physics courses of 120-200 students. The note sheets are evaluated based on organization, quantity, the use of examples and diagrams, and the number of topics covered. In addition, a Likert scale survey was given to students regarding how they generated and used their note sheets. Preliminary results are presented and suggest negative correlations between exam grades and the quantity of equations on note sheets, and those who most strongly agreed with the statement "I referred to my note sheet many times during the exam." Positive correlations are found between exam grades and organization, and students who most strongly agreed with the statement "making my note sheet helped me review for the exam."

PST2C08: 6–6:45 p.m. Teaching Assistant and Student Interactions in a SCALE-UP Classroom

Poster - George DeBeck V, Oregon State University, Corvallis, OR 97330; debeckg@onid.orst.edu

Dedra Demaree, Oregon State University

In the spring term of 2010, Oregon State University began using a SCALE-UP-style classroom in the instruction of the introductory calculus-based physics series. Instruction in this classroom was conducted in three two-hour sessions facilitated by the primary professor and either two graduate teaching assistants (GTAs) or a graduate teaching assistant and an undergraduate learning assistant (LA). During the course of instruction, two of the eight tables in the room were audio and video recorded. We examine the practices of the GTAs and LAs in interacting with the students through both qualitative and quantitative analyses of these recordings. In particular, we examine changes in the practices of the GTAs and LAs as they gain experience in the SCALE-UP environment, as well as differences between the practices of the individual GTAs and Las.

PST2C09: 5:15–6 p.m. Rasch Model Analysis of a Brief Electricity and Magnetism Assessment (BEMA)

Poster - Lin Ding, School of Teaching and Learning, The Ohio State University, Columbus, OH 43210; ding.65@osu.edu

The Brief Electricity & Magnetism Assessment (BEMA) is a 30-item multiple-choice test, designed to measure student understanding of basic electricity and magnetism (E&M) concepts at the introductory physics level. It differs from concept inventories, such as the FCI, in that it covers a broad spectrum of sub-topics in a specific knowledge domain. A great deal of research previously has been conducted to evaluate its validity and reliability, as well as to apply it for gauging student performance. These efforts all utilized the Classical Test Theory (CTT) for analyzing quantitative information extracted from a large collection of data. In the present study we used the Rasch model, an item response-based theory (IRT), to analyze BEMA. Specifically, we investigated the extent to which the BEMA items can measure a single underlying construct--students' understanding of E&M. We also attempted to seek multiple latent constructs in BEMA for comparison with the single-construct case.

* This project is partially supported by the OSU EHE SEED grant.

PST2C10: 6–6:45 p.m. Solving Synthesis Problems through Analogical Encoding

Poster - Lin Ding, School of Teaching and Learning, The Ohio State University, Columbus, OH 43210; ding.65@osu.edu

Andrew F. Heckler, Cameron M. Teichgraeber, Ohio State University

Real-world physics problems often require a solver to apply several concepts jointly to reach a coherent solution. In an effort to enhance students' problem solving abilities, we developed and used synthesis problems, which combine multiple topics that are taught at sufficiently different time points in the introductory physics course or beyond, to help students with recognition, coordination, and integration of fundamental physics concepts. To further provide appropriate scaffolding, we employed the analogical encoding approach by presenting to and asking students to compare two examples of similar underlying structure yet differing surface features prior to their solving a target problem. We investigated the effects of analogical encoding on students' solving physics synthesis problems through three training conditions: example problems with comparison, examples without comparison, and no examples. All students solved the same target synthesis problem at the end of training. Preliminary results show an advantage for analogical encoding.

PST2C11: 5:15–6 p.m. Towards a Better Understanding of Confusion

Poster - Jason E. Dowd, Harvard University, Cambridge, MA 02138; jedowd.work@gmail.com

Ives S. Araujo, Universidade Federal do Rio Grande do Sul
Eric Mazur, Harvard University

Physics instructors typically try to avoid confusing their students. However, the truism underlying this approach, "confusion is bad," has been challenged by educators dating as far back as Socrates, who asked students to question assumptions and wrestle with ideas. This begs the question: Are confused students lost, or does their confusion indicate more critical thinking than less-confused learners? In previous work, we focused on a single reading assignment, a snapshot. Insights from this work allowed us to refine and expand our study to more than 40 snapshots that span two semesters of introductory physics, which involved Just-in-Time Teaching and research-based reading materials. We evaluated performance on assignments while simultaneously asking students to self-assess their confusion over the material, and then probed whether "confused" students were correct more or less frequently than "not-confused" students. We highlight our results and draw some conclusions about confusion. Is it really as bad as it seems?

PST2C12: 6–6:45 p.m. E-Games and Graph Problems: Helping Students Play the Game

Poster - Elizabeth Gire, University of Memphis, Memphis, TN 38152; egire@memphis.edu

Dong-Hai Nguyen, N. Sanjay Rebello, Kansas State University

An epistemic game is a structured activity used to guide inquiry or solve a problem. For example, list making is an epistemic game one might use to identify and organize items needed for making a meal. Physicists often (implicitly) use a graphical analysis epistemic game to analyze data or to solve problems involving graphs. In analyzing a set of interviews with introductory physics students, we use the framework epistemic games to characterize students' abilities to solve graph problems and how a tutor helps these students become more competent players of this e-game.

PST2C13: 5:15–6 p.m. Case Studies of Increasing Participation in a Physics Learning Community

Poster - Renee Michelle Goertzen, Florida International University, Miami, FL 33199; rgoertze@fiu.edu

Eric Brewe, Laird Kramer, Florida International University

We present a case study of two introductory undergraduate physics students' increasing participation in the physics learning community at Florida International University (FIU). An implicit goal in the reforms implement by the Physics Education Research Group at FIU has been the establishment of multiple opportunities for entry into and participation in a community of physics learners. These opportunities include classes using research-based curricula (Modeling Instruction and Investigative Science Learning Environment), a Learning Assistant program, and a growing cohort of physics majors. Using interviews conducted across a year of introductory physics, we explore the trajectories of two students who have successfully increased their participation in a physics learning community.

PST2C14: 6–6:45 p.m. Enhancing Student Interest through Increased Autonomy in the Physics Classroom

Poster - Nicholas R. Hall, University of California, Davis, Davis, CA 95616; nrhall@ucdavis.edu

David Webb, University of California, Davis,

We perform an experiment involving 300 students in an active-learning introductory physics course for biological science undergraduates at the University of California, Davis. The students are divided into 10 discussion/labs (DLs) that meet for 140 minutes twice a week and are taught by five teaching assistants (TAs). Five DLs are "autonomy-supportive" in that during the second half of each class the students choose how to apply, expound on, or clarify what they have learned. We compare this experimental group to a control group of five "traditional" active-engagement DLs. Each TA teaches one autonomy-supportive and one traditional DL. We hypothesize that increased autonomy-support will help improve attitudes, increase interest, and enhance performance. We measure these effects with grades and specially designed surveys. This study could have important implications for introductory physics class design by testing whether the positive effects of increased student autonomy in class outweigh the benefits of the alternatives.

PST2C15: 5:15–6 p.m. Probing Student Understanding with Alternative Questioning Strategies

Poster - Jeffrey M. Hawkins, The University of Maine, Orono, ME 04473; jeffrey.hawkins@maine.edu

Brian W. Frank, Michael C. Wittmann, John R. Thompson, Thomas M. Wemyss, The University of Maine

Common research methodology uses research tasks that ask students to identify a correct answer and justify their answer choice. We propose expanding the array of research tasks to access different knowledge that students might have. By asking students to discuss answers they may not have chosen naturally, we can investigate students' abilities to explain something that is already established or to disprove an incorrect response. The results of these research tasks also provide us with information about how students' responses vary across the different tasks. We discuss three underused question types and their possible benefits. Additionally, we present results from data gathered using these question types and contrast these with results gathered using a traditional question.

PST2C16: 6–6:45 p.m. Increasing the Impact of PER: Recommendations from Typical Faculty*

Poster - Charles Henderson, Western Michigan University, Kalamazoo, MI 49008-5252; charles.henderson@wmich.edu

Melissa H. Dancy, University of Colorado–Boulder
Chandra Turpen, Western Michigan University

In previous work,[1,2] we found that most physics faculty in the United States are familiar with and value instructional strategies based on Physics Education Research (PER). Yet, we also found that use of these strategies lags considerably behind knowledge. We have attempted to understand this gap between knowledge and use from several perspectives. In this poster we will explore this issue from the perspective of typical faculty. As part of a larger study, we conducted telephone interviews with 70 physics faculty who indicated that they had some exposure to PER. Based on these conversations, we describe the actions faculty recommended that the PER community might take in order to have more of an impact on the teaching practices of typical faculty.

* Supported, in part, by NSF Award No. 0715698.

1. C. Henderson & M. Dancy, "The Impact of Physics Education Research on the

Teaching of Introductory Quantitative Physics in the United States," *Physical Review Special Topics: Physics Education Research*, **5** (2), 020107 (2009).
2. M. Dancy & C. Henderson, "Pedagogical practices and instructional change of physics faculty," *Am. J. Phys.*, **78** (10), 1056-1063 (2010).

PST2C17: 5:15–6 p.m. Influence of Prior Preparation on Students' Use of Online Hints*

Poster - Dehui Hu, Kansas State University, Manhattan, KS 66506-2601; dehuihu@phys.ksu.edu

Joshua Von Korff, N. Sanjay Rebello, Kansas State University

How do students combine their existing resources and invent new strategies when facing a challenging physics problem? In our study, we examine student use of resources and transfer of problem-solving skills in the context of differentiation and integration. Physics problems that use integration and differentiation require students to coordinate their understanding of mathematics as well as physics concepts, procedures, and representations. After a 50-minute tutorial session, students work through a challenging physics problem over a 30-minute testing period. By using an online environment to control and monitor their progress through a series of hints, we assess their use of resources and the impact of hints and previous learning. We also compare students' performance under different preparations by giving different tutorial materials prior to the testing period.

* This work is supported in part by U.S. National Science Foundation grant 0816207.

PST2C18: 6–6:45 p.m. A Case Study on Reflective Writing

Poster - Xiang Huang, Concordia University, Montreal, QC H4B 1R8x; xianghuang@gmail.com

Calvin Kalman, Concordia University

Reflective writing is a student-centered approach widely used in science and engineering courses which helps students to develop a holistic scientific mindset. In this study, we incorporate data on reflective writing from two institutions: one a PhD-granting university and the other a junior college. We use a mixed method study to look for relationships between students' epistemological believe, writing products and ways of learning.

PST2C19: 5:15–6 p.m. Students' Response Characteristics on Sequences of Phenomenological Demonstration in Electric Connections of Light Bulbs

Poster - Myung Su Hwang, Korea National University of Education, Cheongwon, Gun, Korea; fox1120@hanmail.net

Jae Sool Kwon, Jung Bog Kim, Korea National University of Education

We found an effective sequence of phenomenological demonstration by analyzing the levels of cognitive conflict and the types of student's response according to presenting orders of series and parallel connection of electric light bulbs. Parallel connection ahead caused a higher score in cognitive conflict than series connection ahead. Also, we found that earlier representation of questions different from students' predictions is more efficient for causing cognitive conflict than earlier representation of predictable questions. Students solving questions about series circuit first and then parallel circuit recognized the difference of connections more easily compared to the opposite sequence. However, students experiencing the parallel connection first tried to find out more the scientific reasons in mixed connection questions. Presenting a parallel circuit before series circuit turned out to be more effective for strategy for higher cognitive conflict.

PST2C20: 6–6:45 p.m. Johnson-Laird Cognitive Framework: Its Application During Problem Solving*

Poster - Bashirah Ibrahim, Kansas State University, Manhattan, KS 66506-2601; bibrahim@phys.ksu.edu

N. Sanjay Rebello, Kansas State University

The study explores the categories of cognitive structures constructed by engineering students taking a calculus-based physics course at Kansas State University. A sample of 19 students completed 10 non-directed tasks, with different representational format, on the topics of kinematics and work. Individual interviews were conducted immediately following these tasks. The Johnson-Laird (1983) cognitive framework was applied to classify the participants' mental representations. The framework proposes three main types of internal constructs: propositional representations constituting syntactic structures that connect a series of symbols together, mental models that are analogical representations of a real-world situation or objects, and mental images that are internal views of mental models with greater visual spatial features. We will discuss the importance of this framework in the classification of students' mental representations in this study.

* Supported in part by NSF grant 0816207.

PST2C21: 5:15–6 p.m. Online Pre- and Post-Diagnostic Testing Across Multiple Classes

Poster - Stephen H. Irons, Yale University, New Haven, CT 06520; stephen.irons@yale.edu

C. Meg Urry, Yale University

Over the last several years we have instituted diagnostic pre- and post-testing in our three primary introductory physics classes (life sciences, engineering, physics majors). For the fall semester we developed and used a conceptual test that is broader than the standard FCI. This decision was based on our discovery that FCI scores for the tested cohort were quite high, leaving little room to measure improvement. For the spring semester we administered the Conceptual Survey in Electricity and Magnetism (CSEM) in its unaltered form. Our data reveal that students as a whole self-select fairly reliably in terms of which introductory course is best for them. In addition, we found teaching methods that involve interactive engagement led to larger normalized gains than using standard instructional techniques. We will also describe our experience in administering these tests in an online form and discuss the possible effect this had on our results.

PST2C22: 6–6:45 p.m. Nonscience Majors' Thinking about Ionizing Radiation

Poster - Andy Johnson, Black Hills State University, Spearfish, SD 57783; andy.johnson@bhsu.edu

Anna Hafele, Black Hills State University

We have been developing materials to teach nonscience majors about ionizing radiation in a science literacy course. The Radiation by Inquiry Project (DUE 0942699) is uncovering problematic learned and spontaneous ideas about radiation, atoms, radioactivity, and the interaction of radiation with matter. This poster identifies some of the common ideas, our tools and strategies for getting students beyond them, and provides evidence of substantial learning. Http://www.camse.org/andy/radiation

PST2C23: 5:15–6 p.m. Case Study of Student Pairs Working on Electronics Capstone Projects*

Poster - Nasser M. Juma, Kansas State University, Manhattan, KS 66506-2601; mhuninas@phys.ksu.edu

N. Sanjay Rebello, Kristan L. Corwin, Brian R. Washburn, KSU

We observed three pairs of students, each considered to be a different case, as they worked on lab experiments in an upper-division electronics and instrumentation laboratory course. In the first half of the course, the students learned about various analog and digital electronic components through mini-lectures and lab activities building electronic circuits. In the second half of the course each pair worked on a different open-ended capstone project that required them to use their knowledge of electronics to improve the measurements done on a physics experiment they have worked on in a previous semester. The student pairs brainstormed ideas to improve the measurement design and built circuitry to implement their design. Our data sources included observations of groups work, interviews with instructors and students, as well as artifacts produced by the students. We present the results of our case study focusing on comparisons between the student pairs.

* This work is supported in part by NSF grant DUE-0736897.

PST2C24: 6–6:45 p.m. Students Reconciling Contradictory Commitments in Damped Harmonic Motion Problems

Poster - Adam Kaczynski, The University of Maine, Orono, ME 04469A; Kaczynski@gmail.com

Michael C. Wittmann, The University of Maine

In intermediate and advanced physics courses, students are expected to use mathematical, graphical, and physical reasoning, as well as their intuitions. These intuitions may contradict each other and can be inconsistent with ideas developed during small group learning activities. On the topic of damped harmonic motion, students have intuitions about the mathematics, the physics, and the way the graph of the motion should look. Students remain committed to some of these intuitions to the point of not using provided instructional resources. They also deal with contradictions when their commitments to one kind of reasoning conflict with their commitments to another (e.g., the analysis of a mathematical derivation conflicts with that of a free-body diagram summarizing physical reasoning). These multiple commitments have an effect on students' classroom discussion and the way that students reconcile contradictory commitments and conclusions.

PST2C25: 5:15–6 p.m. Gender Differences in Psychological Factors and Interventions to Address Them

Poster - Lauren E. Kost-Smith, University of Colorado–Boulder, Boulder, CO 80302; Lauren.Kost@colorado.edu

Steven J. Pollock, Noah D. Finkelstein, University of Colorado–Boulder

Despite males and females being equally represented at the college level in several STEM disciplines (biology, chemistry, mathematics), females continue to be under-represented in physics. Our research attempts to understand and address this gender gap by focusing on introductory physics courses. We characterize gender differences in performance, psychological factors, and retention that exist in Physics 1 and 2.[1,2] We find gender differences in performance can largely be accounted for by differences in the physics and mathematics backgrounds and incoming attitudes and beliefs of males and females. But these background factors do not completely account for the gender gaps. We hypothesize, based on gender differences in self-efficacy, that identity threat is playing a role in our courses. Working with researchers in psychology, we implemented an identity threat intervention in three offerings of Physics 1. [3] We report on the effectiveness of the intervention to alleviate gender gaps in performance.

1. L. E. Kost, S. J. Pollock & N. D. Finkelstein, *PRST-PER*, **5**, 010101.
2. L. E. Kost-Smith, S. J. Pollock & N. D. Finkelstein, *PRST-PER*, **6**, 020112. 3. A. Miyake, et al., *Sci.*, **330**, 1234.

PST2C26: 6–6:45 p.m. Mentoring Undergraduate Physics Majors at a Hispanic Serving Institution*

Poster - Laird H. Kramer, Florida International University, Miami, FL 33199; Laird.Kramer@fiu.edu

David Jones, Eric Brewe, Florida International University

We present an overview of the undergraduate physics learning community at Florida International University. The number of intended and declared physics majors at FIU has increased by 1500%, when comparing three-year averages to the early 1990s. This is most compelling as FIU is a minority-serving urban public research institution in Miami, serving more than 42,000 students, of which 60% are Hispanic, 12% are Black, and 56% are women. We attribute this dramatic growth to a number of factors, including strategic mentoring activities integrated into our programs. This poster will highlight the mentoring activities within FIU's Physics Department, how those strategies integrate into other research-based approaches, and how multiple faculty have developed into effective student mentors.

* Supported by NSF Award # PHY-0802184.

PST2C27: 5:15–6 p.m. Self-Reported In-Class Emotional Responses: A Trial Run

Poster - W. Brian Lane, Jacksonville University, Jacksonville, FL 32211; wlane@ju.edu

It is important for physics teachers to understand the impact of students' emotional responses to class discussions and activities. In an upper-level electromagnetic theory course, we asked students to report their emotional states in class using flashcards and clickers, with each card or button corresponding to one of the emotions most commonly experienced while learning physics (curiosity, frustration, happiness, anxiety, boredom, and confusion), and based the flow of class discussion on these responses. The students responded very positively to this teaching strategy, indicating that their learning experience was enhanced and that they perceived a great level of support from the instructor. In this poster presentation, we describe the outcomes of this teaching strategy, outline the lessons learned for future refinement, and propose an implementation in multiple introductory physics courses with the goal of comparing students' in-class emotional states with their learning gains and learning attitude shifts.

PST2C28: 6–6:45 p.m. Successes and Constraints in Enactment of One Relatively Successful Reform

Poster - May Lee, University of Colorado–Boulder, Boulder, CO 80302; may.lee@colorado.edu

Melissa Dancy, University of Colorado–Boulder
Charles Henderson, Western Michigan University
Eric Brewe, Florida International University

Although nearly two decades of research documents the potential positive impact of research-based reforms on conceptual understanding, the American Institute of Physics found that less than 30% of high school physics teachers in the U.S. enact reforms in their classrooms. One of the more successfully disseminated reforms is Modeling Instruction. Students taught by expert modeling teachers have gains on the Force Concept Inventory that are at least 30% greater than the students taught through traditional instruction. Our primary research question is "Why has this reform been relatively successful?" We interviewed five people who played critical roles in the development of Modeling Instruction. In this poster, we discuss significant aspects of the reform that led to its successes and constraints as identified in the interviews.

PST2C29: 5:15–6 p.m. Investigating Students' Understanding of Magnetism

Poster - Jing Li, University of Pittsburgh, Pittsburgh, PA 15260; fairylee86@gmail.com

Chandralekha Singh, University of Pittsburgh

We are investigating the difficulties that students have in learning about magnetism. A 30 item research-based survey was developed. During the development of the survey, we administered free-response questions to a large number of students in the classroom and interviewed a subset of students individually. We will discuss the reliability and validity issues and present our findings about difficulties with magnetism concepts after traditional instruction.

PST2C30: 6–6:45 p.m. Teaching Assistants' Reasons for Design of Problem Solutions for Introductory Physics

Poster - ShihYin Lin, University of Pittsburgh, Pittsburgh,15260; hellosilpn@gmail.com

Chandralekha Singh, University of Pittsburgh
William Mamudi, Charles Henderson, Western Michigan University
Edit Yerushalmi, Weizmann Institute of Science, Israel

As part of a larger study to understand how instructors make teaching decisions, we investigated how graduate teaching assistants (TAs) perceive features of written problem solutions. TAs are an important population to understand; they often provide significant instruction and they also represent the pool of future physics faculty. Twenty-four first-year graduate TAs enrolled in a training course were provided with different instructor solutions for the same physics problem and asked to discuss their preferences for prominent solution features. Preliminary findings reveal that providing a schematic visualization of the problem, listing knowns/unknowns and

PST2C31: 5:15–6 p.m. Physical and Virtual Manipulatives' Effect on Students' Models of Pulleys*

Poster - Adrian M. Madsen, Kansas State University, Manhattan, KS 66502; adrianc@phys.ksu.edu

Amy Rouinfar, N. Sanjay Rebello, Kansas State University
Tram Do Ngoc Hoang, Ho Chi Minh City University of Pedagogy

Several studies have investigated differences in students' learning with physical and virtual manipulatives. However, not as many studies have looked into the process by which any differences in learning occur. In this study, we look closely at the process of conceptual change as students interact with either physical or virtual pulley systems. Students in five conceptual physics laboratory classes investigated various pulleys systems over two consecutive laboratory classes, each nearly two hours long. Half of the students in each class learned with a computer simulation while the other half used actual pulleys, strings, and weights. All students were given identical instructions that prompted them to construct their own understanding of pulley systems by comparing and testing different systems. We report on how students' ideas about pulleys changed as they progressed through the activities and compare learning with physical and virtual manipulatives.

*This work is supported in part by U.S. Dept. of Education IES grant award R305A080507

PST2C32: 6–6:45 p.m. Effectiveness of Prescribed Prompts at Priming Sensemaking During Group Problem-Solving

Poster - Mathew A. Martinuk, University of British Columbia, Vancouver, BC V6T 1Z1; martinuk@physics.ubc.ca

Joss Ives

Many researchers and textbooks have promoted the use of rigid prescribed strategies for encouraging development of expert-like problem-solving behavior in novice students. The UBC Physics 100 course has been using Context-Rich problems with a prescribed five-step strategy since 2007. We have been analyzing audio recordings of students during group problem-solving sessions to analyze students' epistemological framing based on the implicit goal of their discussions. By treating the goal of "understanding the physics situation" as "sensemaking," we analyze the effectiveness of structured prompts intended to promote a shift to a sensemaking discussion. This poster will describe the setting, research methods, and results.

PST2C33: 5:15–6 p.m. Do Students Reason Better in Interactive Courses?

Poster - Mojgan Matloob Haghanikar, Kansas State University, Manhattan, KS 66506; mojgan@phys.ksu.edu

Sytil Murphy, Dean Zollman, Kansas State University

As part of a study on the science preparation of elementary school teachers, we compared students' reasoning skills in courses with inquiry-oriented teaching strategies and their counterparts in traditional courses. We devised content questions that are open-ended and probed students' ability of applying recently learned concepts in a new context. Inspired by Bloom's revised taxonomy,[1] we designed a rubric to analytically examine students' responses. Our rubric describes seven traits that we consider as the evidence of understanding for which we defined three levels of accomplishment. In this paper we present our analysis of five inquiry-oriented and traditional pairs of classes from five different universities. The classes came from a variety of disciplines. We will also investigate if the differences between the classes are statistically significant. Supported by National Science Foundation grant ESI-055 4594

1. L.W. Anderson & D.R. Krathwohl, A *Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*, New York, Longman (2001).

PST2C34: 6–6:45 p.m. The PER User's Guide: A New Web Resource for Consumers of Physics Education Research

Poster - Sarah B. McKagan, 2436 S. Irving St., Seattle, WA 98144; sam.mckagan@gmail.com

The PER User's Guide* is a web resource to help physics educators learn about the results of physics education research (PER) and apply those results in their classroom. We are launching a pilot site this year with guides to a small selection of research-based teaching methods. We plan to extend this site to become a comprehensive guide to all aspects of PER that are relevant to educators. This will help educators by summarizing, condensing, and translating the vast web of knowledge contained in the field of PER into a format that is easily accessible, enabling educators to quickly find and use the information they need. The PER User's Guide design is based on user testing and research into faculty adoption and adaption of research-based teaching methods.

*The PER User's Guide is a collection hosted on compadre.org and is supported by NSF NSDL 0840853.

PST2C35: 5:15–6 p.m. Examining Correlations Between Lecture Conceptual Question Responses and Course Performance

Poster - Jeffrey T. Morgan, University of Northern Iowa, Cedar Falls, IA 50614-0150; jeff.morgan@uni.edu

Cynthia Wakefield, University of Northern Iowa

We have implemented peer instruction in an introductory level conceptual physics course for non-science majors, based on the success that others report with this method.[1] We expected to see that learning from peer conversation, as evidenced by answering conceptual questions correctly following discussion, would correlate with course grade, but did not observe any link. We did, however, note moderate correlation between answering a conceptual question correctly prior to peer conversation and course grade, indicating that while peer conversation improves the interactivity of a lecture course, interaction may be more important to student success than arriving at the correct answer.

1. C.H. Crouch and E. Mazur, "Peer Instruction: Ten years of experience and results," *Am J. Phys*. **69** (9), 970-977.

PST2C36: 6–6:45 p.m. To What Extent Is Seeing Not Believing?

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

Nathaniel Lasry, John Abbott College
Eric Mazur, Harvard University

Demonstrations are vital components of most undergraduate physics courses. Despite their prominence, research has shown that students learn little, if anything from lecture demos. Worse, some research suggests depending on the delivery, demos can even contribute to students' misconceptions. We analyze one delivery method that requires students' predictions of lecture demonstration outcomes in introductory mechanics and electricity and magnetism at two large research universities. We compare students' predictions before having seen the demonstration to what they report as having observed both right after the demonstration and several weeks later. Students' post-demonstration explanations of the physics behind each demonstration are also analyzed. Triangulation of these data points leads us to better understand how students' pre-instructional beliefs influence their interpretation and memory of physics lecture demonstrations. This can mitigate the "disconnect" that has been shown to exist between what instructors think they are demonstrating and what students actually observe/remember.

PST2C37: 5:15–6 p.m. Development Strategies for Interactive Online Learning Environments in Physics*

Poster - Christopher M. Nakamura, Kansas State University, Manhattan, KS 66506; cnakamur@phys.ksu.edu

Sytil K. Murphy, Dean A. Zollman, Kansas State University

Michael Christel, Scott Stevens, Carnegie Mellon University Entertainment Technology Center

The Pathway Active Learning Environment (PALE) is part of an ongoing program of research aimed at investigating how to use interactive multimedia technology to facilitate online instruction in physics. Our research efforts are in part directed at uncovering and codifying general strategies to develop and implement online learning environments in efficient ways. PALE relies heavily on pre-recorded video both as a means of conveying verbal explanations and as a way of demonstrating physical phenomena. To function optimally it also requires significant input from students. Both of these requirements imply significant amounts of effort over prolonged periods of time are needed to create systems that respond appropriately to students' actions. This effort may be organized and distributed via the Internet by a larger group of developers. In this way an efficient and ongoing development cycle may be implemented. This poster discusses strategies for implementation.

* This work is supported by the U.S. National Science Foundation under grant numbers REC-0632587 and REC-0632657.

PST2C38: 6–6:45 p.m. The Physics Class: Challenges and Problems in College Teaching in Mexico

Poster - Miguel Olvera Aldana, ESCOM-IPN, UPALM Zacatenco México, D.F.; molveraa@ipn.mx

This work studies the failures in a class of physics at Superior School on Computing from National Polytechnic Institute of Mexico (ESCOM-IPN), emphasizing that it is the only course of physics in the ESCOM curriculum. On the other hand, it was needed analysis and quantification on the influence of the physics course in the Computational Systems Engineers formation since perspective of developing their thesis. Finally, we show some actions by teachers from the basic science area in ESCOM to decrease these indices and motivate the students, including preparatory courses, problems, books, and electronic notes.

PST2C39: 5:15–6 p.m. Using Online Homework Data to Assess Student Confidence

Poster - Joseph D. Peterson, University of Wisconsin-Platteville, Platteville, WI 53818; peterson.joseph.d@gmail.com

Andrew Pawl, University of Wisconsin-Platteville

A popular type of question in online homework involves a set of several true/false statements where students must submit their answer to all the statements at once. This discourages random guessing because although one true/false statement has only two possible answers, a question containing N such statements has two raised to the Nth power possible answers. We have studied student response patterns to a number of these questions with the goal of determining which of the individual true/false statements exhibit a large proportion of response switches (i.e. from true to false or from false to true) and which statements exhibit largely consistent responses. The tendency of students to change their answer to a statement or to remain consistent is one indication of student confidence in the knowledge tested.

PST2C40: 6–6:45 p.m. Perception of Model of Competences in Physics Teaching *

Poster - Mario Humberto Ramírez Díaz, CICATA-IPN, Legaria 694, Col. Irrigacion, Mexico 11500; mramirezd@ipn.mx

Since the '70s, two concepts from the business world have been adopted by education: innovation and competence. This talk will show how some physics educators are resisting or refusing to adopt the model of competence. This work is based on previous research made in Tabasco, Mexico, and directed to teachers in Law, History, and Sociology. We interviewed physics teachers, both college and high school, to get their opinion and experience with the model of competence. We present evidence about rejecting the model based on negative aspects of using the practice. However, some teachers found positive aspects of the model they can use in their daily practice, which we present in the talk.

* Work supported by COFAA-IPN

PST2C41: 5:15–6 p.m. Reflection about Negative Introduction of Technology in Physics Classes in Mexican Universities

Poster - Mario Humberto Ramírez Díaz, CICATA-IPN, Legaria 694, Col. Irrigación, Del. Miguel Hidalgo. Mexico 11500; mramirezd@ipn.mx

Luis Antonio García Trujillo

In recent years there has been much discussion about the idea that we must improve or optimize the learning processes in the traditional technologies classes. This idea in part has been inspired because of the fact that the new generation of students has grown up with direct technology interaction. However, in our experience as physics teachers in different universities in Mexico, we can't deny that occasionally the incorporation of technologies into the classroom is beneficial, for example we have used graphic software in the physics process, numeric simulations of experimental evidence, or applets available on the web. But, in our experience the students think the problems are monotone, furthermore they don't conceive that a problem could be solved with a mix of equations that describe the physics phenomena. In this work we give reflections on the introduction of technology in the physics class and its negative aspects on students' learning of physics in some universities in Mexico.

PST2C42: 6–6:45 p.m. Student Understanding of the Concepts of Substance and Chemical Change*

Poster - Amy D. Robertson, University of Washington, Seattle, WA 98195-1560; awrob@uw.edu

Peter S. Shaffer, Lillian C McDermott, University of Washington

One of the fundamental notions in basic chemistry is that a chemical change is a process that transforms substances and conserves atoms. As part of a multi-year study on student reasoning about topics related to the particle nature of matter, a set of questions was designed to probe the extent to which university-level chemistry students apply the description of chemical change articulated above. Results from these questions will be presented and compared with results from previous studies involving K-12 students.

*This work has been supported under a National Science Foundation Graduate Research Fellowship.

PST2C43: 5:15–6 p.m. Increasing Confidence by Characterizing Self-Efficacy Experience Opportunities

Poster - Vashti Sawtelle, Florida International University, Miami, FL 33199; vashti.sawtelle@gmail.com

Eric Brewe, Renee Michelle Goertzen, Laird H. Kramer,

We present the analysis of a qualitative investigation of three women from a Modeling Instruction (MI) classroom completing a problem-solving task as a discussion of self-efficacy experience opportunities (SEOs). Self-efficacy, or confidence in one's own ability to perform a task, has been shown to strongly correlate with persistence and success in science fields. At Florida International University, we have demonstrated that the MI class has a positive impact on introductory students' physics self-efficacy. To further investigate this development, we focus on one of the key elements of the MI classroom: modeling physical phenomena. This presentation will focus on characterizing SEOs and linking them to the development of self-efficacy as well as the Modeling process. Further, we believe this analysis provides a partial explanation for how the MI classroom positively impacts self-efficacy.

PST2C44: 6–6:45 p.m. Using Cogenerative Mediation in Classrooms

Poster - Natan Samuels, Florida International University, Miami, FL 33199; nsamu002@fiu.edu

Eric Brewe, Florida International University

This poster will present ongoing research on our cogenerative mediation process for learning environments (CMPLE). Student and teacher participants in CMPLE have the opportunity to be collectively engaged in modifying their learning environment based on their preferences. Our research question is "How does this mediation process help participants negotiate modifications to their learning environment?" We are addressing this question by focusing on both student and teacher participants. Our data includes interviews and classroom artifacts.

PST2C45: 5:15–6 p.m. Peer Instruction and Just-in-Time Teaching Walk Into a Classroom...

Poster - Julie A. Schell, Harvard University, Cambridge, MA 02138; schell@seas.harvard.edu

Jason Dowd, Brian Lukoff, Kelly Miller, Eric Mazur, Harvard University

Peer Instruction (PI) (Mazur, 1997) and *Just-in-Time Teaching* (JiTT) (Novak et al., 1999)[1] are two widely used, research-based pedagogies in physics education. Deployed in conjunction, both methods provide a series of scaffolded opportunities for student metacognition before and during class time. With JiTT, students respond to carefully developed pre-class reading questions that effectively "warm them up" for the subsequent course meeting. Students' ability to respond to these questions provides them with immediate feedback on their understanding of the readings and points them to areas that require more focused attention. With PI, students spend in-class time responding to a series of carefully developed conceptually based questions, called ConcepTests, which also provide multiple self-assessment opportunities. In this poster, we use data from a semester-long study of JiTT and PI to test the hypothesis that correctness on JiTT pre-class reading questions has a positive relationship with in-class correctness on students' responses (before PI) to related ConcepTests.

1. E. Mazur, *Peer Instruction: A User's Manual,* Upper Saddle River, NJ: Prentice-Hall, 1997. G.M. Novak, E.T. Patterson, A.D. Gavrin & W. Christian, *Just- in-Time Teaching: Blending active learning with web technology,* Upper Saddle River, NJ: Prentice-Hall, 1999.

PST2C46: 6–6:45 p.m. Improving Students' Understanding of Addition of Angular Momentum

Poster - Chandralekha Singh, University of Pittsburgh, Pittsburgh, PA 15260; clsingh@pitt.edu

Guangtian Zhu, University of Pittsburgh

We are investigating the difficulties that upper-level students taking quantum mechanics have in learning about the addition of angular momentum. To help improve student understanding of these concepts, we have developed quantum interactive learning tutorials (QuILTs) and tools for peer-instruction. We will discuss the common students' difficulties and the effectiveness of research-based tools in improving students' understanding of these concepts. This work is supported by the National Science Foundation grant NSF-PHY-0855424.

PST2C47: 5:15–6 p.m. Peer Instruction for Quantum Mechanics

Poster - Chandralekha Singh, University of Pittsburgh, Pittsburgh, PA 15260; clsingh@pitt.edu

Guangtian Zhu, University of Pittsburgh

We are developing and evaluating resource material for "Peer Instruction" in quantum mechanics. A central component of the resource material is research-based concept tests that can be used by instructors as a formative assessment tool. The instructors can use these tools for bridging the gap between the abstract quantitative formalism of quantum mechanics and the qualitative understanding necessary to explain and predict diverse physical phenomena. Asking questions during the lecture and asking students to discuss it with each other before polling the class has already been shown to be effective at the introductory level. This method provides a mechanism to convey the goals of the course and the level of understanding that is desired of students and also helps students monitor their learning. We will discuss the development and assessment of these tools. This work is supported by the National Science Foundation (NSF-PHY-0653129).

PST2C48: 6–6:45 p.m. Student Understanding of Taylor Series Expansions in Statistical Mechanics

Poster - Trevor I. Smith, University of Maine, Orono, ME 04469; Trevor.I.Smith@umit.maine.edu

John R. Thompson, Donald B. Mountcastle, University of Maine

One goal of physics instruction is to have students learn to make physical meaning of specific mathematical ideas, concepts, and procedures in different physical settings. As part of research investigating student learning in statistical physics, we are developing curriculum materials that guide students through a derivation of the Boltzmann factor, using a Taylor series expansion of entropy. Using results from written surveys, classroom observations, and both individual think-aloud and teaching interviews, we present evidence that, while many students can recognize and interpret series expansions, they often lack fluency with the Taylor series, despite previous exposures in both calculus and physics courses. We present students' successes and failures both using and interpreting Taylor series expansions in a variety of physical contexts.

PST2C49: 5:15–6 p.m. Problem Solving in Kinematics as a Measure of Conceptual Understanding

Poster - Daniel M. Smith, Jr., South Carolina State University, Orangeburg, SC 29115; dsmith@scsu.edu

Student difficulties in solving kinematics problems are often attributed to students' inability to choose the correct equation, or to weak skills in algebra. Evidence is presented from a calculus-based physics class, however, that students fail to solve problems because they lack a conceptual understanding of the problem, as determined by their ability to relate the problem data to a diagram. The limited roles that—choosing the right equation,-- and weak algebra skills play in problem solving is further explored by having students solve problems graphically by using interactive software designed especially for one-dimensional kinematics problems.

PST2C50: 6–6:45 p.m. The Positive Impact of Student Engagement on Learning and Retention

Poster - Adam G. Tournier, McKendree University, Lebanon, IL 62269; agtournier@mckendree.edu

Minh Truong, Fontebonne University

Student engagement in the classroom, laboratory, and outside of traditional course settings has a dramatic and real impact on both conceptual and practical understanding of the material in algebra-based physics courses. The small class sizes available at liberal arts institutions create an environment whereby students can have more access to their professors in all areas of the course. The students that are engaged more frequently in the classroom and lab setting have a more profound understanding of the material both conceptually and in application. Students who are engaged outside of the traditional course setting with both their instructors and peers demonstrate the greatest understanding and retention of the course material.

PST2C51: 5:15–6 p.m. Is This Good Teaching? Assessment Challenges for Both Faculty and Institutions*

Poster - Chandra A. Turpen, Western Michigan University, Kalamazoo MI 49008-5200; Chandra.Turpen@colorado.edu

Charles Henderson, Western Michigan University
Melissa Dancy University of Colorado–Boulder

As part of a larger research study, we focus on the investigation of barriers to instructional change. One significant barrier that has emerged is that neither faculty nor their institutions know how to evaluate student learning (or teaching effectiveness) in introductory physics courses. In this poster, we will present results from telephone interviews with 70 physics faculty related to how faculty and their institutions evaluate teaching effectiveness. We will focus on the following research questions: 1) What information is gathered about instructors? teaching and students? learning? 2) How is this information used? 3) How are different sources of information perceived or valued by faculty? Helping faculty (and possibly institutions) make judgments about whether their instruction is working may be an integral part of supporting efforts to improve undergraduate physics instruction.

* Supported, in part, by NSF Award No. 0715698

PST2C52: 6–6:45 p.m. TAs' Judgments about Student Problem-solving Difficulties

Poster - Joshua S. Von Korff, Kansas State University, Manhattan, KS 66506-2601; vonkorff@phys.ksu.edu

Dehui Hu, N. Sanjay Rebello, Kansas State University

Physics education researchers commonly judge students' behavior as "novice" or "expert" behavior. How do TAs make similar judgments about student problem solving ability? We report on a quantitative and qualitative analysis of focus group interview data from a study of TA discussions. In our study, TAs analyzed student problem solving, by reading transcripts of conversations and trying to anticipate or explain student difficulties. Our study classifies TAs' judgments about student problem solving using the "novice-centered" and "expert-centered" axis. We also consider Tas' justifications for their claims, and other features of their discussion. We describe the relative frequency of these different ways of speaking, both for individual TAs and in the aggregate.

* This work is supported in part by U.S. National Science Foundation grant 0816207.

PST2C53: 5:15–6 p.m. Exploring Student Interpretations of Worked Examples

Poster - Judy Vondruska, Box 2219, Brookings, SD 57006; Judy.Vondruska@sdstate.edu

This project will present results of a qualitative research study undertaken in the spring of 2011 which focused on how students interacted with worked problem examples in physics and the level to which they understood the worked examples. While many textbook publishers are now providing worked examples in various forms with varying degrees of explanation and interactivity, it is unclear to what extent these are truly useful to the learner. This study undertakes the effort to explore this level of understanding more deeply.

PST2C54: 6–6:45 p.m. Development of a Standardized Fluids Assessment

Poster - DJ Wagner, Grove City College, Grove city, PA 16127; djwagner@gcc.edu

Sam Cohen, Adam Moyer, Jason Wetstone, Elizabeth Carbone

We are developing an FCI-style assessment covering hydrostatic topics commonly included in introductory physics courses. Students from all three introductory tracks (conceptual-, trig-, and calculus-based) at Grove City College have completed draft versions of our assessment, both pre- and post-instruction, and we are ready to distribute a beta version for testing by other institutions. 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 beta-testers. Stop by and chat!

PST2C55: 5:15–6 p.m. Math Preparation for Under-prepared Students in Physics Courses

Poster - Jing Wang, Eastern Kentucky University, Richmond, KY 40475; jing.wang@eku.edu

Jerry Cook, Eastern Kentucky University

Previous studies suggest that students enrolled in introductory physics courses are usually not well prepared in mathematical skills. Math placement tests and course prerequisites are the two frequently adopted methods in dealing with the issue. Unsatisfied by either method, the Department of Physics and Astronomy (PHAS) at Eastern Kentucky University (EKU) decides to offer an alternative solution by offering an auxiliary short course taken concurrently with introductory physics. Recommendations are made to students with relatively-low math pre-test scores. However, the course is open to anyone who is taking introductory physics. This work will discuss PHAS's practice of assisting math-unprepared students through this course called Success in College Physics.

PST2C56: 6–6:45 p.m. Using Computer Coaches for Problem Solving to Explore Student Decision-making Difficulties

Poster - Qing Xu, University of Minnesota-Twin cities, Minneapolis, MN 55455; qxu@physics.umn.edu

Ken Heller, Leon Hsu, Andrew Mason, University of Minnesota-Twin cities

The Physics Education Group at the University of Minnesota has been developing Internet physics coaches to help students improve their problem-solving skills in introductory physics. In this poster, we will show the keystroke data collected from students' usage of the computer programs, including the identity and timing information for all students' keystrokes and mouse clicks while using the programs, as well as derived information such as the average time spent on each module. We use the data to try to determine how students use the computer programs, where they might have the most difficulty, and details of their decision-making behavior during the problem-solving process. Other data sources such as students' written solutions will be used as a consistency check.

PST2C57: 5:15–6 p.m. Correlation between FCI Gains and Interactive Engagement

Poster - Philip W. Young, University of Wisconsin - Platteville, Platteville, 53818; youngp@uwplatt.edu

Introductory physics classes at the University of Wisconsin - Platteville moved from a traditional lecture hall environment to studio classrooms in spring 2009. To assess the transition, we have been administering the Force Concept Inventory (FCI) to all sections of calculus-based Physics I beginning in spring 2008. We have also defined an Interactive Engagement Index (IEI) for each section. This index is based on self-reported information on six factors: time spent lecturing; student engagement with concepts, problem solving, and hands-on learning activities; the degree of integration of the lab with the lecture; and large-group discussions. The correlation between FCI gain and IEI for all 20 sections between S08 and F10 is 0.92. This poster will present details on the IEI, update the data to include in spring 2011, and look at the correlation in more depth. This work was supported by NSF-DUE CCLI 0633583.

PST2C58: 6–6:45 p.m. Students' Difficulties with Scalar Multiplication of a Vector and Vector Subtraction

Poster - Genaro Zavala, Tecnologico de Monterrey, Monterrey 64849, Mexico; genaro.zavala@itesm.mx

Pablo Barniol, Tecnologico de Monterrey

In this work we investigate students' understanding of: 1) scalar multiplication of a vector and, 2) vector subtraction. We administered two tests to 717 students completing introductory physics courses at a private Mexican university. In the first part, we used a modified version of a problem designed by Van Deventer [1] to investigate students' difficulties with multiplication of a vector by a positive scalar and we designed a problem to study students' difficulties with multiplication of a vector by a negative scalar. We compared the frequencies of the errors in these two problems to comprehend students' conceptions in these vector operations. In the second part, we designed a vector subtraction problem and identified errors that haven´t been reported in the literature.

1. J. Van Deventer, Comparing student performance on isomorphic math and physics vector representations, Master's Thesis, The University of Maine, 2008.

PST2C59: 5:15–6 p.m. New Pictorial Representations and Supporting Text of Sound Standing Waves of Air Columns in a Tube

Poster - Liang Zeng, The University of Texas-Pan American, Edinburg, TX 78539; zengl@utpa.edu

Corpuz Edgar, Chris Smith, Jennifer Rodriguez

New pictorial representations of sound standing waves of air columns in a tube were drawn for the first three harmonics in an open-open tube as well as in an open-closed tube. Supporting text describing air molecule motion over time was also provided. These representations and supporting text were designed to reveal the main characteristics of the physical mechanisms of sound standing waves in these two different types of tubes. Through a pilot study utilizing surveys and student interviews, we investigated the differences in the effects on student learning of underlying physics concepts between the new pictorial representations and the existing ones in an introductory physics textbook. The implications of our results for teaching were discussed.

PST2C60: 6–6:45 p.m. Students' Ability in Constructing Formal Logical Reasoning*

Poster - Shaona Zhou, South China Normal University, Guangzhou, Guangdong 510631, China; zhou.shaona@gmail.com

Hua Xiao, South China Normal University
Jing Han, Lei Bao, Ohio State University
Kathy Koenig, Wright State University

While students seem to easily pick up the valid variables in a context of multi-variable situations, they often have difficulty in constructing the correct logical relations between variables and outcomes. This research investigated students' understanding about two kinds of logical thinking involving conditional relations. We found that students' reasoning in situations involving necessary conditions outperformed their reasoning involving sufficient conditions. Results from students at different grade levels showed steady improvement with age on picking the correct variables, while their logical thinking had no obvious changes. The results suggest that logical thinking is a higher level scientific reasoning ability that doesn't fully develop through our current education which emphasizes content knowledge.

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

PST2C61: 5:15–6 p.m. Improving Students' Understanding of Quantum Measurement

Poster - Guangtian Zhu, University of Pittsburgh, Pittsburgh, PA 15260; zhuguangtian@gmail.com

Chandralekha Singh, University of Pittsburgh

The measurement of a physical observable in a quantum system is very different from the measurement in a classical system. Understanding the properties of quantum measurement is essential for interpreting quantum mechanics. We investigate the students' difficulties related to the quantum measurement by giving written tests and interviewing advanced undergraduate and graduate students in the quantum mechanics class. We also discuss the students' improvement of interpreting quantum measurement after they use the research-based learning tools. Our data shows that the Quantum Interactive Learning Tutorial (QuILT) and Peer Instruction Tools will enhance students' understanding of the quantum measurement.

*Supported by NSF

PST2C62: 6–6:45 p.m. Surveying Students' Understanding of Quantum Mechanics*

Poster - Guangtian Zhu, University of Pittsburgh, Pittsburgh, PA 15260; zhuguangtian@gmail.com

Chandralekha Singh, University of Pittsburgh

Development of conceptual multiple-choice tests related to a particular physics topic is important for designing research-based learning tools to reduce the difficulties. We explore the difficulties that the advanced undergraduate and graduate students have with non-relativistic quantum mechanics of one particle in one spatial dimension. We developed a research-based conceptual multiple-choice survey that targets these issues to obtain information about the common difficulties and administered it to more than a hundred students from seven different institutions. The issues targeted in the survey include the set of possible wavefunctions, bound and scattering states, quantum measurement, expectation values, the role of the Hamiltonian, time-dependence of wavefunction and time-dependence of expectation value. We find that the advanced undergraduate and graduate students have many common difficulties with these concepts and that research-based tutorials and peer-instruction tools can significantly reduce these difficulties. The survey can be administered to assess the effectiveness of various intructional strategies.

*Supported by NSF

PST2C63: 5:15–6 p.m. Student-Generated Diagrams for Understanding Chemical Equations

Poster - Dyan L. McBride, Mercyhurst College, Erie, PA 16546; dmcbride@mercyhurst.edu

Reni Roseman, Mercyhurst College

It is clear that students have difficulty creating a physical interpretation of equations. This project is part of a larger study involving the interactions of physics, math, and chemistry learning. In this poster, we present findings from a study of student-generated diagrams that represent chemical equations. The results of the study indicate that while many students have difficulty creating representations of the equations, they are able to adapt and improve their model to include a variety of features.

PST2C64: 6–6:45 p.m. ViPER: A Possible Model for Solo Physics Education Researchers

Poster - Scott W. Bonham, Western Kentucky University, Bowling Green, KY 42101-1077 scott.bonham@wku.edu

Jing Wang, Jon Gaffney.=, University of Kentucky

The Kentucky Virtual Physics Education Research (ViPER) group was formed in August 2010 by three solo physics education researchers in the state. Using Web 2.0 tools as well as periodic face-to-face gatherings, we conduct regular group meetings, share literature and data, and work collaboratively on several projects. The collaboration provides many of the benefits of a larger research group, such as complementary research skills, mentoring, interviewing each other's students, critical feedback and sharing resources. ViPER also significantly reduces the isolation we would have otherwise experienced as solo physics education researchers. These initial activities have been supported by a PERLOC mini grant and the chairs of our respective departments, and we are currently applying for larger collaborative grants. In this poster we will share specifics about how we conduct our virtual research group and what we believe to be the key factors, making it a model for other solo PER faculty.

PST2C65: 5:15–6 p.m. Three Undergraduate Experiments in Rubidium-Argon Collision Spectroscopy

Poster - David A. Olsgaard, Simpson College, Indianola, IA 50125; david.olsgaard@simpson.edu

Mike Henry, Austin Roy, Tayler Buresh, Simpson College

Many laser spectroscopy experiments utilizing rubidium vapor cells have been demonstrated in the undergraduate laboratory. We introduce three new undergraduate spectroscopy experiments using rubidium vapor cells back-filled with an argon buffer gas. These experiments introduce students to the role elastic and inelastic collisions can play in the absorption and emission spectrum of atoms. The first experiment is a dramatic demonstration of hyperfine optical pumping aided by velocity-changing collisions with the buffer gas in which we observe 100% transfer of population to one hyperfine level. The second experiment shows an unexpected modification of the rubidium fluorescence spectrum as a function of argon pressure and laser intensity. A simplified 3-level rate equation model predicts the unusual feature. The third experiment is the observation of a decrease in the excited state lifetime of the 6P3/2 level as function of buffer gas pressure. A Stern-Volmer plot yields the inelastic collision cross-section.

Wednesday, August 3

Klopsteg Award & DSCs	10:15–11:30 a.m.	HC Auditorium
Henry Doorly Zoo	1–5 p.m.	offsite
PERC Banquet	5–7 p.m.	HC Ballroom C

Session FA: PER: Investigating Classroom Strategies II

Location: Harper Center 3023 & 3023A
Sponsor: Research in Physics Education Committee
Date: Wednesday, August 3
Time: 8–9:50 a.m.

Presider: Warren Christensen

FA01: 8–8:10 a.m. Collaboration Among Local Colleges to Build a Community of Expertise

Dedra Demaree, Oregon State University, Corvallis, OR 97331; demareed@physics.oregonstate.edu

Sissi Li, Oregon State University
Dennis Gilbert, Lane Community College
Greg Mulder, Linn Benton Community College

In summer 2010, Oregon State University (OSU) received an NSF grant in collaboration with local community colleges (CC) to build pedagogical content knowledge (PCK). The 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. There is a large number of students who transfer between OSU and the CC's, and there is terrific reformed teaching (with common reform goals) going on at all three institutions with documented success. However, the professors with the most expertise teach only a fraction of the students within the system. This talk will discuss how we are sharing and documenting instructional knowledge and course materials to build a community of expertise that can pass PCK more readily to new instructors.

FA02: 8:10–8:20 a.m. Developing Beliefs and Attitudes about Doing Physics in Introductory Classes

Sissi L. Li, Oregon State University, Corvallis, OR 97331; lisi@onid.orst.edu

Dedra N. Demaree, Oregon State University

Learning to do physics is more than knowing the concepts and solving homework problems. Scientists know that doing science requires the conceptual understanding, problem solving, and critical thinking skills as tools; moreover, doing science is more than just using those tools, it also involves having appropriate attitudes and beliefs about doing science. These attitudes and beliefs include curiosity, skepticism, tenacity, creativity, and more. To examine how these attitudes are developed, we selected three teachers who teach calculus-based introductory college physics at a large research university and two community colleges. We observed their lecture classes, and conducted post-class interviews and student interviews. Through these three case studies, we will present how teachers build a learning community to support learners in developing beliefs and attitude for doing physics.

FA03: 8:20–8:30 a.m. Transforming Assessment to Achieve and Measure Preparation for Future Learning

Yuhfen Lin, Florida International University, Miami, FL 33199; fireflylin@gmail.com

David T. Brookes, Florida International University

One way to measure transfer is through assessing preparation for future learning, but how many of us are brave enough to test our students' ability to learn by giving them an exam question on a topic we have not covered? At the same time, have our physics classes prepared them for their future learning? When we gave our students a question on a brand new topic as their final exam, we wanted to believe they could learn on their own. They demonstrated not only the ability to find the correct equation to solve the problem, but they also were not satisfied until they were able to achieve deeper understanding by making sense of the new knowledge in terms of their current understanding. In the next talk, we will provide more details of how we created a learning environment that encouraged students to take charge of their own learning.

FA04: 8:30–8:40 a.m. Building a Sustainable Learning Environment in a Physics Classroom

David T. Brookes, Florida International University, Miami, FL 33199; dbrookes@fiu.edu

Yuhfen Lin, Florida International University

In the words of Sugata Mitra, "Education is a self-organizing system, where learning is an emergent phenomenon." If we take this to the extreme: good teaching has little to do with what we teach or how we teach it. What we should be concerned with is designing a learning environment that will encourage the spontaneous emergence of learning. In this talk I will present a) some initial ideas about how we can model a physics course as a self organizing system, and b) an ongoing two-year experiment to design a physics learning environment that promotes emergent learning. Our initial results show that students are learning the content at a level that is comparable to other reformed courses, developing positive attitudes toward physics, and developing their identities as learners, knowers, and physicists. Most importantly, students have developed the ability to learn on their own.

FA05: 8:40–8:50 a.m. Beyond the Standard Pedagogical Model

Paul J. Camp, Spelman College, Atlanta, GA 30314; pcamp@spelman.edu

Michael Burns-Kaurin, Derrick Hylton, Natarajan Ravi, Marta Dark-McNeese, Spelman College

For several years, the physics department at Spelman College has used project-based instruction as a central focus of our curriculum at all levels. This presentation will describe our work on the second-semester introductory course, in which we have moved all of the circuits material to a project-based investigation conducted entirely in the lab. There are several important differences between our implementation and similar efforts such as Workshop Physics, notably the use of complex, ill-formed problems as a central focus of the pedagogy, the use of distributed expertise to drive collaboration and communication, and the improvement of process skills through iterative refinement. We will describe the foundations of our pedagogical design in cognitive and learning science and previous similar efforts in other learning contexts, contrast it with other inquiry-based designs, and describe some of what we are observing in the test and comparison classes. Data collection and processing is currently ongoing so this presentation will necessarily focus more on the design rationale than on the results.

FA06: 8:50–9 a.m. Adopt, Adapt, or Abandon? Instructors' Decisions to Use Research-based Materials

Stephanie V. Chasteen, University of Colorado–Boulder, Boulder, CO 80309; stephanie.chasteen@colorado.edu

Rachel E. Pepper, Steven J. Pollock, Katherine K. Perkins, UC Boulder

Physics education researchers often develop materials for classroom use. Instructors then choose which of those materials they would like to implement. We present a case study of University of Colorado's transformed junior E&M course. After the transformation work in Sp/Fa 2008, four subsequent instructors of this course decided which materials—such as tutorials, clicker questions, or use of documented student difficulties—to use. Based on detailed interviews of those instructors, we examine what was and was not sustained, and discuss aspects of the course materials that enabled sustainability across instructors. We also present examples of less successful implementation that provide useful feedback on the use of PER-based resources—both for educational researchers and for the instructors making use of these instructional techniques.

* All junior level resources are available at http://www.colorado.edu/sei/departments/physics_3310.htm. This work was funded by CU's Science Education Initiative and the National Science Foundation Grant No. 0737118.

FA07: 9–9:10 a.m. Assessing the Algebra-based Electricity and Magnetism Studio: First Steps

Jacquelyn J. Chini, University of Central Florida, Orlando, FL 32816; jchini@physics.ucf.edu

Archana Dubey, University of Central Florida

The studio mode of learning combines the lecture, laboratory, and recitation components of a traditional course in an integrated, student-centered environment. Others have demonstrated the success of studio in introductory calculus-based physics. However, there have been fewer studies on the effectiveness of this strategy for algebra-based physics courses. In spring 2011, one instructor was assigned to teach both studio-mode and traditional sections of the second semester introductory algebra-based physics course at the University of Central Florida. We discuss the differences between the ways one instructor taught the same content in these two formats. Having the same instructor for both the studio and lecture courses allows for comparison between these formats without variations introduced by individual instructors. We begin to assess the effectiveness of our algebra-based studio by comparing the performance of students from these sections in common tasks, including the Survey of Electricity, Magnetism, Circuits and Optics (SEMCO) and quizzes.

FA08: 9:10–9:20 a.m. Implementation of Research-based Instructional Strategies: Report from a Longitudinal Study of 15 Junior Faculty

Melissa Dancy, University of Colorado–Boulder, Boulder, CO 80309; melissa.dancy@gmail.com

Charles Henderson, Western Michigan University

As part of a continuing research program to better understand barriers and identify affordances toward increasing research-based teaching practices among university physics faculty, we have embarked on a five-semester study of 15 diverse faculty who recently participated in the Physics and Astronomy New Faculty Workshop. Data collected includes: pre- and post-semester interviews, periodic web-based surveys, and collection of teaching artifacts. In this talk we will share findings from the first year of the study focused on the experiences faculty had with the New Faculty Workshop, what aspects of the workshop they decided to integrate into their teaching, how they went about implementing new ideas, and the outcomes of their efforts.

FA09: 9:20–9:30 a.m. Teaching Mathematical Physics through Problem-based Learning

Gintaras Duda, Creighton University, Omaha, NE 68178; gkduda@creighton.edu

Problem-based and project-based learning (PBL) are two pedagogical techniques that have several clear advantages over traditional instructional methods: 1) both techniques are active and student centered, 2) students confront real-world and/or highly complex problems, and 3) such exercises model the way science and engineering are done professionally. This talk will present an experiment in project/problem-based learning in a mathematical physics course and an attempt (still in its infancy) to deliver an upper division physics course completely in the problem/project based format. More specifically, one group project in the course involved modeling a zombie outbreak of the type seen in AMC's "The Walking Dead." Students researched, devised, and solved their mathematical models for the spread of zombie-like infection. Results of student interviews and surveys will be presented as well as an instructor's perspective on using PBL in upper division physics courses.

FA10: 9:30–9:40 a.m. 'Implicit Action' – Understanding Discourse Management in Modeling Instruction

Jared L. Durden, Florida International University, Miami, FL 33199; jdurd001@fiu.edu

Eric Brewe, Laird Kramer, Florida International University

We identify "Implicit Action," a discourse management tool, through a qualitative video analysis of a Florida International University Modeling Instruction Introductory Physics I class. Implicit Action in Modeling Instruction is where instructors deliberately create intellectual space in which students ideally see value and need for the construction of new classroom norms and tools that are productive in developing a learning community. This space is created by the implications expressed through the instructors' deliberate actions. Modeling Discourse Management is a technique to moderate student discussion in Modeling Instruction classes at the university level (Desbien, 2002). Implicit Action is one of eight Modeling Discourse Management tools that we have identified and, by means of qualitative analysis, have illustrated the effectiveness of its ability to implement Modeling Pedagogical Theory.

FA11: 9:40–9:50 a.m. Increasing the Impact of PER: Recommendations from Typical Faculty*

Charles R. Henderson, Western Michigan University, Kalamazoo, MI 49008-5252; charles.henderson@wmich.edu

Melissa H. Dancy, University of Colorado–Boulder
Chandra Turpen, Ramón Barthelemy, Western Michigan University

In previous work,[1,2] we found that most physics faculty in the United States are familiar with and value instructional strategies based on Physics Education Research (PER). Yet, we also found that use of these strategies lags considerably behind knowledge. We have attempted to understand this gap between knowledge and use from several perspectives. In this talk we will explore this issue from the perspective of typical faculty. As part of a larger study, we conducted telephone interviews with 70 physics faculty who indicated that they had some exposure to PER. Based on these conversations, we describe the actions faculty recommended that the PER community might take in order to have more of an impact on the teaching practices of typical faculty.

* Supported, in part, by NSF Award No. 0715698.

1. C. Henderson & M. Dancy, "The Impact of Physics Education Research on the Teaching of Introductory Quantitative Physics in the United States," *Physical Review Special Topics: Physics Education Research*, **5** (2), 020107 (2009).
2. M. Dancy, & C. Henderson, "Pedagogical practices and instructional change of physics faculty," *Am. J. Phys.* **78**(10), 1056-1063 (2010).

Wednesday morning

Session FB: Teaching Physics Around the World

Location: Harper Center 3027
Sponsor: International Physics Education Committee
Date: Wednesday, August 3
Time: 8–10 a.m.

Presider: Gordon Aubrecht

This Invited/Contributed session will highlight different contexts around the world in which physics is taught. It will also illustrate challenges and successes in bridging geographic and cultural divides.

FB01: 8–8:30 a.m. Physics Teacher Certification in Brazil: Who Said Reforming Is Easy?

Invited - Katemari Rosa, Columbia University, Teachers College, New York, NY 10027; kdr2109@tc.columbia.edu

One of the fundamental questions to improve physics education is related to teacher education, particularly physics teacher's certification programs. In the United States, these programs vary not only in their curriculum but in their format and requirements. This presentation brings the contribution of a distinct tradition for preparing physics teachers, providing ideas for new experiences. Specifically, we examine the curriculum reform of a physics teacher certification program in Brazil, focusing on the process of the reform, and how physics education research informed the creating of new disciplines, the departmental debate, and the development of a new view for the role of a physics educator. Our goal is to take the physics teacher education discussion to all the professionals involved in this process, not only curriculum experts, share our failures and success, and establish a venue for expertise exchange between Brazil and United States.

FB02: 8:30–9 a.m. Stimulating Creative Ideas and Developing Self-learning Ability of Freshman Students

Invited - Zhi-Yong Zhou, Southeast University, Jiangning District, China; zhouzhy@seu.edu.cn*

Ying-Hui Kuang, Hui Zhong, Ying Yun , Southeast University, China

Creative ideas and the ability to do independent study are important characteristics for students to be successful in their university lives and careers thereafter. These two aspects are also what we wish to cultivate in freshman students through "Introduction to Bilingual Physics," which was designed by Prof. Ying Yun for physical engineering students. The main contexts about classical and modern physics are organized through the "key line" method and are introduced in several ways, including blackboard presentations, multimedia materials, experiment demonstrations, and network simulations. Following that, students are encouraged and guided to do scientific research with suitable complexity by working in a self-organized group, and then they are asked and selected to present their ideas or discoveries in class and even at international occasions. This teaching model has proven to be effective over a 10-year teaching practice, during which the performance of the students has been tracked.

* Sponsor: Lei Bao

FB03: 9–9:30 a.m. The Global Laboratory at SUNY Oswego

Invited - Shashi M. Kanbur, SUNY Oswego, Oswego, NY 13126; shashi.kanbur@oswego.edu

Cleane L. Medeiros, Lorrie Clemo, Deborah Stanley, Webe Kadima, SUNY Oswego

A key competency required for graduates in today's highly competitive job market is skill in solving science, technology, engineering and mathematics (STEM) based problems in an international context. Increasingly, scientific and technological innovations occur as a result of teams of multinational researchers working in many different global settings. The Global Laboratory at SUNY Oswego aims to provide our undergraduates with these skills by providing six-eight week STEM-based cutting-edge research experiences at a number of leading research driven universities worldwide (UFPB, UFAL, UFMGS in Brazil; Indian Institute of Science, Bangalore, India; National Central University, Taiwan; University of Kinshasha, DRC). As a specific example, between 2011-2013, we will take six students per summer to work on cutting-edge astrophysics research projects at the Graduate Institute of Astronomy, National Central University, Taiwan. In this talk, we describe the pedagogical/cultural/cognitive benefits to students and our plans to expand the Global Laboratory.

FB04: 9:30–9:40 a.m. Quantum Entanglement and its Application

Ying-Hong Zhao, Chieng-Shiung Wu College, Southeast University, Jiangsu, China; 213102517@seu.edu.cn*

Xiao-Jiao Yuan, Jin Guo, Chieng-Shiung Wu College, Southeast University

Nowadays, the discussion about the inharmony between the local effect of relativity and the non-local effect of quantum mechanics raised by quantum entanglement has become one of the most difficult problems in physics. By taking a course called Bilingual Physics with Multimedia last semester, we have some new ideas about independent and explorative study. Inspired by the concept of education, we decided to study quantum entanglement and its application from a freshman's view. This essay mainly talks about exploring the history of quantum entanglement, the basic principles and the experimental facilities of quantum teleportation, as well as the latest scientific development on it. At last, we conclude that the exploration of science as endless and we also come up with some deep thoughts about the coming era of quantum information.

* Sponsor: Lei Bao

FB05: 9:40–9:50 a.m. My Experience with Physics Students and Teachers in Vietnam

Asim Gangopadhyaya, Loyola University Chicago, Chicago, IL 60626; agangop@luc.edu

During this summer I hope to have an opportunity to meet with teachers and students in South Vietnam. In particular, I would like to see their curricula and compare it with ours, and with an older curriculum in India that I am familiar with. I would also like to find out their way of teaching and see whether it has substantial differences from ours.

FB06: 9:50–10 a.m. Computer Simulations in Promoting Physics in Jamaica

Michael Ponnambalam, University of the West Indies, Kingston 00007, Jamaica; michael.ponnambalam@uwimona.edu.jm

After attending an AAPT Workshop at the Summer Meeting of 2006, we had our first computer-simulation-based experiment in the Algebra-based Freshman Physics course in November 2006, using two borrowed computers. The success of that venture led us to a Virtual Lab with 25 computers by October 2008. The use of the computer simulations in promoting the teaching of physics to the university students as well as in enhancing physics outreach to high schools, and even to the primary schools, will be discussed.

Session FC: Innovative Labs for Introductory Courses

Location: Harper Center 3028
Sponsor: Laboratories Committee
Co-Sponsor: Apparatus Committee
Date: Wednesday, August 3
Time: 8:30–9:50 a.m.

Presider: Tim Grove

FC01: 8:30–8:40 a.m. The Mash-up Report: A New Physics Lab Assessment Tool

Larry Bortner, University of Cincinnati, Cincinnati, OH 45221; bortnelj@ucmail.uc.edu

Carol Fabby, University of Cincinnati

We have developed an online, partial credit multiple choice lab report designed to reduce the student's composition time and virtually eliminate the grader's time. For each section of the report (called a centort), students are presented with snippets that have been previously graded with a rubric, with at least one choice for each level of the rubric. Each snippet is drawn randomly from a pool so that no two students have the same choices for the full centort. Grading is automatic but can be withheld from the student until after a submission deadline.

FC02: 8:40–8:50 a.m. Introductory E&M Labs Based on Challenge Projects

Michael Burns-Kaurin, Spelman College, Atlanta, GA 30314; mburns-k@spelman.edu

Paul Camp, Derrick Hylton, Marta McNeese, Natarajan Ravi

We changed the structure of the laboratory portion of the second semester of the calculus-based introductory course to center on two challenge projects, the design of the wiring for a house and the construction of a simple radio. Each challenge is broken down into sub-challenges that each include rounds of planning, performing, analyzing, and interpreting experiments. Moreover, each group typically performs a different experiment and shares the outcome with other groups (distributed expertise). Although the experiments end up similar to the experiments students performed before this change, the experiments are now in the context of complex, ill-formed problems, with the goal of improving the students' skills in the actual process of scientific investigation. This presentation will focus on the implementation of this approach, including some discussion of instructors' impressions and assessment of content knowledge; another presentation will focus on the rationale for this structure. Supported by NSF-CCLI DUE-0837216.

FC03: 8:50–9 a.m. Video-based Introductory Mechanics Labs Learning Effects

Sergio Flores, University of Juarez, Juarez, Chihuahua 32310, Mexico; seflores@uacj.mx

Juan Ernesto Chavez, Luis Leobardo Alfaro, Sergio Miguel Terrazas, University of Juarez
Maria Dolores Gonzalez, Instituto Tecnologico de Juarez

Many introductory physics students have understanding problems when they try to learn physics concepts through the knowledge mathematical representations during lab sessions. The research group named Physics and Mathematics in Context from the University of Ciudad, Juarez, Mexico, has developed a research approach based on videos to detect, analyze, and categorize students' understanding of problems to recognize and learn the properties of concepts such as forces as vectors. These videos are projected during the lab sessions to allow a direct interaction between the object knowledge (physical concepts) and the knowledge subject (the students). These videos show the materials, instruments, procedures, and the corresponding description of the cognitive and physical abilities students demand to develop the labs successfully. This didactic design is based on the theories of mathematical representations and visualization. We will show and describe samples of these videos and the corresponding learning effects found during lab sessions.

FC04: 9–9:10 a.m. The Physics of Rube Goldberg

Joseph L. Nothnagel, McHenry County College, Crystal Lake, IL 60012; joenothnagel@comcast.net

The popular 1963 board game "Mouse Trap" provided the inspiration for a creative assessment of the first two semesters of a three-semester calculus-based physics course. The game was fashioned from the cartoon images created by Rube Goldberg. The Merriam-Webster dictionary adopted the word "Rube Goldberg" as an adjective defined as accomplishing something simple through complex means. Physics is laden with "complex means" exemplified in the myriad of equations introduced in the first two semesters of classic physics. The lab involves the construction on paper of a "Mouse Trap." Twenty independent steps are to be constructed leading to the dropping of a net on the mouse. Each step must be one of the many equations studied in classic physics. The utility of the equation demonstrated in the action within each step along with complete calculations will be used to validate sufficient input force to output force to move from one step to the next of the mouse trap.

FC05: 9:10–9:20 a.m. Lab Experiments Using Radioisotopes with Wide Range of Half-Lives

John E. Tansil, Southeast Missouri State University, Cape Girardeau, MO 63701; jtansil@semo.edu

There are two common techniques for experimentally determining the half-life of a radioisotope. The first method involves measuring activity as a function of time and is limited to isotopes whose half-lives are short compared to time of measurement, yet long enough so that activity is well above background during time of measurement (a few minutes in a typical lab period). The second method is for long-lived isotopes and requires measuring activity and calculating the number of radioactive atoms from the known chemical composition of the sample. We have been using two radioisotopes whose half-lives differ by a factor of E14. The short-lived radioisotope is Barium-177m (T = 2.55 min) and the long-lived radioisotope is naturally occurring Potassium-40 (T = 1.277 E9 yr) which is found in a variety of common potassium compounds. We will discuss specific procedures with these lab experiments and how they fit in the overall nuclear science curriculum.

FC06: 9:20–9:30 a.m. Teaching Physics Related to an Early Attempt at Medical Imaging

Dean A. Zollman, Kansas State University, Manhattan, KS 66506; dzollman@phys.ksu.edu

Sytil K. Murphy, Kansas State University
Ebone B.Pierce, Dillard University
Johannes v.d. Wirjawan, Widya Mandala Catholic University

When President Garfield was shot on July 2, 1881, physicians could not determine the location of the bullet. Alexander Graham Bell proposed that he use his newly invented telephone and another relatively new development, the induction balance, to locate it.[1] This early attempt at nonintrusive medical imaging ultimately failed. The apparatus provides students with a way to learn several aspects of electromagnetism and AC circuits in a context that should be motivating to medical students who are studying physics. Even the reasons for the failure are directly related to understanding magnetic fields. Our progress toward developing a teaching activity on this topic has included creating an induction balance with readily available materials and detecting the location of hidden pieces of metal. This project is funded by NSF under grant DUE 04-26754.

1. Alexander Graham Bell, "Upon the electrical experiments to determine the location of the bullet in the body of the late President Garfield and upon the successful

form of induction balance for the painless detection of metallic mass in the human body, *Am. J. of Sci.* **25**, 22-61, (1883).

FC07: 9:30–9:40 a.m. Using a WiiMote to Track Multiple Objects in Two Dimensions

Eric Ayars, California State University, Chico, Chico, CA 95929; ayars@mailaps.org

Kyle Scully, Alex Skeffington, California State University, Chico

We will present a method of using the built-in camera on a Wii game controller with LabVIEW to track two-dimensional motion of up to four objects simultaneously in real time. We will show you how to do it (it's CHEAP!) and demonstrate some potential applications of this method to introductory lab experiments.

FC08: 9:40–9:50 a.m. Terminal Velocity of High-Altitude Balloon Payloads: Experiment Versus Theory

Paul Seifert, Concordia College, Moorhead, MN 56562; seifert@cord.edu

Gordon McIntosh, University of Minnesota, Morris

The terminal velocity of a high-altitude balloon payload descending under a parachute can be calculated using the Prandtl expression for the drag force and knowing the force of gravity (weight) on the payload. A simple model of the terminal velocity versus altitude has been developed, accounting for the changing density of the atmosphere during descent. This model will be compared to the actual terminal velocity of payloads launched by the University of Minnesota, Morris and ConHAB (Concordia College) balloon groups. We will also compare results between our two different parachute designs. The model and flight data will be used to develop an undergraduate laboratory activity illustrating differences between experimental real-world data and theoretically modeled data.

Session FD: Physics and Society Education

Location: Harper Center 3029
Sponsor: Science Education for the Public Committee
Date: Wednesday, August 3
Time: 8–10 a.m.

Presider: Art Hobsn

This session includes two invited talks on the general theme of communicating science to the public, followed by contributed 10-minute talks on topics in physics and society education.

FD01: 8–8:30 a.m. Dammit, Jim (Cameron), I'm a Screenwriter, Not a Physicist!

Invited - Ann G. Merchant, National Academies, 500 Fifth St., NW, Washington, DC 20001; amerchan@nas.edu

Science at its best is adventurous, creative, imaginative, and passionate. Indeed, given its propensity to explore uncharted territory, science is often the basis for provocative and compelling storylines in both film and television. But beyond good storytelling, entertainment channels possess the very real ability to affect opinions, inform ideas, and even change behavior. Recognizing the power of the popular media to shape society's outlook, in 2008 the National Academy of Sciences launched a new program called The Science & Entertainment Exchange to facilitate the connections between the entertainment industry and top scientists from around the country who can help bring the reality of engaging science to the creative arts. With more than 250 consultations to its credit, The Exchange has spent the last few years working with screenwriters, directors, producers, and set designers to bring more—and better—science to theaters and living rooms around the country.

FD02: 8:30–9 a.m. Using the Performing Arts in Education and Communication of Science*

Invited - Brian Schwartz, The Graduate Center of the City University of New York, New York, NY 10016; bschwartz@gc.cuny.edu

For the past 10 years, the author and his colleagues have been operating an outreach program for students and the public based on the theme of Science & the Performing Arts. Formal evaluations of the program indicate that using the performing arts to educate and communicate science is very effective in gaining the interest of students and a new audience of adults, typically not biased towards science. Approximately 10 events are presented each year under the heading Science & the Arts (see http://web.gc.cuny.edu/sciart). In this paper, we include results from an international conference held at the Graduate Center of CUNY in October 2010. The conference had invited sessions on the following themes: 1- Science and Theater; 2- Science and Dance; 3- Science and Music; 4- Science and Films, TV and Radio and 5- Science Festivals and Science Cafes.

*The program and videorecording of the sessions can be found at www.sciartconference2010.com.

FD03: 9–9:10 a.m. Global Energy Resources: An Interdisciplinary, General Education Course

Ernest R. Behringer, Eastern Michigan University, Ypsilanti, MI 48197; ebehringe@emich.edu

Margaret A. Crouch, Rhonda K. Longworth, Eastern Michigan University,

During fall 2010, we taught a new interdisciplinary course entitled Global Energy Resources: Physics, Philosophy, and Policy. This course fulfills a general education requirement in the area of global awareness. Students were introduced to energy concepts and technologies, theories of distributive justice, and national and international institutions that set and enforce policy, all applied to the distribution and use of global energy resources. Students were asked to complete homework assignments, in-class activities, a midterm exam, a group project, and a final exam. 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 2020. A detailed description of the course will be given, along with a summary of successes and challenges.

FD04: 9:10–9:20 a.m. Energy and Public Policy: A Course in Science and Government

Walter F. Cuirle, U.S. House Page School, Library of Congress LJ A-11, Washington, DC 20540-9996; walter.cuirle@mail.house.gov

"Energy and Public Policy" is a one-semester science elective offered by the Page School of the U.S. House of Representatives. The course is a form of project-oriented inquiry: working in small groups, students pick a problem in the area of energy or the environment that they think can be solved by legislation, then they write the legislation. The focus on legislation changes the character of the syllabus. Students want to learn the science they need to solve their problem and they prefer to learn it in the order in which questions arise in their legislative process. The course does not use a conventional textbook. Instead, students are given an electronic library of documents of the sort they might use if they actually worked for a House committee and were drafting legislation.

FD05: 9:20–9:30 a.m. Teaching Radiation Literacy and Nature of Science via Inquiry

Andy Johnson, Black Hills State University, Spearfish, SD 57783; andy.johnson@bhsu.edu

Anna Hafele, Black Hills State University

Most Americans know very little about ionizing radiation, nuclear power, and nuclear waste. What they do know is based on movies, cartoons, and video games. Non-science majors wonder? Will radiation make them radioactive mutants? What about cell phones and microwaves? Is radiation chemicals or waves? To top it all off, many students know very little about atoms. We are developing innovative materials for teaching non-scientists about radiation using inquiry. This approach also teaches students new ways to reason scientifically. I will present some ways we have developed to help students clarify types of radiation and contamination by direct experimentation, understand causes and effects of radiation using innovative online atom simulators, and apply their new knowledge to make sense of radiation health effects and nuclear waste. Find the materials at http://www.camse.org/andy/radiation. The Radiation by Inquiry project is supported by NSF DUE 0942699

FD06: 9:30–9:40 a.m. Science in the News

Matthew B. Koss, College of the Holy Cross, Worcester, MA 01610; mkoss@holycross.edu

Much of the vital scientific information that we need to know for our personal or civic utility or for its cultural value comes to us via the popular press. How do we negotiate and evaluate all that scientific information in order to know what is true, what is important, and what we are to do? In the course Science in the News, I have attempted to teach key elements of scientific-technical literacy with the methods and effectiveness of the media that provides scientific and technical information to the general public. In this talk I will present a précis on this course.

FD07: 9:40–9:50 a.m. Can We Deal with Societal Issues in an Introductory Course?

Peter Lindenfeld, Rutgers University, Piscataway, NJ 08854; lindenf@physics.rutgers.edu

Suzanne Brahmia, Rutgers University

Yes, it is possible to include societal issues in an introductory course. It helps to have a textbook that includes them. Studies show that texts are rarely read, but perhaps this is not completely the fault of the students. A new book[1] attempts to deal with both questions. It includes chapters on Energy in Civilization and Laws and their Limits. It incorporates mathematics as part of the conversation, and includes a Guided Review that encourages reading. Perhaps surprisingly, although it includes material not usually in such books, it is less than half as massive as the standard texts.

1. Peter Lindenfeld and Suzanne White Brahmia, *Physics: The First Science*, Rutgers University Press 2011, www.first.rutgers.edu

FD08: 9:50–10 a.m. Physics of Energy – from Uganda to U.S.

Abigail R. Mechtenberg, University of Michigan, Ann Arbor, MI 48104; amechten@Umich.edu

We introduce an internationally developed and implemented curriculum that opens the eyes of physics education practitioners to the vast array of teaching and learning possibilities for the application of the physics of energy. This curriculum and research has been implemented in the U.S. and also in Uganda, East Africa, and Liberia West Africa (and now Guatemala). The academic level is suited for undergraduate physicists, engineers, and professional technicians; however, the astute teacher can easily apply this to other students as we have applied it to U.S. junior energy camps. From this innovative and institutionally transforming curriculum, the Ugandan participants built large-scale bicycle electric generators, merry-go-round generators, a back-up hand crank surgical lamp, hydroelectric generator, incinerator generator, and vertical wind turbines from local parts and materials. The U.S. participants have built classroom working devices such as a solar-powered car with i-pod player, steam engine, and many more devices. During our workshops multiple designs have been executed in groups. Participants leave with a clear understanding of the creativity they possess within themselves and realize the importance of (1) the knowledge of physics and (2) ease of designing these devices themselves. Mixing DIY (design it yourself) with the physics of energy has created an unexpected synergy.

Session FE: Developing Teacher Leaders

Location: Skutt Student Center Ballroom F
Sponsor: Teacher Preparation Committee
Date: Wednesday, August 3
Time: 8–9:30 a.m.

Presider: Jon Anderson

FE01: 8–8:30 a.m. Evolving into a Teacher Leader

Invited - Kenneth E. Wester, Illinois State University, Normal, IL 61790; kwester@ilstu.edu

This talk will address various aspects of teacher leadership, including the roles of teacher leaders, the importance of teacher leaders, ways of preparing future teacher leaders, and the evolution of the classroom teacher into that of a teacher leader. I will address the path I took in becoming a teacher leader and eventually a physics teacher educator at the university level.

FE02: 8:30–9 a.m. 'OMG, You Want Me to Teach WHAT?'

Invited - Karen J. Matsler, UTArlington/UTeach, Arlington, TX 76019-0043; kmatsler@me.com

How does the professional community go about developing the local leaders to help reluctant recruits to teach physics effectively? The discussion will share experiences and data relevant to the effectiveness of professional development focusing on what we need, what we have, what we know, and what works.

FE03: 9–9:10 a.m. Reflections of a PhysTEC Physics Teacher in Residence

Rod A. Ziolkowski, California State University-Long Beach, Long Beach, CA 90815; rodziolkow@aol.com

Identifying, encouraging, and mentoring prospective/beginning high school physics teachers is my primary role as PhysTEC physics teacher in residence at California State University-Long Beach. I will describe the leadership role I play when interacting with the physics department faculty, developing curriculum and programs, and interacting with beginning physics teachers. After 25 years teaching high school students, I see my physics-teacher-in-residence position as equal parts responsibility and opportunity and I look forward to sharing my experiences with you.

FE04: 9:10–9:20 a.m. Inquiry and the Use of Technology in Teaching Physics

Mark LaPorte, Middle Tennessee State University, Murfreesboro, TN 37132; mlaporte@mtsu.edu

Effective implementation of technology within the context of inquiry instruction has been known to enhance the meaningful learning of physics by both enhancing the conceptual understanding and the motivation of students. Students who are explicitly aware of the questions they are trying to answer are more intellectually engaged in the design of the procedures to answer those questions. Mentoring pre-service teachers in the effective use of technology within the context of inquiry instruction is an important function of the TiR's role in preparing high-quality physics teachers. Examples of current technologies used in physics classrooms and how these technologies can be effectively used in inquiry-based curriculums are discussed.

FE05: 9:20–9:30 a.m. Feeling Connected

James L. Overhiser, Cornell University, Owego, NY 13827; joverhis@gmail.com

A sense of feeling connected is part of being human. This is especially true for a young teacher. Involving pre-service and freshman teachers in content-specific networks early in their career helps them understand the connections that can be made to support their work in the classroom. This can also remove the anonymity that teachers work under and place them in a cooperative group of professional development. Doing this early in the career of a teacher will help them see the importance of such networking and teach them the responsibility of moving into leadership roles to keep the network active and viable.

Session FF: Introductory Courses

Location: Skutt Student Center Ballroom DE
Sponsor: Physics in Undergraduate Education Committee
Date: Wednesday, August 3
Time: 8–10 a.m.

Presider: John Griffith

FF01: 8–8:10 a.m. The Law of Refraction without Trigonometry: Beaten to It by Descartes!

David Schuster, Western Michigan University, Kalamazoo, MI 49008-5252; david.schuster@wmich.edu

Betty Adams, Western Michigan University
Adriana Undreiu, University of Virginia's College at Wise

Investigating and discovering a law for refraction is potentially an ideal activity for inquiry-based physics. However, the law of refraction involves sine functions; this complicates an empirical search for a law (as it did historically) and may also seem to preclude it for students with no trigonometry. Wanting a guided-discovery approach nonetheless, we "invented" a geometrical representation: incident and refracted ray directions can be specified not only by angle but by semi-chords in a reference circle. This proves very successful: students discover that various possible relationships, such as angle ratios, are initially promising but do not work at large angles; and they finally arrive at a simple and visually elegant law: the ratio of semi-chords for incident and refracted rays is constant. We then found that we had been beaten to this form of the law by nearly 400 years, by Descartes among others! Thus in the case of refraction, exemplary inquiry pedagogy has a counterpart in history. Note that the approach also reveals the underlying meaning of sine functions and a reason why trigonometry was invented. Students then go on to use the semi-chord representation to solve refraction problems by geometrical construction.

FF02: 8:10–8:20 a.m. Discovering the Law of Refraction*

Adriana Undreiu, University of Virginia's College at Wise, Department of Natural Sciences, Wise, VA 24293; au8e@uvawise.edu

Betty Adams, David Schuster, Western Michigan University

Refraction can serve as a wonderful example of a guided-discovery approach to a physics topic. Yet many textbook treatments remain the antithesis of this, despite the fact that physics is more than just a body of knowledge. Our inquiry-based approach involves exploring refraction behavior and tracing rays, then testing for possible relationships between incident and refracted ray directions, seeking a law that works at all angles. (A semi-chord representation for ray directions makes the task easier and less abstract). If a course has no lab, students still use graphic ray-direction data to seek a law, as a valuable inductive discovery problem. Note that conventional problems are purely deductive, missing an important facet of real science. We will contrast the approach, both epistemologically and pedagogically, with direct didactic presentations common in textbooks. Refraction has proved to be one of the most successful inquiry-based topics in our course for prospective

teachers, for learning both the physics and the nature of scientific inquiry.
* Will be presented by Betty Adams.

FF03: 8:20–8:30 a.m. Characterizing Iconic Problems of the Introductory Physics Course

Juan R. Burciaga, Denison University, Granville, OH 43023; burciagaj@denison.edu

The introductory physics course has a backbone of problems that form the basis of future study, that is problems that physics students see again and again throughout their study of physics, each time approaching a given problem in greater depth and complexity. Characteristics of these iconic problems may offer insight into some of the "habits of mind" employed by physicists as they approach problem solving in the discipline and perhaps shed some light on the intractable nature of the curriculum. The paper reports on a census of the iconic problems from the introductory sequence and identifying the characteristics that make these problems valuable to the physics discipline and the physics curriculum.

FF04: 8:30–8:40 a.m. Measurements of Students' Performance on Computational Exercises in Introductory Mechanics

Marcos D. Caballero, Georgia Institute of Technology, Atlanta, GA 30332; caballero@gatech.edu

Matthew A. Kohlmyer, North Carolina State University
Michael F. Schatz, Georgia Institute of Technology

The impact of laboratory and homework exercises on the development of computational thinking is evaluated using a proctored end-of-course computational exercise. We present the motivation for and development of this proctored assignment, an analysis of erroneous student code, and the implications for teaching computation to introductory physics students.

FF05: 8:40–8:50 a.m. Summary Writing vs. Reflective Writing

Xiang Huang, Concordia University, Montreal, QC, H4B 1R8, Canada; x.xianghuang@gmail.com

Calvin Kalman, Concordia University

Reflective writing is an effective activity to help students to develop a scientific mindset and critical thinking skills. It gets students to metacognitively examine their concepts and relate them to other ideas. In this study, we compare two sections taught by the same professor, one with instructions to do summary writing and the other with instructions to do reflective writing.

FF06: 8:50–9 a.m. The Answer Is in the Back of the Book

Stephanie A. Magleby, Brigham Young University, Provo, UT 84602; sam25@physics.byu.edu

One plus one is three; because three is the answer in the back of the book. Sound familiar? We have seen increased instances of this kind of "wishful math" in our undergraduate physics and engineering courses. In this talk I will discuss the pedagogical pros and cons of having the answer readily available in the back of the book. Also, we discuss different teaching and grading techniques to counteract this "creative math" trend.

FF07: 9–9:10 a.m. Reforming Undergraduate Course for Engineering/Physics Majors: Factors Influencing Students' Performance

Deepika Menon, University of Missouri, Columbia, MO 65211; dm2qc@mail.mizzou.edu

Karen King, University of Missouri

There has been emphasis on reforming traditional undergraduate physics courses for science/engineering majors. This study was conducted with 273 undergraduate students, enrolled in calculus-based course for physics majors at a large Midwestern University. The focus was to understand the factors that influence students' performance within the course. The course has weekly 2½ hours of lecture, 2½ hours of laboratory, and a small group recitation section focusing on problem solving. Students are assigned weekly online homework and pop-up quizzes (counts towards attendance). Regression analysis shows that students' average exam score is neither influenced by gender nor their major (engineering/physics/other sciences). However, students' average exam score is highly significant with their lab score, pop quizzes, and online assignments. Findings of the study would help science faculty design courses for science/engineering majors with emphasis on factors that strongly contribute towards their average grade. Reform-based courses would further help reduce drop outs, providing "preparatory classes" for students at risk.

FF08: 9:10–9:20 a.m. Computer Simulation vs. Demonstration in the Introductory Physics Lecture

Monica Pierri-Galvao, Marywood University, Scranton, PA 18411; mpierrigalvao@marywood.edu

Students today belong to a computer generation. They grew up playing video games and using computers for all their learning and entertainment needs. In view of this new student profile, it is worth asking the question if learning can be enhanced by replacing traditional demos with computer simulations in the lecture setting. To investigate this issue, we replaced four demonstrations with simulations in an introductory physics course and compared the learning outcomes with a pre- and post-test.

FF09: 9:20–9:30 a.m. Student Difficulties Using Graphs Required for a Materials Science Course

Rebecca J. Rosenblatt, The Ohio State University, Columbus, OH 43210-1117; rosenblatt.rebecca@gmail.com

Andrew F. Heckler, The Ohio State University

We report on a number of student difficulties with standard graphs and diagrams used in an university-level introductory materials science and engineering course. We investigated student understanding of a variety of graphs and diagrams including atomic bonding potential energy graphs, material concentration and diffusion graphs, stress-stain plots, and phase diagrams. Some of the difficulties with graphs are similar to those previously found in studies of introductory physics topics, such as students confounding slope with height and the failure to attend to the axis labels. However, we have identified a number of other difficulties specific to the type of graph or diagram used. For example, many students have difficulties both using the boundaries of an alloy phase diagram to derive information about the microstructure of the alloy and understanding the physical meaning of the boundaries between phases. We also report on the effectiveness of some graph activities implemented in recitation.

FF10: 9:30–9:40 a.m. Tracking Student Focus During Lectures

David Rosengrant, Kennesaw State University, Kennesaw, GA 30144; drosengr@kennesaw.edu

Doug Hearrington, Kennesaw State University

This study investigates the gaze patterns of undergraduate college students attending a lecture-based physics class to better understand the relationships between gaze and focus patterns and student attention during class. The investigators used a new eye-tracking product, Tobii Glasses with infrared markers, which eliminate the need for subjects to focus on a computer screen or carry around a backpack-sized recording device, thus enabling a broader range of research questions to be investigated. 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. After the lectures, most subjects attended an interview at which they were shown part of their video of their gaze patterns and were asked to reflect on their thinking and attention. We report on the subjects as a whole and then in subgroups based upon grades and specific courses.

FF11: 9:40–9:50 a.m. Fostering Computational Thinking: Computer Modeling Homework in Introductory Mechanics

Michael F. Schatz, Georgia Institute of Technology, Atlanta, GA 30144; michael.schatz@physics.gatech.edu

Marcos D. Caballero, Georgia Institute of Technology
John B. Burk, The Westminster Schools
Matthew A. Kohlmyer, North Carolina State University

Introductory physics courses typically fail to provide students with significant opportunities to use a computer to solve science and engineering problems. We present an overview of recent work to develop laboratory and homework exercises on numerical modeling, simulation, and visualization for students in introductory mechanics in both high school and large enrollment university courses.

FF12: 9:50–10 a.m. The Educational Pitfalls of 'Plug-In' Physics

Hiro Shimoyama, The University of Southern Mississippi, Hattiesburg, MS 39401; hironori.shimoyama@usm.edu

In the field of physics teaching and learning, university students' performance on exams sometimes does not effectively indicate their understanding. Namely, due to ill-conceived approaches to academic tasks, some students can obtain a higher score without actually learning scientific concepts. One typical approach is so called "plug-in" physics, by which students focus on only the values and related formulas. From an instructor's point of view, it is often difficult to identify this problem. Although this method may enable students to obtain "correct" answers, such students do not necessarily acquire the basic principles of physics and they cannot deal with certain types of problems in authentic "real world" contexts. This talk depicts some real examples of "plug-in" physics and explores possible solutions to this widespread problem, including the requirement of partial and sequential answers and use of visual stimuli-based problems in the design of assessments.

Session FG: *Panel:* New Avenues for Collaboration and Mentoring

Location: Skutt Student Center Ballroom ABC
Sponsor: Educational Technologies Committee
Co-Sponsor: Physics in Two-Year Colleges Committee
Date: Wednesday, August 3
Time: 8:30–10 a.m.

Presider: Todd Leif

Leslie Huling Austin writes in her article "Research on Learning to Teach: Implications for Teacher Induction and Mentoring Program" that to survive the shock of classroom reality, novice teachers need collegial support from experienced teachers and peers. Providing such a mentor in physics proves especially difficult in high schools and two-year colleges that only employ one physics instructor. The panelists will discuss their use of technology to mentor new physics instructors at institutions other than their own, and how successful it has been. Two of the panelists mentor new high school teachers, while the third panelist mentors new two-year college instructors.

Panelists:

– *Nina Morley Daye, Orange High School, Hillsborough, NC*

– *Scott Schultz, Delta College, University Center, MI*

– *Al Thompson, Ponderosa High School, Parker, CO*

Session FH: Assessment Beyond Conceptual Inventories

Location: Skutt Student Center 104
Sponsor: Physics in Undergraduate Education Committee
Co-Sponsor: Research in Physics Education Committee
Date: Wednesday, August 3
Time: 8–10 a.m.

Presider: Aaron Titus

This session will highlight assessment methods and assessment instruments that go beyond multiple choice, conceptual inventories. Methods and instruments might include lab skills assessment, problem solving, writing, and experimental or computational tasks.

FH01: 8–8:30 a.m. Why Conceptual Inventories Are Insufficient Assessment of Our Instructional Methods*

Invited - Beth Thacker, Texas Tech University, Lubbock, TX 79409; beth.thacker@ttu.edu

We present data on written pre- and post-testing and conceptual inventory pre- and post-testing in introductory labs as part of a large-scale assessment project. We address the benefits and drawbacks of each kind of assessment and discuss the need for a more comprehensive assessment to evaluate our instructional methods.

*This project is partially supported by grants NIH 5RC1GM090897-02 and NSF 0737181.

FH02: 8:30–9 a.m. Sustaining and Improving through Programmatic Assessment and Feedback Loops

Invited - Vincent H. Kuo, Colorado School of Mines, Golden, CO 80401; hkuo@mines.edu

As the fifth largest undergraduate physics program in the country, the ABET-accredited Engineering Physics degree at the Colorado School of Mines currently has 240 majors, representing substantial growth over the past decade. A shift in program philosophy contributed to our current status. But are we successful? To better understand how we got here, and how best to proceed into the future, we turn to both horizontal and vertical assessments at the programmatic level. As is well known in the engineering education community, accredited programs must implement a process for developing program goals and objectives, along with a delivery plan that makes use of assessment and feedback to demonstrate continuous improvement. In this talk I will provide an overview of our undergraduate degree program, highlight some of the changes we have made, and describe our three overlapping assessment/feedback loops at the scale of individual courses, program learning objectives, and overall program goals.

FH03: 9–9:30 a.m. What Stops a Person from Successfully Solving a Physics Problem?

Invited - Wendy K. Adams, University of Northern Colorado, Greeley, CO 80631; wendy.adams@colorado.edu

Physics educators regularly make use of concept inventories and perceptions surveys (aka: attitudes and beliefs) to evaluate instruction. However, these two types of evaluation only touch on a fraction of what is learned in a course. Students apply a range of processes, expectations and bits of knowledge when solving a physics problem and some of these are impacted by the course. The question is how can we identify what these processes, expectations and bits of knowledge are, how can we teach them and then how can we measure them? While developing the CAPS (Colorado Assessment of Problem Solving), I identified 44 processes, expectations and bits of knowledge used to solve an in depth real world problem. In this presentation I will present these skills, ideas on how to teach them and measure them.

FH04: 9:30–9:40 a.m. Formative Assessment of Hypothetico-deductive Reasoning by Directly Challenging Student Epistemology

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

A critical skill necessary for practicing scientists is the application of the hypothetico-deductive model and the use of all available epistemological resources to determine new truths. Hypothetico-deductive reasoning can be assessed via written tests; however, these types of assessments avoid situations where students have deeply held pre-conceived knowledge. We present a case study where first-year physics majors are confronted with epistemic complexity; their pre-conceived "knowledge" is directly challenged, forcing them to apply different epistemological resources towards the design of an appropriate experiment. Students struggle with developing hypothetico-deductive models that probe strongly held beliefs, whereas they do not for unknown or weakly held assumptions. For strong beliefs, students limit themselves to certain modes of knowledge construction, specifically those that led to the beliefs in the first place. These challenges can be used to probe the depth of student reasoning, and explicit confrontation of this dichotomy can make students stronger truth seekers.

FH05: 9:40–9:50 a.m. Measuring Conceptual Understanding in Kinematics by Problem-Solving

Daniel M. Smith, Jr., South Carolina State University, Orangeburg, SC 29115; dsmith@scsu.edu

To solve kinematics problems, students are usually advised to (1) draw a diagram or graph, (2) write down known and unknown quantities, (3) choose kinematic equations that will allow the determination of the unknown quantities, and (4) solve that equation. Frequently this prescription does not result in the student finding a problem solution, but why? Often student difficulties are attributed to their inability to choose the correct equation, or to weak skills in algebra. Evidence is presented from a calculus-based physics class, however, that students fail to solve problems because they lack a conceptual understanding of the problem, as determined by their ability to relate the problem data to a diagram. The limited roles that "choosing the right equation," and weak algebra skills play in problem-solving is further explored by having students solve problems graphically by using interactive software designed especially for one-dimensional kinematics problems.

FH06: 9:50–10 a.m. Phased-Array Homework: Used to Shape and Steer Student Understanding

Stacy H. Godshall, U.S. Military Academy, West Point, NY 10996; stacy.godshall@us.army.mil

Students demonstrate different levels of preparation and understanding of material which often coincide with how diligent the students are with their daily preparation prior to class. Having them attempt homework problems prior to class enables them to be better prepared to ask specific questions about concepts and also better prepared to perform on exams. This paper will introduce "phased-array homework" which is a flexible system of assigning homework that also incorporates specific timing of publication to students of "partial solutions" for reference by the students. As the name of the homework system implies, phased-array homework allows an instructor to shape and steer student understanding in much the same way that a phased-array antenna allows for the shaping and steering of a transmitted electromagnetic signal to yield its subsequent effective radiation pattern. Implementation method and results will be presented as well as student perspective on the system.

Session FI: Teacher Recruitment, Training, and Enhancement

Location: Skutt Student Center 105
Sponsor: Teacher Preparation Committee
Date: Wednesday, August 3
Time: 8–9:30 a.m.

Presider: Duane Merrell

FI01: 8–8:10 a.m. Expectancy Violation in a Physics Course for Education Majors

Jon D. H. Gaffney, University of Kentucky, Lexington, KY 40504; jon.gaffney@uky.edu

At the University of Kentucky, an interactive, hands-on physics course is required of pre-service elementary and middle school teachers. This pedagogically reformed course is substantially different from their other science courses and could be a touchstone for science education methods classes. In a previous presentation (AAPT Jacksonville, 2011), I relayed the differences in goals for students and instructors, claiming that students reported the most success meeting the goals they valued highest. Deeper investigation revealed satisfaction with many aspects of the course but confusion about its role in the teacher preparation process. In this presentation, I will discuss the role that student expectations and expectancy violations play in their perceptions of the course, which may in turn affect whether they deem it relevant to their future careers. I will present additions to the course that I have introduced to facilitate necessary shifts in student expectations.

FI02: 8:10–8:20 a.m. Using the RTOP to Gauge Implementation of IPTIR Program Goals

Jeremy B. Hulshizer, University of Northern Iowa, Department of Education, Cedar Falls, IA 50112; jeremy.hulshizer@gmail.com*

Lawrence T. Escalada and Jeffrey T. Morgan, University of Northern Iowa

The Iowa Physics Teacher Instruction and Resources (IPTIR) program at the University of Northern Iowa trains physics teachers in research-based inquiry strategies; many out-of-field teachers also use the program to gain certification to teach physics. As part of their program activities, participants submit two video lessons each academic year, which the staff use to evaluate the degree to which participants are employing methods emphasized by the program. The Reformed Teaching Observation Protocol [1] is used to rate each submission. We discuss trends observed in examining the RTOP scores of program participants, as well as correlations between RTOP scores and student performance on various standardized conceptual assessments and other measures.

1. Sawada, Daiwo, et al. "Measuring Reform Practices in Science and Mathematics Classrooms: The Reformed Teaching Observation Protocol," *School Science and Mathematics* 102(6), pp. 245-253.

*Sponsors: Lawrence Escalada and Jeffrey Morgan.

FI03: 8:20–8:30 a.m. Content, Process, Affect, and Physics Courses for Future Teachers

Paul Hutchison, Grinnell College, Grinnell, IA 50112; hutchiso@grinnell.edu

A physics class must have some physics knowledge in it. This self-evident statement hides complexity worth examining. It is important to think about the role of physics knowledge and the role of students in relation to it. This study explores how different knowledge-student relationships interact with the multiple goals in physics courses aimed at pre-service elementary teachers, though the findings bear on any course for future teachers. I draw on analyses of existing curricula, scholarship from the science education and teacher education research communities, and data collected when I taught such courses. My study indicates different relationships between students and physics knowledge can create classroom environments that prize some goals over others. It's not clear this must necessarily be a zero-sum game, where the most important goal is identified and supported. I speculate how a physics course for teachers might be organized to simultaneously support multiple instructional goals.

FI04: 8:30–8:40 a.m. Training of In-service Science Teachers Using Peer Instruction (PI)

Jongwon Kim, Korea National University of Education, Cheongju, Chungbuk, 363791, Republic of Korea; bellbesty@hotmail.com

Jungbok Kim, Korea National University of Education

Using peer instruction in introductory physics courses is growing at institutions across the U.S., however, this approach is rarely used for training in-service science teachers. We have been incorporating peer instruction for training in-service science teachers since 2010. This has been aimed to 169 teachers in five classes (two elementary schools, two middle schools and one combined). We surveyed 135 teachers from these classes to research their perspectives and recommendations for using peer instruction, and investigated 56 of them with six conceptests for light propagation. We found that 93% of the teachers acknowledged the value of peer instruction to develop their concept of science. Through analysis of teachers' answers to these questions, we identified that the percentage of correct answers increases significantly after peer instruction. Finally, we found broad agreement of about 91% for using peer instruction for training in-service science teachers.

FI05: 8:40–8:50 a.m. PTRA ToPPS Project at NWOSU

Steven J. Maier, Northwestern Oklahoma State University, Alva, OK 73717; sjmaier@nwosu.edu

In the summer of 2011, a PTRA ToPPS science institute for Oklahoma middle and high school teachers was hosted at Northwestern Oklahoma State University.[1] This institute is the first of its kind for the state of Oklahoma and will be a major step forward for establishing a network of resources and cooperating teachers across northwest Oklahoma. In this presentation, an update of a continuing four-year study that served as the motivation for pursuing an ITQ grant[2,3] will be presented. How the program is expected to address the needs of "out of field" teachers and the call for additional professional development for physical science teachers across the state will also be discussed. Finally, preliminary results of the institute's effectiveness in building upon participants' content knowledge, pedagogical content knowledge, instructional strategies, professional networking and recourses to help their districts and students in their classrooms will be shared.

1. PTRA (Physics Teaching Resource Agents) ToPPS (Teachers of Physics and Physical Science). Program website: www.nwosu.edu/ToPPS.
2. S. J. Maier, "HS Physics Teaching in Oklahoma: A Status Report," AAPT summer conference, Portland, OR, 2010.
3. Funding for this project was made possible by the Oklahoma State Regents for Higher Education Improving Teacher Quality grant program for professional development; NCLB Title II, Part A.

FI06: 8:50–9 a.m. Promoting Changes to Teachers' Classroom Practices

Jeff Phillips, Loyola Marymount University, Los Angeles, CA 90045; jphillips@lmu.edu

One hundred eighteen high school and college teachers in Southern California completed a web-based survey that asked them to self-report what they do in the classroom and answer questions that might shed light on who is adopting various research-based instructional strategies (RBIS). The use of RBIS and a fraction of the course devoted to student-student interaction often correlated with the teachers' view of intelligence (incremental versus entity) and the degree to which they self-regulate their teaching. It was also observed that the teachers' classroom practices do not correlate with many one-way interactions, including attending conference presentations or reading journals. Implications for those looking to promote change in teachers, including AAPT Sections, will be discussed.

FI07: 9–9:10 a.m Teacher-Driven Professional Development and the Pursuit of a Sophisticated Understanding of Inquiry*

*Michael J. Ross,** University of Colorado–Boulder, Boulder, CO 80305; michael.j.ross@colorado.edu*

Samson J. Sherman, Ben J. VanDusen, Valerie K. Otero, UC Boulder

The need for quality physics teaching in the U.S. is well established, and efforts are under way to develop innovative teacher professional development experiences to improve physics education. The physics education research reported here investigates how an innovative program has facilitated growth in physical science teachers' views of scientific inquiry. Streamline to Mastery is an NSF-funded teacher-as-learner-centered professional development program that capitalizes on teachers' knowledge and experience as they move toward mastery in their fields. Teacher participants explicitly chose to focus on their understandings of "inquiry" through the development and implementation of inquiry-oriented curricula. Preliminary findings indicate that teachers' conceptions of inquiry and the relationship of physics classroom inquiry to scientific inquiry have changed significantly as they continue to engage in a variety of experiences around the topic. These results will be discussed along with implications for physics instruction and physics teacher professional development.

*This research is partially funded by NSF grant #DUE 934921

**Sponsor:Valerie Otero

FI08: 9:10–9:20 a.m. Scientific Reasoning Abilities in Pre-service Teachers in the Capstone Science Course

Eric N. Rowley, Wright State University, Centerville, OH 45459; fizx_teacher@mac.com

Kathy Koenig, Wright State University

Prior assessment of our pre-service teachers' understanding of the nature of science (NOS) and scientific reasoning (SR) abilities were found lacking for candidates exiting our program after having completed as many as 11 science content courses. For three years we have implemented a new course to start the science sequence and collaborated to enhance our existing courses. Evaluation of the curriculum indicated that students made significant shifts in understanding and abilities as a result of this one-quarter course. In spring 2011, another year of students were post-tested to determine the longitudinal impact of the revised foundations course. This talk will provide a brief overview of the course along with the findings of this longitudinal study, as well as a discussion of implications of the transitions to semesters in fall 2012.

FI09: 9:20–9:30 a.m. Changing Roles and Identities in a Teacher-Driven Professional Development Community

Ben Van Dusen, Colorado State University–Boulder, Boulder, CO 80305; benjamin.vandusen@colorado.edu

Mike Ross, Sam Sherman, Valerie Otero, UC Boulder

In a climate where teachers feel de-professionalized at the hands of regulations, testing, and politics, it is vital that teachers become empowered both in their own teaching and as agents of change. This physics education research study investigates the "Streamline to Mastery" (S2M) professional development program, in which teachers engage in action research while designing future professional development opportunities for themselves and for fellow teachers. The research reported here describes the process of empowerment through changes in roles and identities over time. Videotaped data were analyzed to glean insight in language, practice, and participation shifts as secondary physical science teachers participated and formed the S2M community and engaged in their own classroom research. Implications for the role of PER in teacher professional development and teacher preparation will be discussed. This research is partially funded by the NSF DUE grant #934921.

AAPT Awards: Klopsteg Memorial Lecture Award
Distinguished Service Citations

Location: Harper Center Hixson-Lied Auditorium
Date: Wednesday, August 3
Time: 10:15–11:30 a.m.

Presider: David Cook

James Hansen

Klopsteg Memorial Lecture Award Presented to James Hansen

Halting Human-Made Climate Change: The Case for Young People and Nature

James Hansen, NASA Goddard Institute for Space Studies, New York City

Humans are now the dominant force driving climate change. The nature of the climate system— its "inertia" and "tipping points"—makes the matter urgent. Business-as-usual would hand our children a situation out of their control—continually shifting shorelines, as many as half of all species committed to extinction, increasing climate extremes with greater floods, droughts, fires, and stronger storms. Government policies are nearly useless. The intergenerational injustice raises a profound moral issue, as greenwashing governments feign ignorance of the actual situation and the fecklessness of their policies. The tragedy is that a simple honest solution is possible—one that stimulates the economy, phases out fossil fuel addiction, and stabilizes climate—but it requires putting the public's interest above that of special financial interests. Adults must unite with young people in a campaign to force well-oiled coal-fired governments, through legal remedies and democratic processes, to tell the truth and do their job.

Distinguished Service Citations Presented

Drew Isola
Allegan H.S.
Allegan, MI

Todd Leif
Cloud County C.C.
Concordia, KS

John L. Roeder
The Calhoun School
New York, NY

R. Steven Turley
Brigham Young University
Provo, UT

AIP Science Writing Award – Children's Category

Gillian Richardson
Kaboom! Explosions of All Kinds

Crkrbrl 6: Crackerbarrel on PER Graduate Students

Location: Harper Center 3027
Sponsor: Research in Physics Education Committee
Co-Sponsor: Graduate Education in Physics Committee
Date: Wednesday, August 3
Time: 12–1 p.m.

Presider: Meghan West

Balancing graduate school and life: organizational strategies and taking time for yourself – come to this Crackerbarrel and discuss.

Crkrbrl 7: Crackerbarrel on Physics and Society Education

Location: Harper Center 3028
Sponsor: Science Education for the Public Committee
Date: Wednesday, August 3
Time: 12–1 p.m.

Presider: Art Hobson

The physics and society education group seeks to spread knowledge about environment, energy, overpopulation, nuclear weapons issues, the scientific process, pseudoscience, and other societal topics by inserting them into K-16 physics courses and by communicating with the public. Please come and help us find ways to achieve this.

Crkrbrl 8: Crackerbarrel on Ideas and Resources for Using History to Teach Physics

Location: Harper Center 3029
Sponsor: History and Philosophy in Physics Committee
Co-Sponsor: Interests of Senior Physicists Committee
Date: Wednesday, August 3
Time: 12–1 p.m.

Presider: Hugh Henderson

Come and join us for snacks and conversation about the history and philosophy of physics. Everyone is welcome to join the conversation.

Session GA: Post-Deadline Session

Location: Harper Center 3040
Date: Wednesday, August 3
Time: 1–2:10 p.m.

Presider: Jeannette Lawler

GA01: 1–1:10 p.m. A Simple Calibrations Lab

Dan Beeker, Indiana University, Bloomington, IN 47405; debeeker@indiana.edu

A simple laboratory exercise to determine the accuracy of a meter stick and ultrasonic motion detector using homemade calibration bars is described. This lab exercise makes an ideal first lab as it is simple to do yet provides a reliable value for the accuracy of measuring devices commonly used in the first year physics labs.

GA02: 1:10–1:20 p.m. Arduino as a Tool for Lab Development and Student Learning

Zengqiang Liu, St. Cloud State University, St. Could, MN 56301; zliu@stcloudstate.edu

Jing Chen, ShunJie Yong, Steve Zinsli, St. Cloud State University

Since its debuted in 2005, the Arduino microcontroller platform has enabled artists and novice electronics hobbyists worldwide to construct unique electronic gadgets, lots of which appear as if they were created by engineers. With Arduino, constructing your own lab equipment becomes very practical, and economical. It is also very educational to students and instructors alike. With beginner-friendly programming environment, strong community support, and sensors, cheaply mass produced for modern electronics (cell phones, tablets, video game systems etc.), we can design and construct high-quality lab equipment to suit out teaching goals and improve student learning experience. Going through the process of constructing even simple equipment should be beneficial to teaching physics content, hands-on skills and convincing our students that physics principles and their applications power our world. A brief introduction of Arduino will be followed by examples of such equipment we created with it.

GA03: 1:20–1:30 p.m. Successful Strategies for Teaching Physics II (Electromagnetism, Optics, Modern Physics)

Deepthi Amarasuriya, Northwest College, Powell, WY 82435-1887; deepthi.amarasuriya@northwestcollege.edu

Teaching calculus-based Physics II (EM, optics, introduction to modern physics) in one semester is difficult - especially when classes meet for three 50 minute lecture sessions, and one 2.5 hr lab per week. Having many mathematically underprepared students adds to the challenge. By judiciously combining "old fashioned" blackboard lectures with concise but comprehensive printed lecture notes, Power Point slides, Java applets and labs that work in tandem with lectures, I have covered the designated topics well enough so that over 75% of my students continue with Engineering and Physics programs.

GA04: 1:30–1:40 p.m. Should Students be Provided Diagrams or Asked to Draw Them While Solving Introductory Physics Problems?

Alexandru Maries, University of Pittsburgh, Pittsburgh, PA 15217; alm195@pitt.edu

Drawing appropriate diagrams is a useful problem solving heuristic that can transform the problem into a representation that is easier to exploit for solving the problem. A major focus while helping introductory physics students learn problem solving is to help them appreciate that drawing diagrams facilitates further problem solution. We conducted an investigation in which approximately 120 students in an algebra-based introductory physics course were subjected to three different interventions during the problem solving in recitation quizzes throughout the semester. They were either asked to solve problems in which the diagrams were drawn for them or they were explicitly told to draw a diagram or they were not given any instruction regarding diagrams. We developed a rubric to score problem solving performance of students in different intervention groups. We will present our findings including some surprising results for problems which involve final/initial situations. This work is supported by NSF.

GA05: 1:40–1:50 p.m. Does Reading Physics Textbooks Help Resolve the Contradictions?

Sevda Yerdelen-Damar, University of Maryland–College Park, College Park, MD 20740; syerdelen@gmail.com

Students' intuitive knowledge about physical phenomena influences their learning. However, inappropriately activated intuitive knowledge leads to contradictions with formal physics knowledge. This study explored whether students become aware of those contradictions when reading textbooks. Firstly, 36 tenth grade students responded to a questionnaire designed to activate their intuitive knowledge about the relation between force and velocity. Specifically, students were asked to compare, intuitively, the magnitude of the push force and friction force exerted on a cup moving at steady speed. 29 students answered the push force should be greater than the frictional force. Secondly, the students read textbook pages explaining explicitly that the net force exerted on an object moving at constant velocity must be zero. Finally, they answered whether they felt any inconsistency between their intuitive knowledge and what they read. Only five students reported they felt contradiction. This result indicates that simply reading the textbook does not guarantee that they will realize the inconsistencies between everyday thinking and formal physics knowledge.

GA06: 1:50–2 p.m. Approaches to Address Persistent Misconceptions about Electric Current Among In-service Teachers

Jung Souk Lee, Harvard University, Cambridge, MA 02138; jslee@seas.harvard.edu

Jung Bog Kim, Seoul National University

This paper explores the development of a tutorial emphasizing movement of charges, and analyzing the changes from teachers during implementing the tutorial. We did preliminary research to determine the elementary teachers' specific difficulties and misconceptions about electrical currents. In the results from the data, we developed a tutorial and implemented it for in-service teachers. Multiple-choice questionnaires on the concept were given before the tutorial, and after completing the tutorial, multiple-choice questionnaires were given again. To better observe some of the specific changes teachers make, all activities of the tutorial were recorded and transcribed. When the educators understood the characteristics of conductors and insulators, they were able to explain friction, induction, and the movement of charges at contact points. This ended the confusion between electric charge and current. These tutorials played an important role in correcting the idea that voltage is the same as current. By emphasizing the interaction of charges in a closed circuit, the teachers understood that current was not consumed but remained constant. Also, the tutorials corrected the misconception that the battery produces constant current in all situations; instead, the teachers began thinking in terms of the movement of charges through a battery in a series and a parallel circuit.

GA07: 2–2:10 p.m. Will the Fox Catch the Rabbit? Non-Cartesean Thinking in Introductory Mechanics

Mikhail Kagan, Penn State University, Abington, PA 19001; mak411@psu.edu

As we typically teach in an introductory mechanics course, choosing a "good" reference frame with convenient axes may present a major simplification to a problem. Additionally, knowing some conserved quantities provides an extremely powerful problem-solving tool. While the former idea is typically discussed in the context of Newton's laws, the latter starts with introducing conservation of energy even later. This work presents an elegant example of implementing both aforementioned ideas in the kinematical context, thus providing a "warm-up" introduction to the standard tools used later on in dynamics. Both the choice of the (non-orthogonal) reference frame and the conserved quantities are rather non-standard, yet at the same time quite intuitive to the problem at hand. Two such problems are discussed in detail with two alternative approaches. The first approach does not even require knowledge of calculus. In the appendix, I also present the brute-force solution involving a coupled system of differential equations. In addition, a few exercises and another similar problem for students' homework are provided.

Session GB: High Performance Computing

Location: Harper Center 3028
Sponsor: Educational Technologies Committee
Date: Wednesday, August 3
Time: 1–2 p.m.

Presider: David Joiner

Two trends in computing architecture have changed the high-performance computing (HPC) landscape. While commodity-based clusters have reduced the cost of supercomputing, core computing has made the desktop computer inherently parallel. Parallelism at all stages, on the GPU, across cores with shared memory, and passing messages between processors is becoming part of HPC programming models on the desktop as well as the supercomputer. This session will illustrate uses of HPC in undergraduate physics teaching and research.

GB01: 1–1:30 p.m. High-Performance Computing with Undergraduates: From Classrooms to Conferences

Invited - Michael W. Roth, University of Northern Iowa, Cedar Falls, IA 50614; rothm@uni.edu

In the last 20 years, computational physics has become a separate branch of study, right along with theoretical and experimental physics. As our computing resources have advanced, we now rely on massively parallel high-performance computing techniques to simulate and model physical systems. There are many interesting research topics in physics spanning a wide range of length and time scales that are accessible to undergraduate students through direct extension of concepts learned in their sequence of courses. Several such research problems will be discussed in context of their importance and effectiveness in equipping physics undergraduates for success in research environments and promoting interdepartmental collaboration.

GB02: 1:30–2 p.m. Research with Undergrads in Computational Molecular Biophysics: Successes and Challenges

Invited - Patricia Soto, Creighton University, Omaha, NE 68178; PatriciaSoto@creighton.edu

Trang Doan, Creighton University

The computational molecular biophysics group at Creighton University aims at deciphering the biophysics of pathological folding processes of proteins and peptides, a hallmark of neurodegenerative diseases such as Alzheimer's and prion diseases. To this end, high-performance computer (HPC) simulations are implemented in which the motion of individual protein and solvent atoms is mimicked by using techniques from classical statistical mechanics. The multidisciplinary nature of the research appeals to college students from diverse academic backgrounds, each student working on a project tailored to their interests and skills. Students are thus engaged for the very first time and have the opportunity to contribute to a project that utilizes scientific computing to tackle cutting-edge science questions. Remarkably, students build upon their computer literacy and develop enthusiasm in further exploring the HPC technology. A likely explanation of such attitudes is that students are challenged to interact actively with HPC resources and applications. The role as users the students develop empowers them and brings a whole new perspective on the potential use of computing in science, technology, and medicine.

Session GC: Laboratories for Astronomy

Location: Harper Center 3029
Sponsor: Laboratories Committee
Co-Sponsor: Space Science and Astronomy Committee
Date: Wednesday, August 3
Time: 1–2:20 p.m.

Presider: Mary Ann Hickman Klassen

An astronomy class is often the only exposure to science a non-science student has. The laboratory portion of an introductory astronomy course can serve many roles: introducing students to the night sky and the tools of astronomy, teaching the process of doing science, providing practice working with quantitative data, and illustrating the physics concepts behind the astronomy. This session features descriptions of lab activities that meet these diverse goals.

GC01: 1–1:30 p.m. Engineering Innovative Curricula for Inquiry in an Undergraduate Astronomy Laboratory

Invited - Daniel J. Lyons, University of Wyoming, Laramie, WY 82070; danjlyons@gmail.com*

The literature argues that students do not develop deep understandings of the structure or nature of the scientific discipline of inquiry unless the underlying ideas are taught explicitly. In response the Center for Astronomy & Physics Education Research CAPER Team has developed an introductory astronomy lab curriculum with a backwards faded-scaffolding approach to support student engagement in authentic inquiry experiences. Backwards faded-scaffolding is a strategy where the conventional and rigidly linear "scientific method" is turned on its head and students are first taught how to create conclusions based on evidence, then how experimental design creates evidence, and only at the end introduces students to—what we believe is the most challenging part of inquiry—inventing scientifically appropriate questions. To assess the curriculum we are using the Views of Scientific Inquiry (VOSI) survey and the Test of Astronomy Standards (TOAST)'.

* Sponsor: Timothy F. Slater, Center for Astronomy & Physics Education Research CAPER Team, www.CAPERTeam.com

GC02: 1:30–2 p.m. Results from a Study of Inquiry in Undergraduate Astronomy Laboratories

Invited - Kendra Sibbernsen, Metropolitan Community College, Omaha, NE 68103-0777; kjsibbernsen@mccneb.edu

This talk will focus on the results from a mixed-method quasi-experimental study that was designed to determine if students in an undergraduate astronomy laboratory increase their understanding of inquiry. A backward-faded scaffold (BFS) format was used for the laboratory exercises. The measure of increase in inquiry was determined by the examining pre-tests and post-tests of the Views of Scientific Inquiry (VOSI) survey, scores on laboratory exercises at the beginning and end of the course, and observations from the instructor. Information will be given outlining how these results are being used to guide recommendations for practice and for further research, including online implementation of the astronomy laboratory exercises and development of a physical science survey laboratory class using the BFS format.

GC03: 2–2:10 p.m. Balloon Data and Planetary Temperature Profiles

Gordon C. McIntosh, University of Minnesota–Morris, Morris, MN 56267; mcintogc@morris.umn.edu

Atmospheric temperature measurements during a balloon flight provide a basis for the comparison of temperatures and the variation of temperatures with altitude in the atmospheres of solar system bodies. The altitudes and temperatures are measured and transmitted to Earth thorough the StratoSAT system. Data from a launch on the morning of Saturday, 6 November 2010, will be presented and compared to temperature profiles from Mars, Venus, and Titan. The data indicate the effects of the Earth's surface, the lapse rate in the troposphere, the altitude of the tropopause, and the increasing temperature of the stratosphere. These data and comparisons form the basis for an astronomy, meteorology, or Earth science laboratory activity.

GC04: 2:10–2:20 p.m. Measuring the Temperature of a Star from Its Continuous Spectrum

John E. Shaw, Northwest Missouri State University, Maryville, MO 64468; jshaw@nwmissouri.edu

David Richardson, Northwest Missouri State University

One way to measure the surface temperature of a star is to measure the ratio of intensities of light through a blue filter compared to a green filter. Assuming the star behaves as an ideal blackbody, Planck's formula can be used to calculate the temperature at the surface of the star. A similar activity can be done in the laboratory by measuring the intensities of light from an incandescent light bulb through infrared, red, green, and blue filters. The students can use the ratio of two of these as a way of determining the temperature of the tungsten filament of the light bulb. A spreadsheet is used to illustrate the predictions of the spectra of a blackbody at different temperatures from Planck's formula.

Session GD: PER in the High School

Location: Harper Center 3023 & 3023A
Sponsor: Physics in High Schools Committee
Co-Sponsor: Research in Physics Education Committee
Date: Wednesday, August 3
Time: 1–1:30 p.m.

Presider: Daniel Crowe

The two purposes of this session are to allow physics education researchers to (1) describe research that they have conducted with high school students and (2) recruit high school teachers to collaborate on future research with high school students.

GD01: 1–1:10 p.m. Effects of Physics and Everyday Thinking in an Urban High School*

*Shelly N. Belleau,** University of Colorado–Boulder, Boulder, CO 80309; shelly.belleau@gmail.com*

Michael J. Ross, University of Colorado–Boulder

The Physics and Everyday Thinking (PET) curriculum is based on educational research and consists of carefully sequenced sets of activities intended to help students develop physics ideas through guided experimentation and questioning with extensive small group and whole class discussion. A high school physics teacher has adapted and implemented the PET curriculum in two urban high schools with the aim of removing barriers that typically limit student access to, and identification with, physics. Though PET was not designed for secondary physics students, this teacher has worked closely with physics education research faculty and graduate students to simultaneously implement and investigate the impact of PET on students' physics learning. Preliminary results indicate that an adapted version of PET has great potential to provide greater opportunities for access and success in understanding physics as well as the nature of science.

* This research is partially funded by NSF grant #DUE 934921

**Sponsor: Valerie Otero,

GD02: 1:10–1:20 p.m. Impact of the Learning Assistant Experience for High School Physics Students

Susan M. Nicholson-Dykstra, Northglenn High School, Northglenn, CO 80260; susan.m.nicholsondykstra@adams12.org

Joshua H. Cuchiaro, Valerie K. Otero, University of Colorado–Boulder

An ongoing partnership was formed between the conceptual physics classes at an urban high school and the second-grade classes at an elementary school in the same district. During the latter half of the course, students in the high school classes learned how to create backward design lesson plans and utilize formative assessments to measure student understanding. The physics students then created lesson plans pertaining to four units of study (Newton's Laws, conservation of energy, electrostatics, and circuits), which they implemented in their partner elementary classroom. Participating physics classes were comparatively evaluated for effects on content understanding and retention, engagement, motivation, and perception of learning. Data from four classes will be presented with recommendations for continuing the elementary-secondary physics partnership. Project was partially funded by NSF grant #DUE 934921 and ING Financial Service's Unsung Hero Award.

GD03: 1:20–1:30 p.m. Assessment Preparation: Impacts of Explicit Reflection Prompts on Learning*

*Emily J. Quinty,** Mapleton Expeditionary School of the Arts (MESA) and University of Colorado–Boulder, Boulder, CO 80309; emily.quinty@gmail.com*

Valerie K. Otero, University of Colorado–Boulder

This research study addresses urban high school students' struggles with preparing for assessments. In this study, students completed a questionnaire immediately following all quizzes and tests reflecting on several aspects of test preparation: how well they thought they did and why, how they knew what to study, what specific activities helped them prepare for the assessment, and what they will do differently to prepare for the next assessment. Responses were analyzed for patterns in student language and metacognitive statements, examining trends in both individual students and classes over time. Responses were also correlated to assessment data and changes in instructional strategies. Results from this study provide insight into what students do to prepare for a quiz or test, and also reveal trends in how students interpret the purpose of reflective activities.

* This research is partially funded by NSF grant #DUE 934921 and

**Sponsor: Valerie Otero

Session GE: Major Consequences of Minor Dishonesty in Physics Classes

Location: Harper Center 3027
Sponsor: Physics in Undergraduate Education Committee
Date: Wednesday, August 3
Time: 1–3 p.m.

Presider: Mary Lowe

This session will demonstrate the seriousness of two minor forms of academic dishonesty on physics learning–copying homework and participating in unmonitored discussion forums. We will present these in the context of Academic Dishonesty Research in general and suggest ways to reduce them.

GE01: 1–1:30 p.m. Making Homework Easier to Do Than to Copy

Invited - Gerd Kortemeyer, Michigan State University, East Lansing, MI 48825; korte@lite.msu.edu

Using the example of LON-CAPA (http://www.lon-capa.org/), this talk presents mechanisms and examples for randomizing introductory physics questions beyond merely inserting random numbers and shifting around answer options. Strategies on how to randomly generate scenarios with desired properties (including different graphs, images, formulas, setups, boundary conditions, data drawn from libraries, and the use of student input for later problem parts), as well as input mechanisms beyond numbers and multiple choice (e.g., formula input and graph input checked for properties rather than correspondence to a given answer), will be presented. Once scenarios and expected inputs are sufficiently different from student to student (while still dealing with the same physics), it becomes harder to reverse-engineer the problem than to deal with the physics -- collaborations between learners morph from cheating into peer-teaching.

GE02: 1:30–2 p.m. Consequences of Participation in Unmoderated Discussion Forums*

Invited - Wolfgang Bauer, Michigan State University, East Lansing, MI 48825; bauer@pa.msu.edu

While sophisticated course management systems and homework engines like LON-CAPA can prevent simple student-to-student copying of answers and cheating a la Cramster, dedicated groups of students will still be able to reverse-engineer most homework problems. We analyze one such case and show that cheating on homework has a quantifiable negative impact on exam performance. We also present a new approach of correlating weekly homework with weekly exams. First indications are that this approach curtails cheating on homework, and that it leads to greater student satisfaction with the course and with the exam framework.

*Research supported by the US National Science Foundation.

GE03: 2–2:30 p.m. Comparing an Academic Dishonesty Survey with Reality

Invited - Young-Jin Lee, University of Kansas, Lawrence, KS 66045; yjlee@ku.edu

David J. Palazzo, United States Military Academy
David E. Pritchard, Massachusetts Institute of Technology

An anonymous survey containing questions frequently used in self-reported academic dishonesty studies plus more sharply worded questions was administered to a large introductory physics class at MIT. The actual copy rate, which was inferred from the log files of the Web-based learning environment students used, was found to be 43% higher than the self-reported copy fraction. Among several contextual and situational factors

often examined in the previous academic dishonesty studies, gender, and major were found to be positively correlated with the observed copying of electronic homework problems. Also, student motivation for learning was found to be negatively correlated with self-reported copying. Students report 70% more copying of written homework than online homework, consistent with easier availability of answers for written homework. The survey and a few interviews suggest that time pressure on students who do not start their homework in a timely fashion is the proximate cause of copying.

GE04: 2:30–3 p.m. Patterns, Consequences, and Reduction of Homework Copying

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

David J. Palazzo, United States Military Academy
Young-Jin Lee, University of Kansas
Rasil Warnakulasooriya, Pearson Education

Homework copying was detected in the online homework tutor MasteringPhysics.com. Copying increased as each weekly deadline approached, for problems later in each assignment, and dramatically over the semester. The majority of students copied less than 10% of their problems and worked steadily over the three days before the deadline, whereas repetitive copiers (>30% of problems) exerted little effort early. Importantly, copying homework problems that require analytic answers correlates with a 2.4 standard deviation decline for similar problems on exams but did not significantly correlate with gain on the Mechanics Baseline Test. Repetitive copiers initially had comparable ability in math in physics to non-copiers. Changes in course format and instructional practices that previous self-reported academic dishonesty surveys and the observed copying patterns suggested would reduce copying have been accompanied by more than a factor of four reduction of copying from about 11% of all electronic homework problems to less than 3%.

Session GF: Research in Undergraduate Math Education

Location: Skutt Student Center Ballroom DE
Sponsor: Research in Physics Education Committee
Co-Sponsor: Physics in Undergraduate Education Committee
Date: Wednesday, August 3
Time: 1–3 p.m.

Presider: John Thompson

In physics we expect students to understand the underlying mathematics concepts and to apply those concepts to specific physics contexts. In mathematics, the research in undergraduate mathematics education (RUME) community explores the learning and teaching of undergraduate mathematics. This session will provide a sample of research projects from the RUME community, which may provide insight into some issues in physics education.

GF01: 1–1:30 p.m. Seeing through Symbols: Personal and Cultural Semiotic Systems in Algebra

Invited - Aaron Weinberg, Ithaca College, Ithaca, NY 14850; aweinberg@ithaca.edu

Algebraic symbolism plays a prominent role in mathematics. We try to teach our students to "see through the symbols" to focus on the underlying meaning of variables, functions, systems of equations, and other algebraic notation. Despite our best efforts, students frequently struggle to use algebraic notation meaningfully. The idea of personal and cultural semiotic systems gives us a new way of understanding how students work with algebraic symbols. Previous research on algebraic representation has attempted to describe either the ways students interpret symbols or the ways they produce symbols. In contrast, viewing students' work as part of a semiotic system unifies these perspectives, enabling us to describe the interaction between symbol production and interpretation. This presentation will introduce the idea of semiotic systems and look at examples of student work to illustrate the concept and show how it can be used to understand students' mathematical activity.

GF02: 1:30–2 p.m. The Functions of Examples in Instruction

Invited - Tim Fukawa-Connelly, University of New Hampshire, Durham, NH 03824; tim.fc@unh.edu

Examples are an important part of our teaching of mathematics and physics. Some of the ways that we might use examples in our teaching are to show how to use a formula, perform an algorithm, illustrate a theory, or help understand concepts. While these are relatively common, there are less common uses to which we might put examples that include having students recreate the fundamental ideas of our disciplines, develop their own original ideas, and develop ways of reasoning that support innovative thinking. In this presentation I will show examples of teachers in mathematics and physics drawing on different scientific functions that examples might serve in teaching at the university level. I will then suggest how instructor's uses of examples can communicate to students what it means to be a scientist, and, perhaps convey the wrong message about our respective disciplines. Or, good teaching may be leading to bad results?

GF03: 2–2:30 p.m. How I Learned to Stop Worrying and Love the Applications: Confessions of a Mathematician.

Invited - Michael C. Oehrtman, University of Northern Colorado, Greeley, CO 80634; michael.oehrtman@unco.edu

In this talk I present findings from my design research using numerical methods and error analyses to establish a strong conceptual foundation for an introductory calculus and differential equations sequence. I will intersperse this discussion with reflections on my own experiences as a student of both mathematics and physics, as a mathematics faculty, and as an education researcher that led me to this approach. I will present results indicating that properly developed, an applied approach to calculus and differential equations can 1) be based on natural language and ideas directly accessible to students, 2) provide a coherent approach to the range of topics covered in the entire sequence, 3) be coherent in meaning and structure across multiple representations, and 4) establish a foundation for subsequent formal mathematical development. A natural hypothesis is that such an approach should also support modeling in science and engineering.

GF04: 2:30–3 p.m. Learning for Transfer: How Much Does Context Matter?

Invited - Joseph F. Wagner, Xavier University, Department of Mathematics & Computer Science, Cincinnati, OH 45207; wagner@xavier.edu

"Transfer in pieces" is a theory of knowledge transfer that stands in contrast to longstanding theories of "transfer by abstraction." It seems almost self-evident that knowledge of mathematics or science should be applicable across different contexts by virtue of its abstractness or distance from the contexts in which it was learned. Surely this has served as a basis for traditional instructional practices in mathematics and science. A transfer-in-pieces approach, however, suggests that the utility of abstract knowledge is somewhat illusory, and that the cognitive mechanisms of transfer are much more attuned to specific features of the contexts in which knowledge is applied. For learning theorists, this presentation offers an introductory tour of the basic tenets of a transfer-in-pieces consideration of the problem of transfer. For teachers, it suggests that the role of learning contexts and initial applications of knowledge may be both more significant and more limiting than we think.

Session GH: PER: Problem Solving II

Location: Skutt Student Center Ballroom ABC
Sponsor: Research in Physics Education Committee
Date: Wednesday, August 3
Time: 1–2:30 p.m.

Presider: Andrew Heckler

GH01: 1–1:10 p.m. Investigating Patterns in Response Times to Graph Questions

Andrew F. Heckler, Ohio State University, Columbus, OH 43210; heckler.6@osu.edu

Thomas M. Scaife, Ohio State University

We investigate patterns in response times as well as response choices to simple multiple-choice questions. In a series of experiments involving questions on graphs in which participants must compare the slopes of two points, we not only found (as expected) that many students consistently answered incorrectly, namely comparing heights rather than the slopes, but we also found that these students responded more rapidly than those answering correctly. Furthermore, by imposing a delay in responding of a few seconds, we found a reduction in incorrect responses, suggesting that many students were capable of answering correctly, but instead they tended to answer quickly. Repetitive training increases accuracy, and this may in part be due to a decrease in processing time of the relevant dimension, i.e. slope. However, providing students with an explicit rule also increases accuracy, but does not appear to change the time to process the correct response.

GH02: 1:10–1:20 p.m. Rigging Your Card Games – Re-examining Expert Categorizations of Physics Problems

Steven F. Wolf, Michigan State University, East Lansing, MI 48825; wolfste4@msu.edu

Gerd Kortemeyer, Michigan State University

On its 30th anniversary, 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 more than 3000 times in scholarly articles over a wide range of disciplines. Yet, some details of the original research design of this card-sorting experiment and its analysis methods are not clear. In replicating the study, particularly the choice of problems seems to strongly influence the outcome; only a carefully "rigged" problem set will have a good signal-to-noise ratio. We replicated the experiment with an expert group, using a large set of problems, and noted the degree to which different specific subsets of problems lead to more or less clear-cut results.

GH03: 1:20–1:30 p.m. The Relationship between Students' Mental Representations and their Translational Skills*

Bashirah Ibrahim, Kansas State University, Manhattan, KS 66506-2601; bibrahim@phys.ksu.edu

N. Sanjay Rebello, Kansas State University

We report on the relationship between students' categories of mental representations and their handling of multiple external representations. It is assumed that the inability to relate and translate information across different representations is governed by the kinds of internal constructs that students operate with. A sample of 19 participants from a calculus-based physics engineering course completed 13 tasks (non-directed and directed) on kinematics, work, and energy. Individual interviews were conducted with the students immediately following the completion of these tasks. Profiles were designed based on the students' actions when solving the problems together with their interview responses. The Johnson-Laird (1983) cognitive framework was used to categorize the students' internal constructs and statistical analysis was performed to determine whether or not a link exists with the ability to translate information across representations. The consequences of this work for the teaching and learning of physics at introductory level will be discussed.

*Supported in part by NSF grant 0816207.

GH04: 1:30–1:40 p.m. Visual Cueing Influencing Eye Movements and Reasoning in Physics Problems

Adrian M. Madsen, Kansas State University, Manhattan, KS 66506-2601; adrianc@phys.ksu.edu

Adam Larson, Lester Loschky, N. Sanjay Rebello, Kansas State University

Visual cues overlaid on diagrams and animations can reduce cognitive load by drawing attention to relevant areas. Additionally, cues can increase speed and accuracy by causing learners to view a diagram in a pattern related to a problem's solution. We investigate the effects of visual cueing on students' eye movements and reasoning on introductory physics problems with a diagram. Students in the treatment group were shown an initial problem, and if they answered that incorrectly, they were shown a series of problems each with moving shapes cueing the correct solution. Students in the control group were also provided a series of problems, but without any visual cues. Students in both groups were asked to verbally explain their reasoning after each question, and were provided a transfer problem without cues at the end. We report on students' eye movements while answering the questions and verbal reasoning for their answers.

GH05: 1:40–1:50 p.m. A Bi-directional Mapping of Faculty Perceptions with a Problem Solving Rubric

Brita L. Nellermoe, University of Minnesota–Twin Cities; University of St. Thomas, Minneapolis, MN 55455; nell0021@umn.edu

Andrew J. Mason, Kenneth J. Heller, University of Minnesota–Twin Cities

We examine a categorization of written problem solving artifacts generated by interviews of 30 faculty members at institutions from a variety of higher education institutions in the Midwestern U.S. (Yerushalmi et al. 2007, Henderson et al. 2007).[1,2] We determine how these categories map to dimensions of a rubric designed for analysis of student problem solutions (Docktor 2009).[3] This mapping examines both the relationship of the rubric to the categories and the categories to the rubric. The results suggest that the rubric dimensions for student problem solutions designed by Docktor emerge naturally from faculty perceptions.

1. E. Yerushalmi, C. Henderson, K. Heller, P. Heller, and V. Kuo (2007). *Phys. Rev. Special Topics-PER* **3**(2), 020109.
2.C. Henderson, E.Yerushalmi, K. Heller, P. Heller, and V. Kuo (2007). *Phys. Rev. Special Topics-PER* **3**(2), 020110.
3. J. Docktor, "Development and Validation of a Physics Problem-Solving Assessment Rubric," *Dissertation, University of Minnesota,* Twin Cities, Minneapolis, MN, 2009.

GH06: 1:50–2 p.m. Using Analogical Problem Solving to Learn about Friction

Chandralekha Singh, University of Pittsburgh, Pittsburgh, PA 15260; clsingh@pitt.edu

Shih-Yin Lin, University of Pittsburgh

Research suggests many students have the notion that the magnitude of the static frictional force is always equal to its maximum value. In this study, we examine introductory students' ability to perform analogical problem solving between two problems that are similar in the application of a physics principle (Newton's second law) but one problem involves friction which often triggers the misleading notion that is not applicable in that particular case. Students from algebra- and calculus- based introductory physics courses were asked in a quiz to take advantage of what they learned from a solved problem provided, which was about tension in a rope, to solve another problem involving friction. To help students process through the analogy deeply and contemplate the applicability of associating the frictional force with its maximum value, students in different recitation classrooms received different scaffolding. Students' performances in different groups are compared. Supported by NSF.

GH07: 2–2:10 p.m. Enhancing the Problem Solving Abilities of Science Students

Olga A. Stafford, South Dakota State University, Brookings, SD 57007; Olga.Stafford@sdstate.edu

It is evident from my own teaching experience, and supported by many instructors' opinions,[1-3] that students aren't equipped with logical problem-solving techniques. I am studying the impact on student learning of using problem-solving sheets during recitation classes, with students working in groups and playing specific roles. I anticipate that successful use of problem-solving sheets will help students develop the necessary skills to solve science problems with conceptual understanding.

1. Polya, *How to Solve It* (Princeton University Press, 1945)
2. Edit Yerushalmi etc., "Instructors' reasons for choosing problem features in a calculus-based introductory physics course," *Phys. Rev. Phys. Ed. Research* **6**, 020108 (2010)
3. Johnson, Johnson & Smit, "Active learning: cooperation in the classroom," Interaction Book Company 1998.

GH08: 2:10–2:20 p.m. Students' Epistemological Beliefs vis-à-vis Problem Solving Sophistication in M&I Physics

Wendi N. Wampler, Purdue University, West Lafayette, IN 47907; wamplerw@purdue.edu

Lynn A. Bryan and Mark P. Haugan, Purdue University

In this study, we investigated the relationship between students' personal epistemological beliefs and problem solving sophistication within the context of a large-scale implementation of the M&I Curriculum. We utilized a mixed methods approach to follow the progress of nine student volunteers from the introductory mechanics course at Purdue University. The quantitative component used the CLASS survey to examine the epistemological beliefs of students over the semester. The qualitative component examined students' problem solving within the context of small group work, as well as epistemological beliefs in the context of the post recitation interviews. Results showed three major trends: a decrease in sophistication of both problem solving and epistemological beliefs, a high level of sophistication of both with little change throughout the semester, and increase in both epistemological beliefs and problem solving. The implications will help us better understand the importance of epistemological beliefs and their influence on students' problem solving.

GH09: 2:20–2:30 p.m. Assessing Student's Ability to Solve Textbook-Style Problems

Jeffrey Marx, McDaniel College, Westminster, MD 21157; jmarx@mcdaniel.edu

Karen Cummings, Southern Connecticut State University

Development of student' problem solving ability is commonly cited as one of the primary goals in introductory physics courses. However, there is no broadly agreed upon definition of what is meant by "problem solving". Most physicists ultimate want students to be able to successfully apply a logical yet flexible approach to solving real world problems significantly different from any they have seen before. Still, many introductory instructors are first and foremost concerned with how successfully and thoughtfully students solve standard textbook-style problems. We have developed a 13-item survey to help assess students' abilities at solving textbook-style problems. In the Fall semesters of 2009 and 2010, we beta-tested this instrument on introductory physics students (pre-instruction and post-instruction) at several institutes and on a pool of "experts." In this talk, we will present details of the survey instrument, its administration, and some results from our beta testing.

Session HA: PERC Bridging Session

Location: Harper Center Hixson-Lied Auditorium
Sponsor: Research in Physics Education Committee
Date: Wednesday, August 3
Time: 3:15–4:45 p.m.

Presider: Elizabeth Gire

HA01: 3:15–4:45 p.m. Complex Interactions between Formative Assessment, Technology, and Classroom Practices

Invited - Edward Price, California State University San Marcos, San Marco, CA 92124; eprice@csusm.edu

Interactive engagement (IE) methods provide instructors with evidence of student thinking that can guide instructional decisions across a range of timescales: facilitating an activity, determining the flow of activities, or modifying the curriculum. Thus, from the instructor's perspective, IE activities can function as formative assessments. As a practical matter, the ability to utilize this potential depends on how the activities are implemented. This talk will describe different tools for small group problem solving, including whiteboards, Tablet PCs, digital cameras, and photosharing websites. These tools provide the instructor with varying levels access to student work during and after class, and therefore provide a range of support for formative assessment. Furthermore, the tools differ in physical size, ease of use, and the roles for students and instructor. These differences lead to complex, often surprising interactions with classroom practices.

HA02: 3:15–4:45 p.m. Assessment Lessons from K-12 Education Research: Knowledge Representation, Learning, and Motivation

Invited - Lorrie A. Shepard, University of Colorado–Boulder, Boulder, CO 80309; lorrie.shepard@colorado.edu

For 30 years, research on the effects of high-stakes testing in K-12 schools has documented the negative effects of teaching to the test. Most obvious is the reduction or elimination of time spent on science and social studies instruction, especially in high poverty schools. Less obvious is the harm to student learning in reading and mathematics when instruction is limited to repetitive drill on worksheets that closely resemble test formats. The lack of generalized, flexible understanding of underlying principles in K-12 tested subjects is similar to Mazur's experience with plug-and-chug versus conceptual test questions. The PER community is well aware of the importance of more complete representation of learning goals as a remedy to this problem. Equally important, however, are the assessment "processes," especially feedback and grading, that can either promote or deter students' engagement and willingness to take responsibility for their own learning. In this talk, I summarize learning and motivation research that has particular bearing on effective classroom assessment practices in K-12 classrooms certainly and even in university courses.

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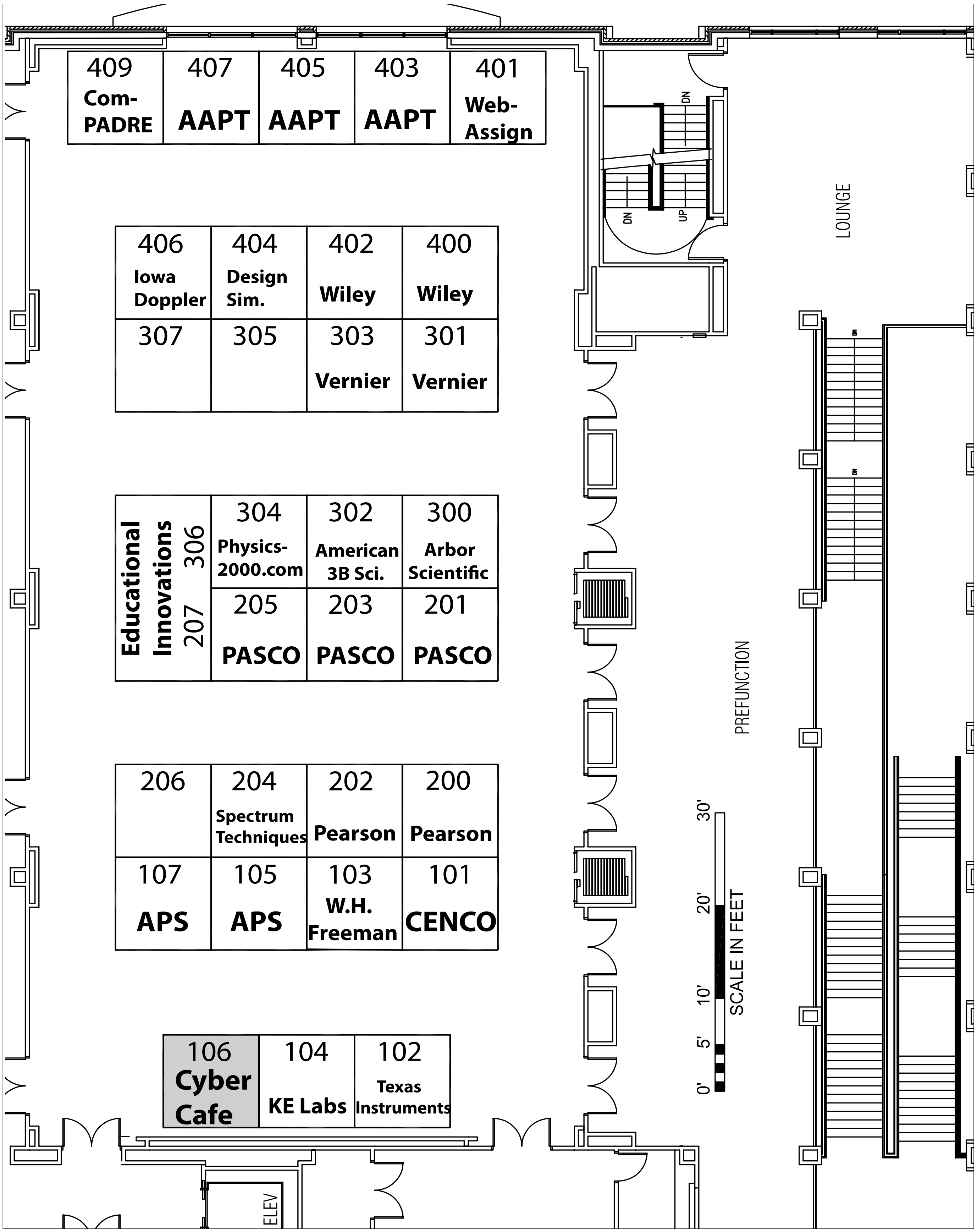

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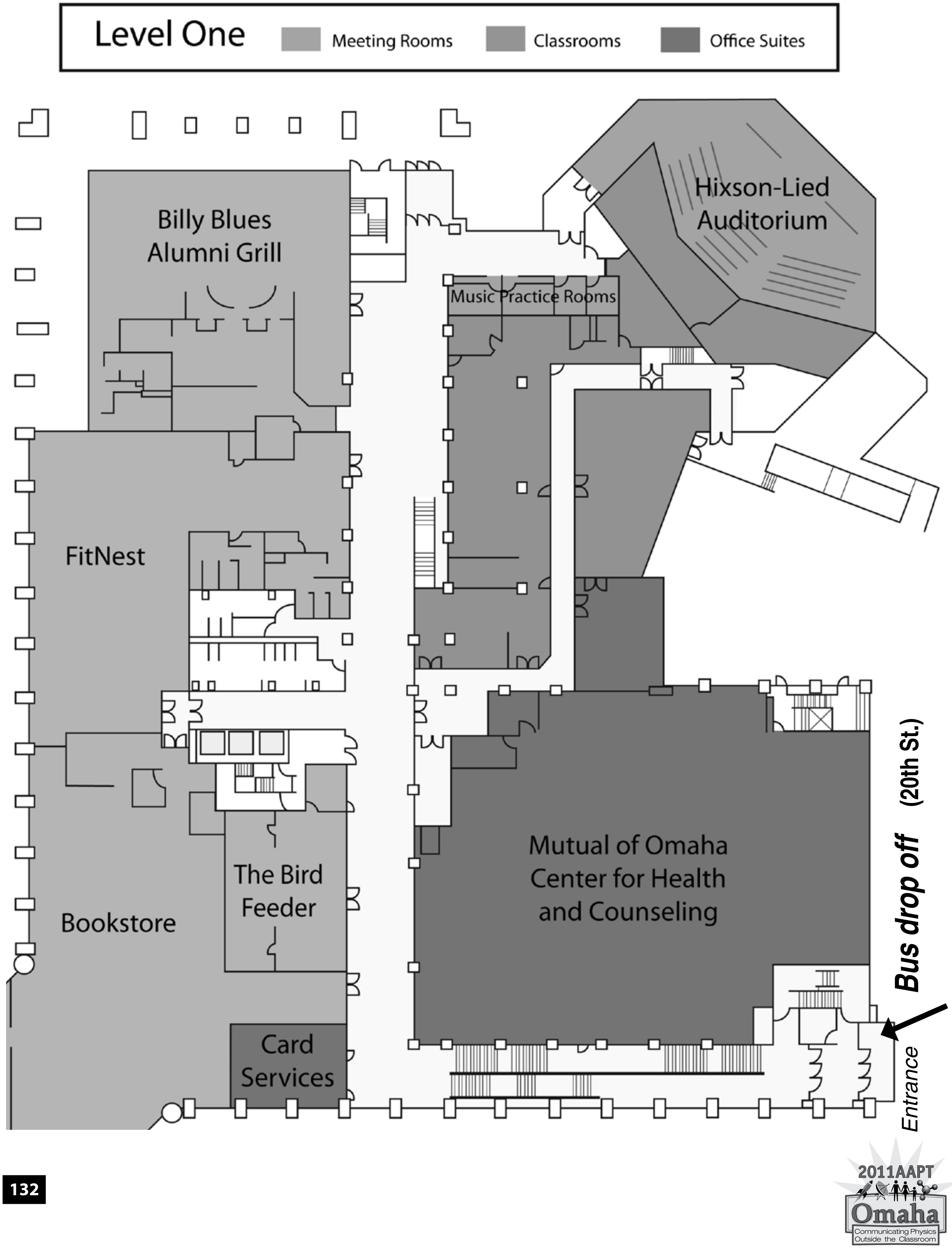

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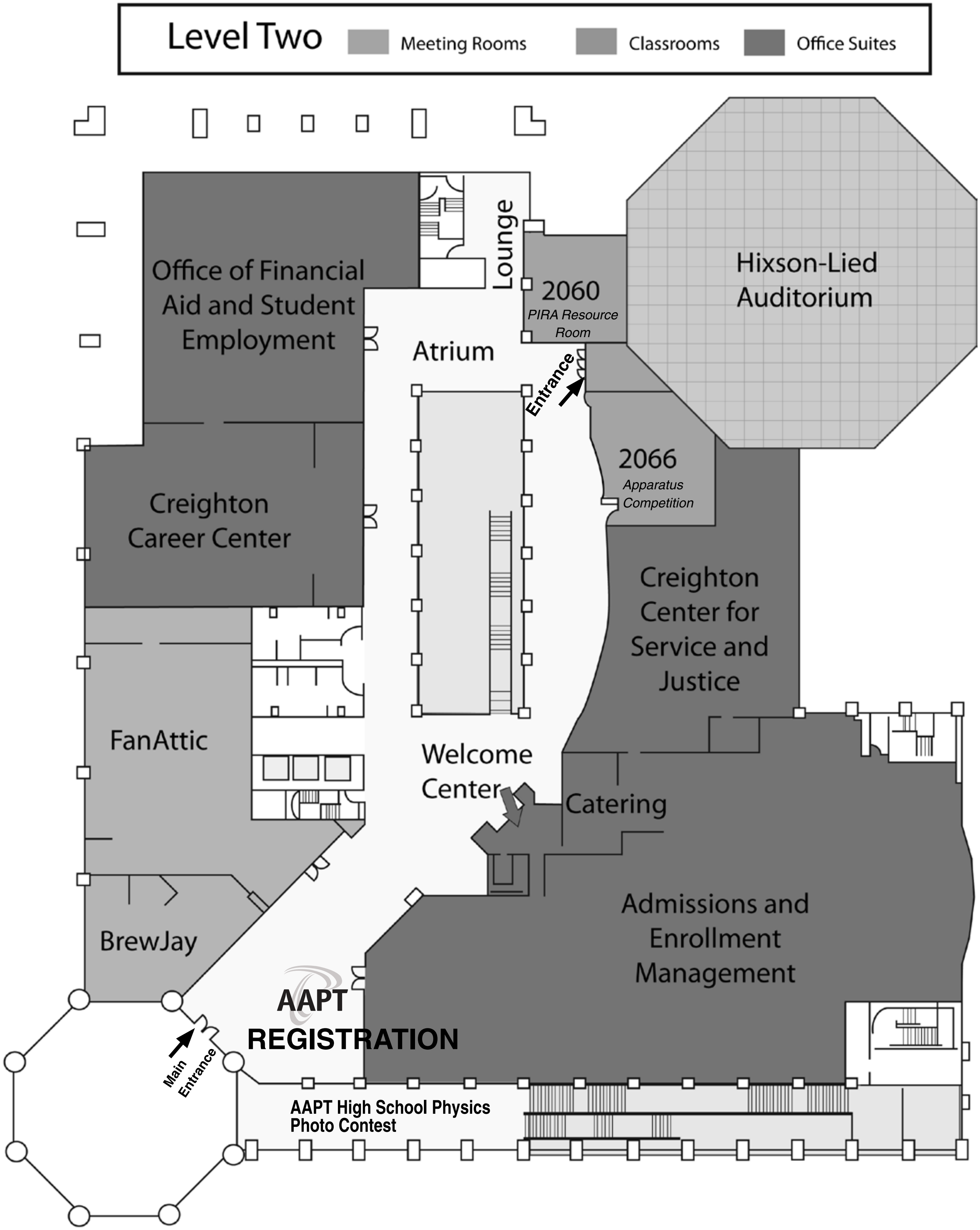

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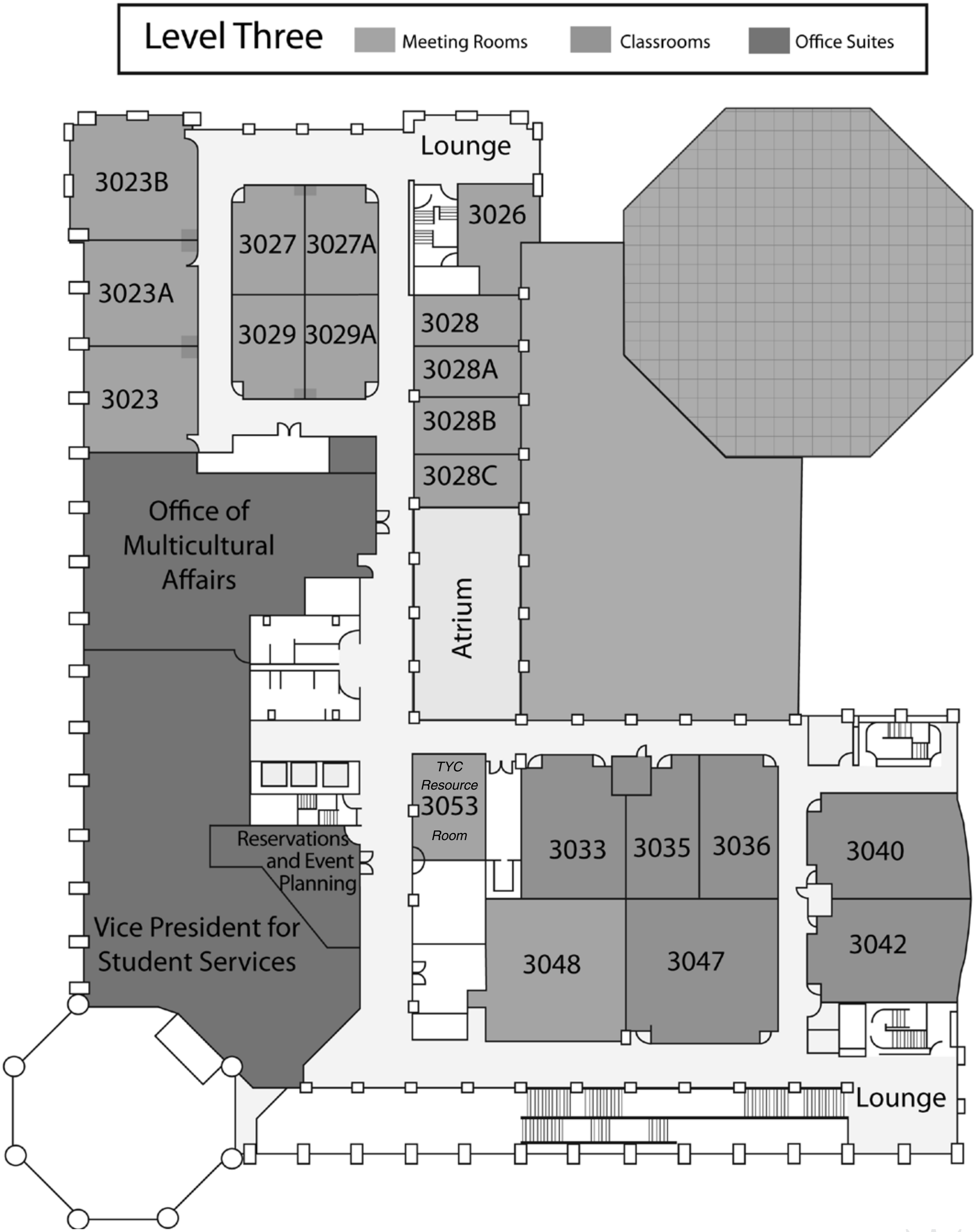

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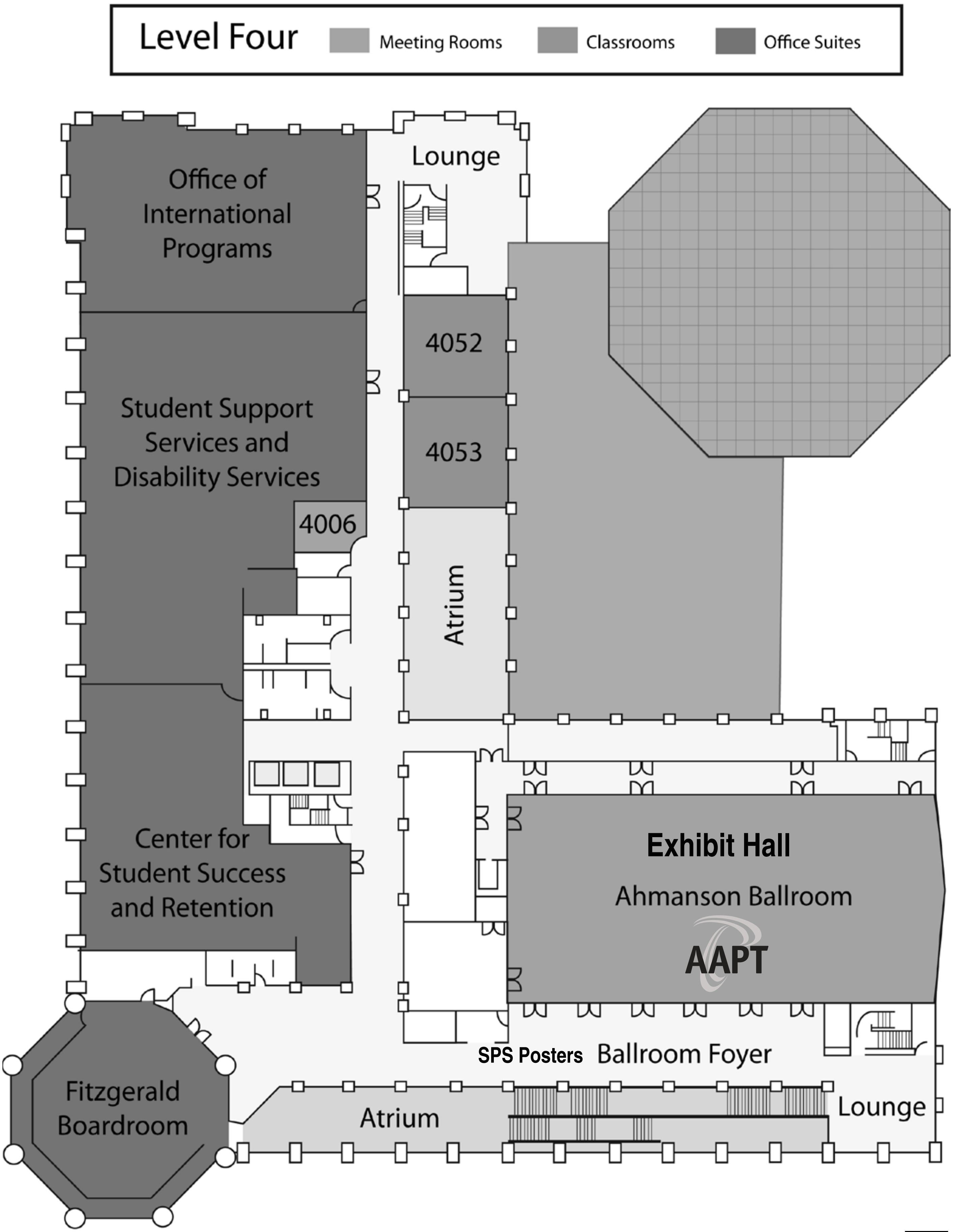

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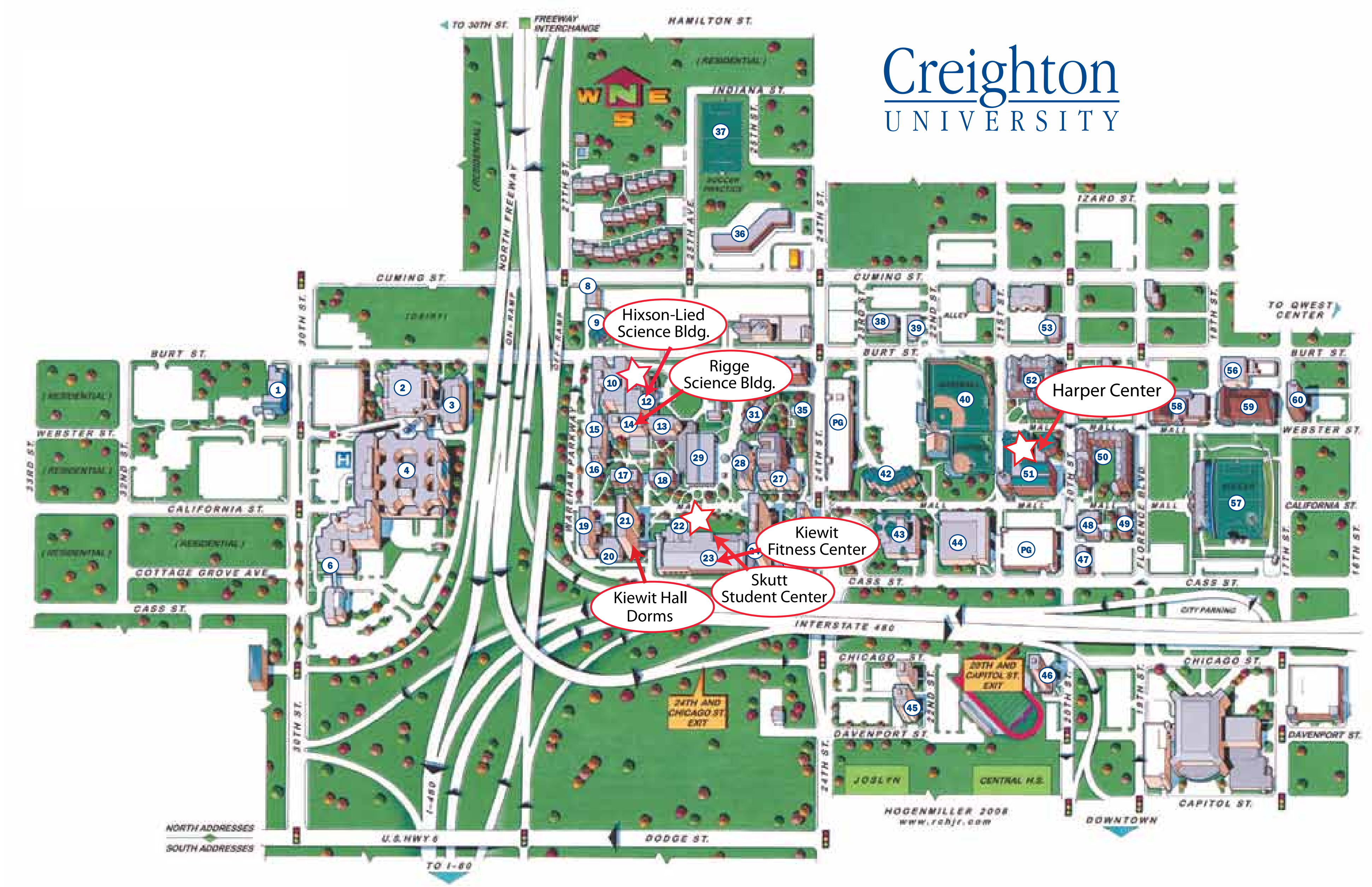

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