AAPT Summer Meeting

Portland, OR
July 17–23, 2010
Hilton Portland and Executive Tower

AAPT
PHYSICS EDUCATION

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

Thanks for the Memories, Warren Hein

In all organizations there are a few individuals who make a difference and leave their mark when they are gone. Warren Hein is such a person. Warren came to AAPT in 1997 as Associate Executive Officer, after having served as Professor of Physics at Northern State University and as Professor and Physics Department Chair at South Dakota State University. As a loyal AAPT member since 1970, he quickly stepped into his duties at the national level and became actively involved in all of the programs and conferences. He worked closely with the staff, area committees, sections, and members to coordinate the many AAPT activities. He maintained a strong relationship with APS, AIP, and NSTA, participating in several joint ventures with these organizations.

In August 2007 Warren took a Leave-of-Absence to serve as a Program Officer in the Division of Undergraduate Education at NSF, while still maintaining his relationship with the Executive Office of AAPT. In September 2008, at the height of the financial crisis in America, Warren returned to AAPT as Executive Officer. His many years as a member, his service as AAPT Associate Executive Officer and his most recent experience at NSF made him fully qualified to step right in and take the reins. Under his leadership AAPT has grown and prospered.

At the Executive Office, Warren has worked with the outstanding professional staff to develop a collegial atmosphere, where all departments work together on projects. He has helped develop a stronger outreach to members and other societies through enhanced marketing and incentives. Fundraising is a vital part of all programs, and cost cutting and having a balanced budget are now a high priority. Several Advisory Committees have been formed to deal with areas of importance to the membership, such as the Meetings Committee, Philanthropy Committee, and the Committee on Governance Structure. He is working with the Executive Board to update the Officer Handbook and to develop a new Strategic Plan for the future of AAPT.

Warren has been involved in the development of many new programs as well as strengthening the old ones. PTRA, New Faculty Workshop, Department Chairs Conference, ComPADRE, and PhysTEC II are all thriving. New ventures with the introduction of the eNNOUNCER and the upgraded website, along with online *AJP* and *TPT* have improved communication with the physics community. Presentations at national meetings, tandem conferences like PTRA, PERC, TYC New Faculty Workshop, Computational Physics, and Advanced Labs have brought in new members and developed relationships with new colleagues and communities. Several special interest groups, like PIRA and ALPhA, have become exciting additions to our meetings.

Many of the puzzle pieces that make up AAPT were either started or strengthened due to Warren Hein during his 13 years in College Park. He has served as a motivator, a spokesman, a liaison, a grant writer, a fundraiser, a leader, and a friend to all of us. On December 31, 2010, he will retire as Executive Officer. Even though he is leaving the office in College Park, his heart will remain with AAPT; and he will remain a vital member and volunteer.

Warren Hein leaves AAPT a better place for his having been there. Thanks for the memories Warren. Enjoy your life with Melanie in your new home in Fenton, Michigan. We will miss you.

Thanks to Lila Adair, who has worked with Warren throughout his thirteen years at AAPT, for drafting this tribute to Warren's service to AAPT

Welcome to Portland!

I am proud to be a native Oregonian (for the last 32 years, that is), and it is my great pleasure to welcome you to beautiful Oregon for the Summer 2010 meeting. I sincerely hope that in addition to attending some of the quality workshops and many of the excellent sessions, you will also take time to get to know what is so special about Oregon, and its largest, most vibrant city, Portland. Schedule some time before or after the meeting to experience beautiful, uncrowded beaches and dramatic cliff-side overlooks of the Pacific Ocean; views (and hikes) of the majestic Cascade Mountains; cascading Multnomah and other falls. All of these Oregon treasures (and Washington's Mt. St. Helens) are within 100 kilometers of downtown Portland. During the meeting enjoy the exciting museums, gourmet, unique and eclectic restaurants, inviting Willamette* and Columbia riverfronts, and efficient TriMet transit system that make Portland one of the most livable cities in the country. Saunter into Powell's Books, head out on a walk around this pedestrian-friendly city, or venture for a hike in the surrounding hills of Washington Park.** I can't imagine a better place to hold the Summer Meeting! (Of course. It's less than a two-hour drive from my house!)

The theme of the meeting is "50 Years with Lasers." There will be a tutorial, "Teaching About Lasers," on Saturday (co-sponsored by LaserFest). Then, Monday will be "Laser Day," featuring 2.5 hours of plenary presentations on uses of lasers in precision frequency measurement (optical frequency combs), biomedical imaging and diagnosis and treatment of the eye. Laser Day will also feature the premier of a new documentary, "Celebrating 50 Years of the Laser," on the development and applications of lasers produced by SPIE (international optical engineering society).

Among the many interesting sessions at SM2010 will be Physics, Technological Innovation, and Careers in the Pacific Northwest, Biomedical Labs for Introductory and Advanced Physics Courses, Dealing with Mathematical Difficulties in Lower and Upper Division Physics Courses, Authentic Assessment in the Physics Classroom, Multiple Models for Mentoring (a panel and an invited/contributed session), Science and Religion, Promoting Diversity in Physics Education, PTRA at its 25th Anniversary (a special plenary), and When Scientists Should Step In: Media, Politics, and Science (a special session with invited speakers from government and the press). For workshops, there will be—among many others—LabVIEW Instruction for the Advanced Laboratory, Research-based Alternatives to Traditional Problems in Introductory Physics, What Every Physics Teacher Should Know About Cognitive Science, Critical Thinking in Astronomy, and Enhancing your Course with Activities Arising from Physics Educational Research.

SM2010 will also feature tours of Vernier Software & Technology, a gala demonstration show in the Portland Performing Arts Center (sponsored by Vernier and featuring professional vaudeville performers and a laser light show sponsored by LaserFest), and an urban picnic in downtown Portland, just two blocks walk from the headquarters Portland Hilton hotel (also sponsored by Vernier).

Best regards,

David Sokoloff
AAPT President Elect and Summer 2010 Program Chair
University of Oregon
Eugene, Oregon

*By the way, that's wil-LAMM-met, and it's ORR-i-gən. Practice!

** Washington Park is just a 12-minute MAX ride from the Hilton, and is also home to the Oregon Zoo, Hoyt Arboretum, World Forestry Center, Portland Children's Museum, International Rose Test Garden, Portland Japanese Garden, Oregon Vietnam Veterans Memorial, and Oregon Holocaust Memorial. The Washington Park MAX station is the deepest subway station in North America! The station itself is a study in Oregon geology, and the elevators mark their position—not by conventional floor numbers—but by "the present" and "16 million years ago."

Special Thanks:

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

Paper Sorters: Paula Engelhardt, Kathleen Falconer, Jill Marshall, and David Sturm

Our local organizers:

–Erik Bodegom, chair, Portland State University, Department of Physics

–Will Porter, Portland State University, Department of Physics

–all PSU volunteers

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Karl C. Mamola (ex officio)
Editor, *The Physics Teacher*

Jan Tobochnik (ex officio)
Editor, *Amer. Journal of Physics*

Warren Hein (ex officio)
AAPT Executive Officer

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 **#aaptsm10** 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

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WebAssign

Contacts:

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

Meeting Registration Desk, hotel: 503-721-2883

Tiffany Hayes, Director of Programs & Conferences

Cerena Cantrell: Associate Director of Programs & Conferences

Janet Lane, Program Coordinator

Natasha Randall, Meetings Assistant

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programs@aapt.org, www.aapt.org

First time at an AAPT meeting?

Welcome to the 2010 AAPT Summer Meeting in Portland! Everyone at AAPT hopes you fulfill all the goals you have for attending this meeting. To help you plan your meeting activities, the following information and suggestions have been developed.

- Being at your first National Meeting can be a lonely experience if you don't know anyone. AAPT members are friendly people, so do not hesitate to introduce yourself to others in sessions and in the hallways. It is fun and rewarding to establish a network of other physics teachers with whom you can talk and share experiences. This is especially true during lunch and dinner.
- Area Committee meetings are not only for members of the committee, but also for friends of the committee. You are welcome to attend any Area Committee meeting. You should be able to find one or two committees that match your interests. Their meeting times are listed on page 13 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 Salon Ballroom II. 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 at 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 a presenter 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.

Dear Dr. Huggins,

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

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

To:<lish.huggins@dartmouth.edu>

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

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

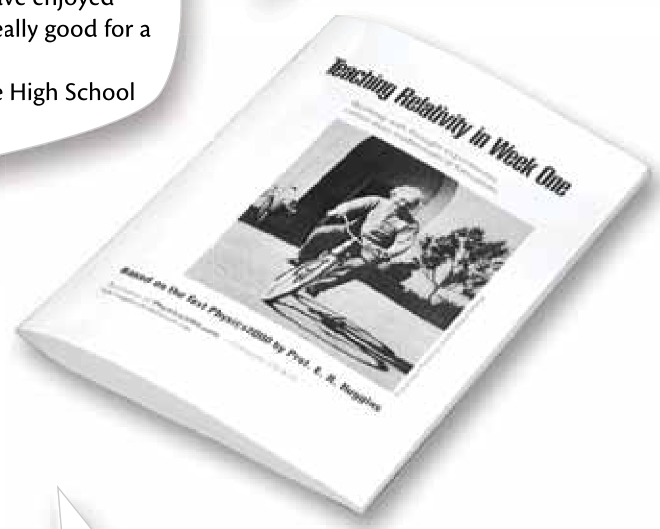
Kind Regards, R. L. 30 Aug 2009

Professor Huggins,

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

M.C., Bentonville High School
11 Aug 2005

Monday, July 19
12–1 p.m.
Salon Ballroom I



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

Welcome to the "City of Roses" – Portland

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

History

Portland began in 1843 on the Willamette River in what was then called Oregon Country. In 1845 the name of Portland was chosen and on February 8, 1851, the city was incorporated. Portland actually started as a spot known as "the clearing," on the banks of the Willamette. The city was named after Portland, ME, after a famous coin toss—in 1843 William Overton struck a bargain with his partner Asa Lovejoy of Boston, MA: for 25¢, Overton would share his claim to the 640 acre site. He later sold his half of the claim to Francis W. Pettygrove of Portland, ME. Pettygrove and Lovejoy each wanted to name the new city after his respective home town; thus the coin toss, which Pettygrew and Portland, ME, won.

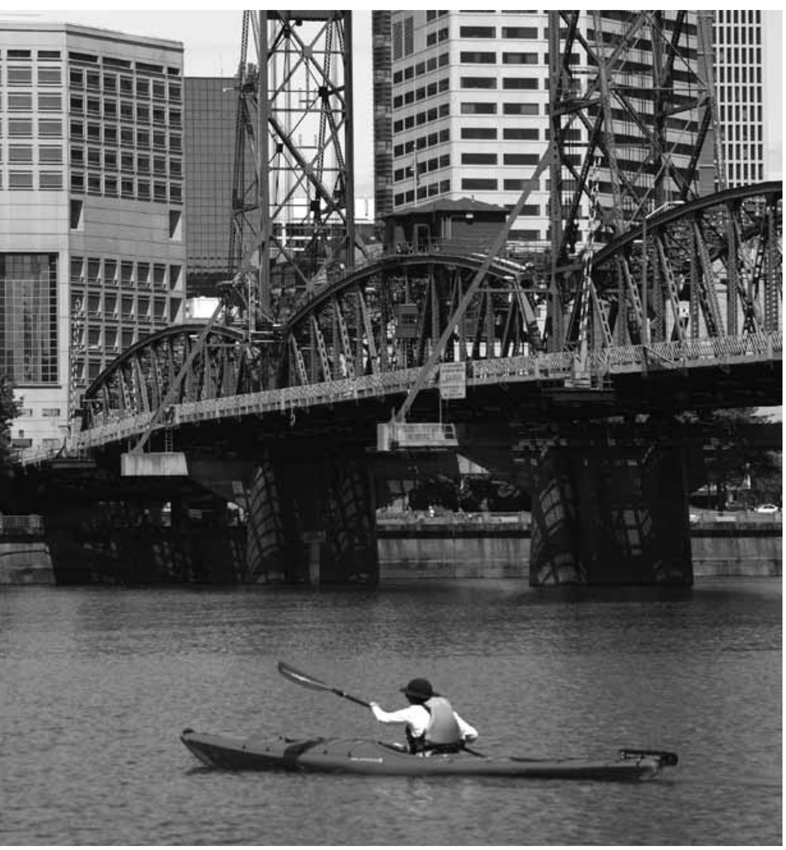
At the time of its incorporation on February 8, 1851, Portland had more than 800 inhabitants, a steam sawmill, a log cabin hotel, and a newspaper, the Weekly *Oregonian*.

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

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

Education

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



Things to do in Portland:

➤ **Portland International Beer Festival:** "An Over the Top Beer Festival" is going on this week, celebrating the world's most legendary brewing styles and the nations that made them famous. *July 16–18, 2010.* LOCATION: North Park Blocks, N.W. 8th and Burnside.

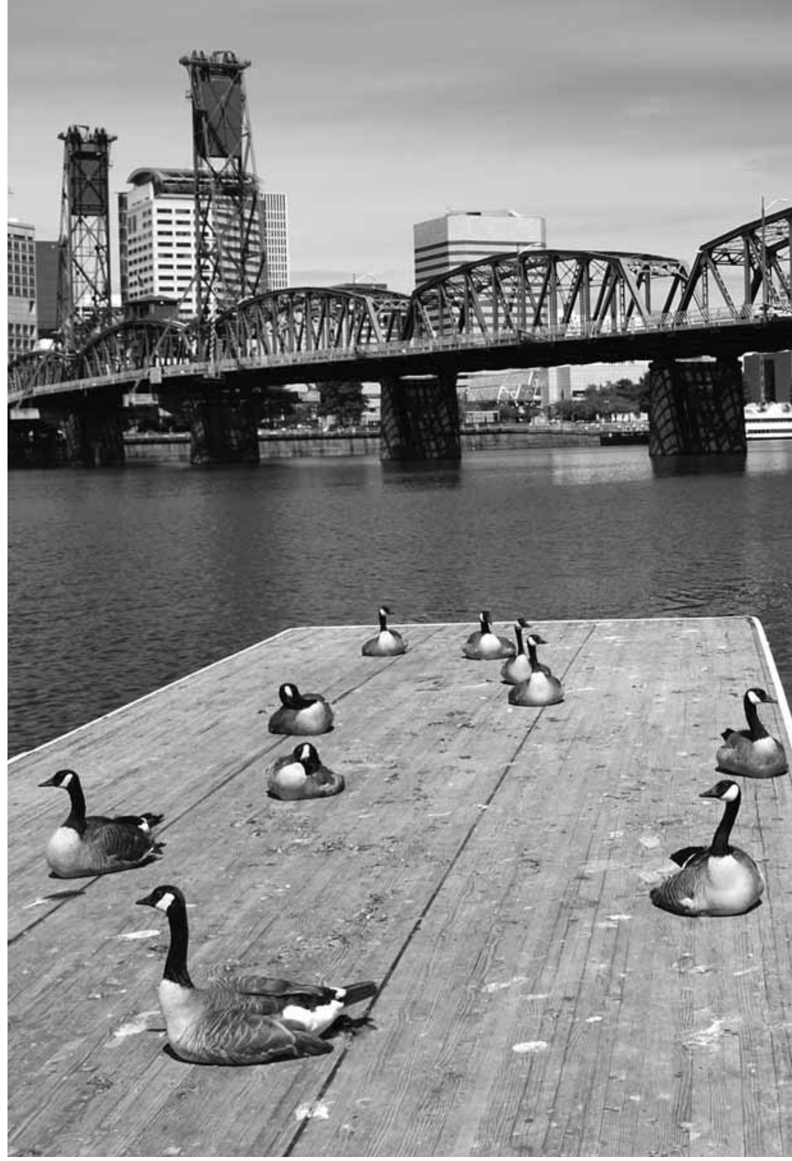
➤ **Portland Saturday Market:** Operating since 1974, the Portland Saturday Market is the largest continually operating outdoor arts and crafts market in the nation. Centered in Portland's historic Old Town, the Market is one of the most popular shopping destinations for local handcrafted goods. *Sat.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

➤ **Audubon Society of Portland's The Lost Bird Project:** A collection of strikingly beautiful sculptures by artist Todd McGrain, The Lost Bird Project honors the lives and loss of five extinct birds. The sculptures are oversized bronze renderings of the Passenger Pigeon, Carolina Parakeet, Heath Hen, Great Auk and Labrador Duck. LOCATION: Tom McCall Waterfront Park, 1020 SW Naito Parkway.

➤ **Oregon Museum of Science and Industry** (OMSI): Planetarium, OmniMax Theater. New Exhibit: SAMSON: The Colossal T.rex: A magnificent 39-foot fossil of one of Earth's most fearsome carnivores. The 66-million-year-old skeleton known as SAMSON is one of the most complete Tyrannosaurus rex skeletons in existence. *Tuesday through Sunday, 9:30 a.m.—5:30 p.m.* LOCATION: 1945 SE Water Ave., Portland, OR 97214-3354; www.omsi.edu

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

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



STATE OF OREGON

PROCLAMATION

OFFICE OF THE GOVERNOR

WHEREAS: Advances in our national and global economy and enhancements in our quality of life depend in large measure on physics, the mother of modern science; and

WHEREAS: Physics teachers have demonstrated through their commitment to teaching that they care deeply about student learning and physics development; and

WHEREAS: The American Association of Physics Teachers (AAPT) supports the development of effective teaching resources and professional enhancement programs for physics teachers in high schools, colleges and universities; and

WHEREAS: Physics teachers are influencing and developing the next generation of physicists and physics teachers through excellence in physics education; and

WHEREAS: Physics teachers collectively contribute to physics education and research, from which the citizens of not only Oregon but the United States of America can greatly benefit intellectually, economically and socially; and

WHEREAS: Continuous enhancements in physics education and in physics teacher preparation are essential here at home in the State of Oregon, which is committed to strengthening our technology-based economy.

NOW, THEREFORE: I, Theodore R. Kulongoski, Governor of the State of Oregon, hereby proclaim **July 18 – 24, 2010** to be

PHYSICS EDUCATION WEEK

In Oregon and encourage all Oregonians to join in this observance.

IN WITNESS WHEREOF, I hereunto set my hand and cause the Great Seal of the State of Oregon to be affixed. Done at the Capitol in the City of Salem in the State of Oregon on this day, June 17, 2010.

Theodore R. Kulongoski, Governor

Kate Brown, Secretary of State

Special Events

Tours of Vernier Software & Technology

Free tours of the Vernier headquarters are being offered 10 a.m.–4 p.m. Monday through Wednesday. Stop by their booth (#215, #217) for details, including how to get there via Max light rail. Each person visiting will get a gift.

Portland City & Columbia River Gorge Tour

Explore the Columbia River Gorge, a geologic wonder that forms the border between northern Oregon and southern Washington. Take in the awe and wonder of the Crown Point Vista house. Lunch is on own.

Sunday, July 18: 8:45 a.m.–1:30 p.m.

Physics Exhibit Show — Welcome Reception

See physics equipment and books from our Exhibitors.

Sunday, July 18: 8–10 p.m. Welcome Reception: 8–10 p.m.
Monday, July 19: 10 a.m.–6 p.m.
Tuesday, July 20: 10 a.m.–4 p.m. Exhibit Hall

AAPT 5K Run/Walk

Enjoy this scenic 5K Run (3.2 miles) or Walk along Terwilliger Boulevard where you will take in the gorgeous view of the Cascade mountains, Mt. Hood, Mt. St. Helens and Mt. St. Adams. Bring your camera and support AAPT!

Monday, July 19: 6:45 a.m.–8 a.m. (Meet in hotel lobby 6:30 for bus pickup; prereg. required)

First Timers' Gathering

The best time to learn about AAPT and the Summer Meeting and to meet fellow attendees and AAPT leadership.

Monday, July 19: 7–8 a.m. Salon Ballroom II

TYC Breakfast

Two-Year College staff begin their day by breaking bread and sharing ideas.

Monday, July 19: 7–8 a.m. Alexander's (ticket required)

Spouses' Gathering

Create connections with other spouses and partners of AAPT attendees.

Monday, July 19: 9–10 a.m. Alexander's

Video: "Celebrating 50 Years of the Laser"

The video is a production of SPIE, the international society for optics and photonics, as part of its Advancing the Laser celebration.

Monday, July 19: 6:15–7 p.m. Galleria I
Tuesday, July 20: 9:20–10 p.m. Galleria III

Young Physicists' Meet & Greet

For younger physicists to mix and mingle.

Monday, July 19: 6:15–7:15 p.m. Salon Ballroom II

Retirees' Breakfast

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

Tuesday, July 20: 7–8 a.m. Alexander's (ticket required)

Great Book Giveaway

AAPT has many physics books to raffle off. Get your free raffle ticket at the AAPT booth in the Exhibit Hall before Tuesday at 4 p.m.

Tuesday, July 20: 5–6 p.m. Registration area

AAPT Picnic/Demo Show

Enjoy great food, live music and beer with your AAPT friends and family. Ever-popular Demo Show follows. ***Thank you to Vernier*** for sponsoring the AAPT Demo Show and Summer Picnic!

Tuesday, July 20: 6:30–8 p.m. Picnic (ticket required)
8–9:10 p.m. Demo Show Portland Center for Performing Arts

Portland Walking Tour

This three-hour walking tour of downtown Portland will discuss the history, culture, and current events of Portland.

Wednesday, July 21: 4–7 p.m.

PORTLAND AAPT 2010 50 Years with Lasers

Committee Meetings

Saturday, July 17

Awards Committee	12–3 p.m.	Forum Suite

Sunday, July 18

Publications Committee	8–10:30 a.m.	Directors Suite
Meetings Committee	8–10:30 a.m.	Council Suite
Nominating Committee	3:30–5 p.m.	Council Suite
Programs Committee I	5–6 p.m.	Broadway I
Section Officers' Exchange	5:30–6:30 p.m.	Pavilion West
High School Share-A-Thon	6–8 p.m.	Broadway I/II
Laboratories Committee	6–7:30 p.m.	Studio Suite
Interests of Senior Physicists	6–7:30 p.m.	Directors Suite
Teacher Preparation Committee	6–7:30 p.m.	Council Suite
Physics in Undergrad. Educ.	6–7:30 p.m.	Senate Suite
Women in Physics Committee	6–7:30 p.m.	Forum Suite
Section Representatives	6:30–8 p.m.	Pavilion West

Monday, July 19

Membership & Benefits Committee	7–8:20 a.m.	Forum Suite
SI Units and Metric Education	7–8:20 a.m.	Directors Suite
Physics Bowl Advisory Committee	7–8:20 a.m.	Studio Suite
Governance Review Committee	7–8:20 a.m.	Senate Suite
Bauder Endowment Committee	12–1 p.m.	Directors Suite
Venture Fund Review	12–1 p.m.	Studio Suite
PERLOC Town Hall Meeting	12–1 p.m.	Grand Ballroom II
Physics in High School	9–10:30 p.m.	Forum Suite
Minorities in Physics	9–10:30 p.m.	Council Suite
International Education	9–10:30 p.m.	Directors Suite
Professional Concerns	9–10:30 p.m.	Studio Suite
Space Science & Astronomy	9–10:30 p.m.	Senate Suite
PIRA Business Meeting	9–10:30 p.m.	Executive Suite

Tuesday, July 20

Educational Technologies	7–8:20 a.m.	Forum Suite
Graduate Educ. in Physics	7–8:20 a.m.	Council Suite
Sci. Educ. for the Public	7–8:20 a.m.	Directors Suite
PTRA Advisory Committee	7–8:20 a.m.	Studio Suite
Review Board	7–8:20 a.m.	Senate Suite
Audit Committee	12:15–1:15 p.m.	Forum Suite
Investment Advisory Committee	12:15–1:15 p.m.	Directors Suite
Apparatus Committee	5–6:30 p.m.	Directors Suite
History and Philosophy	5–6:30 p.m.	Galleria I
Physics in Pre High School	5–6:30 p.m.	Council Suite
Research in Phys. Education	5–6:30 p.m.	Studio Suite
Physics in Two-Year College	5–6:30 p.m.	Senate Suite

Wednesday, July 21

Nominating Committee II	7–8:20 a.m.	Forum Suite
Programs Committee II	7–8:20 a.m.	Council Suite
Barbara Lotze Scholarship	12:30–1:40 p.m.	Executive Suite
Governance Structure (COGS)	12:30–1:40 p.m.	Senate Suite
PERLOC Committee	12:30–1:40 p.m.	Council Suite

Patricia M. Heller

Robert A. Millikan Medal

Patricia M. Heller, University of Minnesota

Guiding the Future: Developing Research-based Physics Standards

Tuesday, July 20, 10:30 a.m. • GRAND BALLROOM I

Pat Heller is Associate Professor of Curriculum and Instruction at the University of Minnesota and a founding member of the Physics Education Research (PER) Group. She has been at the forefront of PER for most of her career, taking on problems and issues that later bloom into entire research areas. One example of this is her work with instructor beliefs. She recognized that no instructional change will happen unless the individual instructor believes in the value of the change. This means we need to know what instructors believe and how those beliefs can change. Her work on cooperative group problem solving has also been of great importance and has not only established a firm research base on the topic in university level physics education, but she and her research group have created (and freely disseminated) materials that are widely used and have influenced many instructors to bring more group problem solving into their classrooms.

Her research program has produced a number of students who are now leaders in the physics education and PER communities. The University of Minnesota Physics Education Research and Development website developed by her research group in physics education is a primary resource for physics teachers and contains first rate materials that have been highly influential for many physics instructors [http://groups.physics.umn.edu/physed/]

The Robert A Millikan Medal, established in 1962, recognizes those who have made outstanding scholarly contributions to physics education.

Robert Scherrer

Klopsteg Memorial Award

Robert Scherrer, Vanderbilt University

Science and Science Fiction

Wednesday, July 21, 8:30 a.m. • GRAND BALLROOM I

Robert Scherrer, Chair of the Department of Physics and Astronomy at Vanderbilt University, Nashville, TN, is a well-known cosmologist, and has made major contributions in the study of element production in the early universe, particle physics in the early universe, the clustering of galaxies, and dark energy. Scherrer has published widely in this field. His work has also been mentioned, over the years, in *Physics Today*, *Nature*, *Science*, *Science News*, *Sky & Telescope*, and *Discover.*

In addition to his research, Scherrer is an accomplished teacher and an outstanding speaker. He received the 1999 Alumni Award for Distinguished Teaching at Ohio State University, Ohio State's top teaching award. He is also the author of a well-respected quantum mechanics textbook, *Quantum Mechanics, an Accessible Introduction* (Pearson, 2006). He is also a science fiction author, having written several short stories, mostly published in *Analog Magazine*. His talk on Science and Science Fiction will focus on the way in which new ideas are introduced in physics, and compares this to the way they are developed in the process of writing a science fiction story. He also discusses the predictive nature of science fiction (vs. science), and the way that information is presented in a short story as opposed to a scientific paper.

Established in 1990, the Klopsteg Memorial Award recognizes outstanding communication of contemporary physics to the general public, in memory of Paul Klopsteg, an American physicist and past AAPT President. The Klopsteg Memorial Award recipient makes a major presentation at an AAPT Summer Meeting on a topic of current significance suitable for non-specialists.

Excellence in Undergraduate Physics Teaching Award

William P. Hogan

William P. Hogan, Joliet Junior College

Stumbling on a Tightrope

Tuesday, July 20, 11:15 a.m. • GRAND BALLROOM I

William P. Hogan is Professor of Physics at Joliet Junior College, Joliet, IL. Hogan received a BS degree in engineering physics, a MS in physics, and a PhD in experimental high energy physics all from the University of Illinois at Urbana-Champaign. He accepted an appointment as a post-doctoral research associate with Rutgers University stationed at Fermi National Acceleration Laboratory after finishing his graduate studies. While working at Fermilab, he began teaching physics as an adjunct faculty member at several Chicago-area two-year colleges and decided to pursue a career teaching physics. In 1997, he joined the physics faculty at Joliet Junior College.

Hogan has been active in physics teaching organizations. He is a member of both the Illinois Section and the Chicago Section of the American Association of Physics Teachers (AAPT) and has presented many papers at Illinois Section meetings. He has served as President-Elect (2005), President (2006), and Past-President of the Illinois Section of AAPT. Currently, he serves on the Executive Board of ISAAPT as one of the TYC representatives.

He was instrumental in the success of TYC21 (an NSF-sponsored project to build networks among two-year college physics teachers) in Illinois. He has served and is now serving another term on the American Association of Physics Teachers Committee on Physics in the TYCs and was Editor for the *AAPT Guidelines for Two-Year College Physics Programs* (2001).

Excellence in Pre-College Physics Teaching Award

Diane Riendeau

Diane Riendeau, Deerfield High School

Who's In??

Tuesday, July 20, 11:45 a.m. • GRAND BALLROOM I

Diane Riendeau, physics teacher at Deerfield High School, Deerfield, IL, earned her MA in Curriculum and Instruction, 2000, Concordia University, and her BA in Mathematics, 1987, Northeastern Illinois University.

One of her philosophies is that high school physics curricula should be concepts driven instead of math driven and hands-on instead of lecture-based. This way students walk away with lived physics experiences. This philosophy is especially applicable to high school freshmen who are still children at heart and enjoy learning by doing and playing. Throwing math at a group of students whose math skills are underdeveloped would be counterproductive to our school's goal of providing physics for all.

She received the Innovative High School Teaching Award, 1992, from the AAPT, and the AAAS Leadership in Science Education for High School Teachers, 2008, and was a finalist in the Presidential Award for Excellence in Math and Science Teaching, 2008, Illinois.

She is a frequent author for *The Physics Teacher*, a former Editorial Board member for the journal, peer reviewer for *TPT*, and currently a *TPT* column editor for "YouTube Physics."

AAPT Distinguished Service Citations 2010

Wednesday, July 21, 9:15 a.m. • GRAND BALLROOM I

Chris Chiaverina
Winnetka, IL

Chris Chiaverina

"Always a physics teacher" is a phrase that aptly describes Chris Chiaverina. Chris received both his bachelor's and MS ED degrees from Northern Illinois University. Before retiring in 2002, he taught physics in an inner-city Chicago high school and in a small Illinois town (Forreston), as well as in suburban Barrington High School and New Trier Township High School in Winnetka. He has also served as a visiting faculty member at DePaul University, Roosevelt University, and at Northern Illinois University.

Chris is a frequent contributor to *The Physics Teacher* and also has served several terms on its Editorial Board. He is currently editor of the *TPT* "Little Gems" column. He has been a co-author or contributor to several physics textbooks, including *Light Science* (Springer-Verlag, 1999), as well as a reprint book on *Teaching Light and Color* (AAPT, 2001). He was a contributing author in the Active Physics curriculum project of AAPT.

Chris has served AAPT in a number of roles on both the local and national levels, becoming AAPT Vice President, President Elect, President, and Past President (2001–2004).

Harvey Leff
Cal Poly State University

Harvey Leff

After receiving his PhD from the University of Iowa under the direction of Max Dresden, Harvey Leff taught on the faculty at Case Western Reserve University, Harvey Mudd College, and Chicago State University. He spent four years as an energy policy analyst for the Oak Ridge Associated Universities before joining the faculty at Cal Poly Pomona in 1983 as department chair.

Harvey served as an officer and Section Representative of the Southern California Section of AAPT from 1987 to 2005, Associate Editor of the *American Journal of Physics* 1992-95, Chair of AAPT's Professional Concerns Committee 1999-2000, and Chair of the AAPT Nominating Committee 2003-04. He was elected to the AAPT Presidential Chain (2005–2008).

Among Harvey's six dozen scientific publications, primarily related to thermal physics, include articles in the *American Journal of Physics* and *The Physics Teacher.* Serving the wider physics-teaching community, Harvey was an organizer of the Gordon Research Conference on Physics Education and Research on Quantum Mechanics in 2002. Harvey has been drummer for the Out-Laws of Physics since 2003.

Sanjay Rebello
Kansas State University

Sanjay Rebello

Sanjay received his PhD and Master's degree from Brown University and has been an active member of AAPT since 1995. He became Assistant Professor of Physics at Kansas State University in 2001 and Associate Professor in 2005. He is currently serving on the Committee Graduate Education in Physics. He organized the 2004 PER Conference at the National AAPT Summer meeting.

An active member of the AOK Section, Rebello brings his graduate students to section meetings where they always present the latest physics education research that the Kansas State University PER group is conducting. He is the kind of "champion" that a local AAPT section needs to maintain its presence in the greater organization.

Rebello promotes good educational practices in the classroom and he practices what he preaches. His students rave at his ability to assist them in understanding physics at both a conceptual level and at even greater depths. Many of his graduate students have continued the tradition of physics education as they have moved on to their own teaching careers, giving talks at various AAPT meetings around the nation. This is probably the most significant and essential part of what Sanjay Rebello has meant to AAPT.

AIP Science Writing Award – Children's Category

Wednesday, July 21, 9:15 a.m. • GRAND BALLROOM I

The 2009 winners of the American Institute of Physics Children's Writing Award are Cora Lee and Gillian O'Riley for their book *The Great Number Rumble: A Story of Math in Surprising Places* (Annick Press, 2007), which takes the reader on a journey as math gets banned at school, chaos rules, kids toss their textbooks, and the math-loving main character proves that life isn't half as fun without his favorite subject.

Cora Lee

Cora Lee is a science writer based in Vancouver, Canada. She studied biochemistry and biotechnology at the University of British Columbia and technical writing at Simon Fraser University. Her early career revolved around the research laboratory. Currently, she works as a consultant, creating medical, regulatory, and other technical documentation for the pharmaceutical, medical device, and biotechnology industries. Author of many articles in children's science magazines, she recently had her second book for children published, *The Great Motion Mission: a Surprising Story of Physics in Everyday Life* (September 2009). She believes that children are the perfect audience—willing to accept impossible answers and open to the most bizarre concepts that scientists can throw at them.

Gillian O'Reilly

Gillian O'Reilly, who lives in Toronto, Canada, has been interested in words ever since she ate the dust jacket off the Shorter Oxford English Dictionary when she was 11 months old. She has a BA in History and has worked in the book industry for over 30 years. Editor of *Canadian Children's Book News*, she is also the author of *Slangalicious: Where We Got That Crazy Lingo* (2004). Her goal in writing nonfiction for children is to intrigue, entertain, and educate. While no mathematician herself, Gillian enjoys the unusual and the "cool" in the world of numbers and shapes. She has become fascinated by the history of mathematics and sciences and the development of our modern understanding of these disciplines. She is always pleased to see mathematical and scientific concepts conveyed to young people (and adults) in a fun, imaginative and memorable way.

PTRA at its 25th Anniversary

Wednesday, July 21, 11:15 a.m. • GRAND BALLROOM I

PTRA, Physics Teaching Resource Agents, is one of the more innovative programs to be developed by a science professional organization. The idea that physics teachers could be engaged to meet together for common learning experiences and then, individually, go out into the community, to assume leadership roles, to network with other physics teachers and be resources and educational assistants was a unique idea in 1985. The speakers will discuss the origin of the idea, its implementation, its development over 25 years, and its present and future plans.

50 Years with Lasers

▶ APS/DLS Symposium on Laser Physics

Monday, July 19, 10:30 a.m.–12 p.m. • GRAND BALLROOM I

Warren S. Warren

Breasts and Brains, Similarities and Differences:
Using Novel Physics to Enhance Clinical Molecular Imaging

Warren S. Warren, Duke University

Warren received his bachelor's degree in chemistry and physics summa cum laude from Harvard in 1977, and his PhD from Berkeley in chemistry in 1980. After post-doctoral work at Caltech with Ahmed Zewail, he moved to Princeton in 1982, and then to Duke in 2005, where he is the James B. Duke Professor and Chair of Chemistry. He is also professor of radiology and biomedical engineering and director of the Center for Molecular and Biomolecular Imaging at Duke, and chair of the Division of Laser Science, American Physical Society. His research interests focus on the use of enhanced control over radiation fields to enhance molecular spectroscopy and imaging, primarily in magnetic resonance and optics. He is a fellow of APS, AAAS, and ISMAR. He is also the author of an award-winning honors chemistry textbook, *The Physical Basis of Chemistry.*

Steven T. Cundiff

Femtosecond Optical Frequency Combs

Steven T. Cundiff, NIST and University of Colorado

Steven Cundiff is a JILA Fellow; JILA is a joint institute between the National Institute of Standards and Technology (NIST) and the University of Colorado in Boulder, CO. He is a physicist in the NIST Quantum Physics Division and an adjoint professor in the Physics and the Electrical, Computer and Energy Engineering Departments at the University of Colorado. His research includes femtosecond comb technology and ultrafast spectroscopy of semiconductors and dense atomic vapors.

Vengu Lakshminarayanan

▶ Lasers and the Eye

Monday, July 19, 3:20–4:20 p.m. • GRAND BALLROOM I

Vasudevan (Vengu) Lakshminarayanan,
University of Waterloo

Vengu received his first degrees in physics from the University of Madras in India, and subsequently a PhD from the University of California at Berkeley, where his thesis was on waveguiding in retinal photoreceptors. He is currently a professor of physics, electrical engineering and optometry (Vision Science) at the University of Waterloo. Prior to this he held research and/or teaching appointments at the University of California at Berkeley, at UC Irvine, and at the University of Missouri. He has also worked in the medical optics industry at Allergan Medical Optics as Principal Clinical Research Scientist. He has published widely (over 300 publications) in areas ranging from quantum chemistry, applied mathematics, control theory and biomedical engineering, cognitive science, medical optics as well as classical and quantum optics. He has also authored/edited/co-edited a number of books, most recently the five-volume *Handbook of Optics* (McGraw Hill, 2010) He is a Fellow of the Institute of Physics, Optical Society of America, SPIE – International Society for Optical Engineering, AAAS and the American Academy of Optometry. He is on the editorial board of a number of journals, including most recently, the *Journal of Modern Optics* and *Optics Letters*.

Free Commercial Workshops

CW01: Explore Sonography with 3B Scientific

Location: Salon Ballroom III
Date: Monday, July 19
Time: 2–3 p.m.
Sponsor: American 3B Scientific

Leaders: Jessics Norica, Johannes Recht

Medical practitioners rely on the principles of sonography when performing all types of ultrasonic procedures. In this workshop, we will use ultrasonic equipment to determine the speed of sound propagated by longitudinal and transverse waves in solids. Longitudinal sound waves are determined by the elastic module of the solid when transverse waves are determined by the shear modulus of the solid. Therefore, the elastic constant of the solid can be determined by measuring the speed of the two wave types. After the demonstration, participants will be given the opportunity to ask questions and perform the experiment. Experiment guides and manuals will be available for all participants. The 3B Scientific Ultrasonic Echoscope and accessories will be utilized to perform the experiment.

CW02: Kinetic Books Workshop

Location: Salon Ballroom II
Date: Monday, July 19
Time: 1:30–3 p.m.
Sponsor: Kinetic Books

Leader: Mark Bretl

Learn how a fully integrated digital physics curriculum can aid your instruction. Application of multiple learning styles and inquiry-based learning in a self-paced package provides students with experimentation and involvement. Join us for an overview of the design and use of our products along with many subject highlights.

CW04: Physics2000 Workshop

Location: Salon Ballroom I
Date: Monday, July 19
Time: 12–1 p.m.
Sponsor: Physics2000

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.

CW05: Quality Educational Demonstrations Workshop

Location: Salon Ballroom I
Date: Tuesday, July 20
Time: 8:20–10:10 a.m.
Sponsor: Quality Educational Demonstrations

Leaders: Brett Carroll, Jackie Krezelak

Quality Educational Demonstrations is a new company with new ideas about physics demonstrations. Our demonstration equipment is innovative, user-friendly, and unforgettable. In this workshop we will present our newest physics demonstration products, including: • a state-of-the-art wine glass breaker that works every time, with only 75W of total amplifier power • a powerful bar-graph measurement and display system, with 10 plug-and-play sensors, which performs over 25 separate demonstrations with unparalleled impact and clarity • an ultrabright point-source LED strobe for shadow projection of SHM oscillations • a collapsible smoke ring cannon that eliminates storage issues • an extremely versatile color mixer that demonstrates both additive and subtractive color mixing in striking new ways • a siren in a vacuum that clearly shows the effects of a vacuum on both sound and electromagnetic wave transmission. If your physics demonstration collection could use a boost, come to the QED workshop and find out just how effective and fun demonstrations can be! If you can't attend the workshop, please drop by our booth (#101) or visit our website at www.qedsci.com for a look at our products.

CW03: Kinetic Books Workshop

Location: Salon Ballroom II
Date: Tuesday, July 20
Time: 8:50–10:20 a.m.
Sponsor: Kinetic Books

Leader: Mark Bretl

Learn how a fully integrated digital physics curriculum can aid your instruction. Application of multiple learning styles and inquiry-based learning in a self-paced package provides students with experimentation and involvement. Join us for an overview of the design and use of our products along with many subject highlights.

CW06: And You Thought It Was About Homework: WebAssign: New Tools, New Content, New Labs

Location: Salon Ballroom II
Date: Tuesday, July 20
Time: 12:15–1:15 p.m.
Sponsor: WebAssign

Leader: Mark Santee

Help your students learn with WebAssign. Find out what's new. WebAssign—the premier independent online homework, quizzing, and testing system—is proud to debut our new program designed to support your laboratory needs. This workshop will include an overview of WebAssign, teaching you how to access and assign questions from all major physics and astronomy textbooks, or write your own. You'll learn more about new assignable simulations, assignable examples with content specific hints and feedback, more online components and tutorials all specific to your textbook. Give partial credit with conditional weighting. Assign practice questions. Give group assignments. Select questions for your assignment knowing how difficult each question is and how many students have tried it before. We will introduce you to WebAssignLabs, our innovative approach to help you prepare your students for the lab experience, collect their lab data, analysis, and report—all using WebAssign. WebAssign Novices and WebAssign Experts (and all those in-between) will find something new and exciting in this workshop. Over 3 million students have successfully used WebAssign. Find out why!

CW07: Vernier Software: New Data Collection Tools for Physics

Location: Salon Ballroom III
Date: Tuesday, July 20
Time: 1–3 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. • Use the new LabQuest Mini interface with Logger Pro. • Try out our new Electrostatics Kits with our Charge Sensor. • Use our Rotary Motion Sensor with its Accessory Kit to look at rotational dynamics. • Explore the Audio Function Generator on Vernier LabQuest. Use it to drive internal or external speakers. • Use our new Power Amplifier to study electrical circuits or to investigate resonance. • Experiment with our new Optics Expansion Kit, including the Color Mixer Kit. • Use the Vernier Spectrometer to collect emission spectra of our new Spectrum Tube Systems. • Use our new Bumper and Launcher Kit with Vernier Dynamic System. • Try out some Vernier products for engineering or physics projects. The Vernier NXT Adapter allows our sensors to be used with the LEGO NXT Robotics system and SensorDAQ, a USB interface for use with LabVIEW. • Explore the video capabilities of Logger Pro.

CW08: Pearson Education MasteringPhysics, MasteringAstronomy Lunch & Learn

Location: Salon Ballroom III
Date: Monday, July 19
Time: 12–1 p.m.
Sponsor: Pearson Education

Leader: Kerry Chapman

Pearson invites you to a lunchtime workshop to learn about all of the new and exciting features available in MasteringPhysics and MasteringAstronomy. The Mastering platform is the most effective and widely used online tutorial, homework, and assessment system for the sciences. If you are new to Mastering, come see how you can engage your students and truly help them learn through Mastering's individualized feedback and coaching. Learn about Mastering's data-supported efficacy and ability to easily demonstrate learning outcomes in your class. If you are a Mastering user, come to see all of the new features and content such as PhET Simulation Tutorials (MasteringPhysics) and WorldWide Telescope Tours (MasteringAstronomy). We'll also talk about best practices for setting up courses, customizing assignments, and using the new tools in the interface. Lunch will be provided and we welcome you to bring your questions.

Please contact kerry.chapman@pearson.com to reserve a seat as space is limited.

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Drop by the Poster Sessions in the Exhibit Hall

Monday: 7:30–9 p.m.
Tuesday: 9:20–10:50 p.m.*

**The posters will be up starting at 8:30 a.m., but the authors will be present in the evenings.*

Snacks: Monday, popcorn and warm pretzels
Tuesday, ice cream bars

Exhibitor Information

Booths # 306, 308

American Association of Physics Teachers

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Visit the AAPT booth for the latest and greatest education resources. See our line of physics toys and gifts, first-time books from our Physics Store Catalog, new and favorite T-Shirts, and Member-Only items. These items will be available to order at the booth. Pick up copies of AAPT's informational brochures on some of the leading education programs such as PTRA and the US Physics Team.

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Browse through featured titles from many publishers. The Great Book Giveaway will be held Tuesday from 5 to 6 p.m. when the books are raffled off. Pick up your raffle ticket at the AAPT Booth before Tuesday at 5 p.m.

Booth # 304

Find out about some fun online physics demos and lessons from **ComPADRE.**

Booth # 312

Physics Teaching Resource Agents (PTRA)

PTRA is celebrating its 25th Anniversary! PTRA is a program that provides professional development on physics content, teaching techniques based on research in physics education, and integration of technology into curriculum. Stop by Booth 312 to meet members of PTRA and learn more about the programs available for middle and high school teachers.

Booth # 314

American Physical Society

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Booth # 315

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Booth # 412

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Booths # 203, 205

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Booth # 108

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Booth # 411

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LIGO, the Laser Interferometer Gravitational-Wave Observatory, searches for gravitational waves at detector facilities in Louisiana and Washington. LIGO's public outreach program includes field trips, teacher workshops, internships, and distance learning tools. Visit the LIGO exhibit to experiment with an interferometer and to investigate LIGO's opportunities for teachers and students.

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Booths # 206, 208

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Booths # 214, 216

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Booth # 316

Physics Teacher Education Coalition

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Booth # 113

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Booth # 202

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Meeting-at-a-Glance

*Meeting-at-a-Glance includes sessions, workshops, committee meetings and other events, including luncheons, Exhibit Hall hours and snacks, plenary sessions, and receptions. All rooms will be in the Hilton Portland and Executive Tower. All workshops will be held at **Portland State University,** except W01 at Reed College, and W05 at Vernier Software & Technology offices.*

FRIDAY, July 16

6–8 p.m.		Pre-registration Pickup	**Plaza Foyer**

SATURDAY, July 17

7 a.m.–4:30 p.m.		**REGISTRATION**	**Plaza Foyer**
8 a.m.–12 p.m.	W06	Applied Critical Thinking: Science, Religion and Asking Cogent Questions	Neuberger Hall 241
8 a.m.–12 p.m.	W08	Critical Thinking in Astronomy	Cramer Hall 159
8 a.m.–12 p.m.	W09	Leadership Roles and Models in the Classroom, Academia, and Beyond	Neuberger Hall 238
8 a.m.–12 p.m.	W10	PIRA Lecture Demonstrations I – Condensed	Science Building 1-107
8 a.m.–12 p.m.	W11	Using Graphing Calculators in the Classroom	Cramer Hall 225
8 a.m.–5 p.m.	W01	LabVIEW Instruction for the Advanced Laboratory	Reed College
8 a.m.–5 p.m.	W03	Piaget Beyond “Piaget”	Cramer Hall 203
8 a.m.–5 p.m.	W04	Research-based Alternatives to Traditional Problems in Introductory Physics	Neuberger Hall 385
9 a.m.–4:15 p.m.	W05	Research-based Curricula and Computer Supported Tools	Vernier
9 a.m –5 p.m.	W02	Learning Physics While Practicing Science	Cramer Hall 201
12–3 p.m.		Awards Committee meeting	Forum Suite
1–3 p.m.	T01	Teaching About Lasers and Their Uses: Lab and Demonstrations	Neuberger Hall 341
1–5 p.m.	W12	Constructing Knowledge and Skills in Intro Labs	Science Building 2-161
1–5 p.m.	W13	Introductory Laboratory Workshop	Science Building 1-424
1–5 p.m.	W14	PIRA Lecture Demonstrations 2 – Condensed	Science Building 1-107
1–5 p.m.	W15	Photovoltaic Kits	Neuberger Hall 238
1–5 p.m.	W16	Promoting Active Inquiry-based Learning with Computers in High Schools	Science Building 2-113
1–5 p.m.	W18	What to Do About the First Day of School and Other Special Events	Cramer Hall 225
5–10 p.m.		AAPT Executive Board	Forum Suite

SUNDAY, July 18

7 a.m.–4 p.m.		**REGISTRATION**	**Plaza Foyer**
8–10:30 a.m.		Publications Committee	Directors Suite
8–10:30 a.m.		Meetings Committee	Council Suite
8 a.m.–12 p.m.	W19	What Every Physics Teacher Should Know About Cognitive Science	Cramer Hall 228
8 a.m.–12 p.m.	W28	A New Methodology for Using Clickers in Lecture Classrooms	Science Building 2-113
8 a.m.–12 p.m.	W29	Biology Inspired Labs for IPLS Course: Bridging Gap between Physical and Life Sci.	Cramer Hall 103
8 a.m.–12 p.m.	W30	Designing a Diagnostic Learning Environment	Neuberger Hall 375
8 a.m.–12 p.m.	W31	Energy in the 21st Century	Cramer Hall 203
8 a.m.–12 p.m.	W32	LivePhoto Physics: Video-based Analysis Activities	Cramer Hall 101
8 a.m.–12 p.m.	W33	Mining the Data: Writing Better Tests	Neuberger Hall 209
8 a.m.–12 p.m.	W34	NTIPERS: Research-based Reasoning Tasks for Intro Mechanics	Cramer Hall 201
8 a.m.–12 p.m.	W36	Road Show Lecture Demonstrations	Science Building 1-107
8 a.m.–12 p.m.	W37	Web Tech Tools for Teachers	Cramer Hall 196
8 a.m.–5 p.m.	W20	Computer Modeling and the Physics Classroom Web Resources	Cramer Hall 159
8 a.m.–5 p.m.	W21	Enhancing Your Course with Activities Arising from PER	Neuberger Hall 237
8 a.m.–5 p.m.	W23	Physics by Design	Science Building 2-161
8 a.m.–5 p.m.	W24	Teaching Astronomy Effectively with Technology	Neuberger Hall 341
8 a.m.–5 p.m.	W25	Teaching Physics for the First Time	Science Building 2-149
8 a.m.–5 p.m.	W26	Using RTOP to Improve Physics and Physical Science Teaching	Neuberger Hall 307
8 a.m.–5 p.m.	W27	Arduino Microcontrollers in the Physics Lab	Science Building 1-201
8 a.m.–10 p.m.		Physics Photo Contest Viewing and Voting	Plaza Foyer
8:45 a.m.–1:30 p.m.		Portland City Tour and Columbia Gorge Tour	Offsite
10:30 a.m.–3:30 p.m.		AAPT Executive Board	Forum Suite
1–6 p.m.		Exhibitors Setup	Exhibit Hall
1–3 p.m.	T02	Computational Physics Examples to Include in Physics Courses	Cramer Hall 101
1–5 p.m.	W35	Playing the Game of Science	Neuberger Hall 241
1–5 p.m.	W38	Advanced and Intermediate Laboratory Workshop	Science Building 1-424

1–5 p.m.	W39	Falsification Labs Workshop	Science Building 2-113
1–5 p.m.	W40	Modeling Applied to Problem Solving: An Adoptable Pedagogy	Cramer Hall 201
1–5 p.m.	W41	Open Source Tutorials	Cramer Hall 103
1–5 p.m.	W42	PhET Simulations – Fun Tools to Help Your Students Learn Physics	Neuberger Hall 222
1–5 p.m.	W43	Physics and Performance	Cramer Hall 203
1–5 p.m.	W44	Physics and Toys II: Energy, Momentum Electricity and Magnetism	Neuberger Hall 209
1-5 p.m.	W45	Strategies to Help Women Succeed in Physics-Related Professions	Cramer Hall 225
3:30–5 p.m.		Nominating Committee	Council Suite
5–6 p.m.		Programs Committee I	Broadway I
5:30–6:30 p.m.		Section Officers' Exchange	Pavilion West
6–7:30 p.m.		Laboratories Committee	Studio Suite
6–7:30 p.m.		Interests of Senior Physicists Committee	Directors Suite
6–7:30 p.m.		Teacher Preparation Committee	Council Suite
6–7:30 p.m.		Physics in Undergraduate Education Committee	Senate Suite
6–7:30 p.m.		Women in Physics Committee	Forum Suite
6–8 p.m.		High School Share-a-thon	Broadway I/II
6–8 p.m.	SUN	SPS Undergraduate Research and Outreach Poster Reception	Galleria III
6:30–8 p.m.		Section Representatives	Pavilion West
7–9:30 p.m.		**REGISTRATION**	**Plaza Foyer**
8–10 p.m.		**Exhibit Hall Opens**	Exhibit Hall
8–10 p.m.		Opening Reception	Exhibit Hall

MONDAY, July 19 *"50 Years of the Laser" Day*

6:45–8 a.m.		AAPT 5K Run/Walk (registration required) meet in lobby by 6:30 for bus pickup	Waterfront
7–8 a.m.		First Timers' Gathering	Salon Ballroom II
7–8 a.m.		TYC Breakfast (ticket required)	Alexander's
7–8:20 a.m.		Membership and Benefits Committee	Forum Suite
7–8:20 a.m.		SI Units and Metric Education Committee	Directors Suite
7–8:20 a.m.		Physics Bowl Advisory Committee	Studio Suite
7–8:20 a.m.		Governance Review Committee	Senate Suite
7 a.m.–5 p.m.		**REGISTRATION**	**Plaza Foyer**
8 a.m–5 p.m.		TYC Resource Room	Grand Parlor A
8 a.m–5 p.m.		PIRA Resource Room	Grand Parlor B/C
8 a.m.–10 p.m.		Physics Photo Contest Viewing and Voting	Plaza Foyer
8:20–9:50 a.m.	AB	Physics, Technological Innovation and Careers in the Pacific Northwest I	Galleria II
8:20–9:50 a.m.	AA	Upper Division Laboratories: Ideas, Equipment, and Techniques	Galleria I
8:20–10:10 a.m.	AC	Using Literature and History to Teach High School Physics	Galleria III
8:20–10:10 a.m.	AD	PER: Student Reasoning	Broadway I/II
8:20–10:20 a.m.	AE	Panel: Bridging the Gap I	Broadway III/IV
8:20–10:20 a.m.	AF	Multiple Models for Mentoring I	Grand Ballroom II
8:20–10:20 a.m.	AG	Panel: Online Science Education Resources	Pavilion East
8:20–10:20 a.m.	AH	Panel: Promoting Diversity in Physics Education	Pavilion West
9–10 a.m.		Spouses' Gathering	Alexander's
10 a.m.–6 p.m.		**Exhibit Hall Open (Coffee and pastries, 10 a.m.)**	**Exhibit Hall**
10:30 a.m.–12 p.m.	**Plenary**	**APS/DLS Symposium on Laser Physics**	Grand Ballroom I
12–1 p.m.		Bauder Endowment Committee	Directors Suite
12–1 p.m.		PERLOC Town Hall Meeting	Grand Ballroom II
12–1 p.m.	CKB01	Crackerbarrel for PER Solo Faculty	Broadway I/II
12–1 p.m.	CKB02	Crackerbarrel on TYC Guidelines	Broadway III/IV
12–1 p.m.		Venture Fund Review	Studio Suite
12–1 p.m.	CW04	Physics2000 Commercial Workshop	Salon Ballroom I
12–1 p.m.	CW08	Pearson Education Commercial Workshop	Salon Ballroom III
1:10–2:20 p.m.	BA	Biomedical Labs for Advanced Physics	Galleria I
1:10–2:40 p.m.	BD	Physics, Technological Innovation and Careers in the Pacific Northwest II	Broadway I/II
1:10–2:50 p.m.	BB	PER: Investigating Classroom Strategies	Galleria II
1:10–3 p.m.	HD	National Task Force on Teacher Education in Physics: Case Studies	Council Suite
1:10–3:10 p.m.	BC	Panel: Multiple Models for Mentoring II	Galleria III
1:10–3:10 p.m.	BE	Best Practices for Teaching with Technology	Broadway III/IV

1:10–3:10 p.m.	BF	Electric Circuits: From Batteries and Bulbs to Electronic Devices	Grand Ballroom II
1:10–3:10 p.m.	BG	State and National Initiatives and Effects on High School Physics	Pavilion East
1:10–3:10 p.m.	BH	Panel: When Scientists Should Step In. Media, Politics, and Science	Pavilion West
1:30–3 p.m.	CW02	Kinetic Books Commercial Workshop	Salon Ballroom II
2–3 p.m.	CW01	American 3B Commercial Workshop	Salon Ballroom III
3:20–4:20 p.m.	**Plenary**	**Lasers and the Eye**	Grand Ballroom I
4:30–5:20 p.m.	DA	Physics and Society	Galleria I
4:30–5:20 p.m.	FB	Video Analysis	Council Suite
4:30–5:30 p.m.	DB	High School/Middle School	Galleria II
4:30–5:50 p.m.	DE	Lecture/Classroom I	Broadway III/IV
4:30–6 p.m.	CA	PIRA Session: The Wonderful World of PIRA	Salon Ballroom I
4:30–6 p.m.	DC	Physics Education Research Around the World I	Galleria III
4:30–6 p.m.	DD	Teaching with Technology I	Broadway I/II
4:30–6 p.m.	DF	Teaching Physics Around the World	Grand Ballroom II
4:30–6 p.m.	DG	The Art and Science of Teaching	Pavilion East
5:30–6 p.m.	DH	Gender	Pavilion West
6:15–7 p.m.		1st Screening of "Celebrating 50 Years of the Laser" video	Galleria I
6:15–7:15 p.m.		Young Physicists' Meet and Greet	Salon Ballroom II
7:30–9 p.m.	PST1	Poster Session I **(SNACKS)**	Exhibit Hall
9–10:30 p.m.		Physics in High School Committee	Forum Suite
9–10:30 p.m.		Minorities in Physics Committee	Council Suite
9–10:30 p.m.		International Education Committee	Directors Suite
9–10:30 p.m.		Professional Concerns Committee	Studio Suite
9–10:30 p.m.		Space Science and Astronomy Committee	Senate Suite
9–10:30 p.m.		PIRA Business Meeting	Executive Suite

TUESDAY, July 20

7–8 a.m.		Retirees' Breakfast (ticket required)	Alexander's
7–8:20 a.m.		Educational Technologies Committee	Forum Suite
7–8:20 a.m.		Graduate Education in Physics Committee	Council Suite
7–8:20 a.m.		Science Education for the Public Committee	Directors Suite
7–8:20 a.m.		PTRA Advisory Committee	Studio Suite
7–8:20 a.m.		Review Board	Senate Suite
7 a.m.–4:30 p.m.		**REGISTRATION**	**Plaza Foyer**
8 a.m.–2 p.m.		Physics Photo Contest Viewing and Voting	Plaza Foyer
8 a.m.–5 p.m.		TYC Resource Room	Grand Parlor A
8 a.m.–5 p.m.		PIRA Resource Room	Grand Parlor B/C
8:20–10 a.m.	EA	Teaching with Technology II	Galleria II
8:20–10 a.m.	EB	Once a TIR Always a TIR	Galleria III
8:20–10:10 a.m.	CW05	Quality Educational Demonstrations Commercial Workshop	Salon Ballroom I
8:20–10:10 a.m.	GB	Biomedical Labs for Introductory Physics	Pavilion West
8:20–10:20 a.m.	EC	Action Research in the High School Classroom	Broadway I/II
8:20–10:20 a.m.	ED	Panel: An Interactive Guide to the Paradigms in Physics Programs	Broadway III/IV
8:20–10:20 a.m.	EE	Panel: Importance of Mentoring and Professional Development to Increase Diversity	Grand Ballroom II
8:20–10:20 a.m.	EF	Panel: What Is the Next Big Thing? Social Networking and Beyond	Pavilion East
8:20–10:20 a.m.	EG	Panel: Problem Solving: A Lever for Conceptual Change	Galleria I
8:50–10:20 a.m.	CW03	Kinetic Books Commercial Workshop	Salon Ballroom II
9–10 a.m.		Exhibitors' Breakfast	Alexander's
10 a.m.–4 p.m.		**Exhibit Hall Open (Coffee and pastries, 10 a.m.)**	Exhibit Hall
10:30 a.m.–12:15 p.m.	**Plenary**	**Millikan Medal, AAPT Teaching Awards**	Grand Ballroom I
12:15–1:15 p.m.	CW06	WebAssign Commercial Workshop	Salon Ballroom II
12:15–1:15 p.m.	CKB03	ALPhA Session: Crackerbarrel for Advanced Laboratory Personnel	Galleria I
12:15–1:15 p.m.	CKB04	Crackerbarrel on Professional Concerns for High School Teachers	Galleria II
12:15–1:15 p.m.	CKB05	Crackerbarrel for PER Graduate Students	Galleria III
12:15–1:15 p.m.		Audit Committee	Forum Suite
12:15–1:15 p.m.		Investment Advisory Committee	Directors Suite
12:15–1:15 p.m.		Past Officers' Luncheon (preregistration required)	Alexander's
1–3 p.m.	CW07	Vernier Commercial Workshop	Salon Ballroom III
1:20–1:40 p.m.	FA	Keeping it Real: How Do We Engage in Authentic Assessment in the Classroom	Galleria I
1:20–2:20 p.m.	FE	Interactive Lecture Demonstrations: Physics Suite Materials	Broadway III/IV
1:20–2:30 p.m.	FD	PER: Topical Understanding and Attitudes	Broadway I/II

1:20–2:30 p.m.	FF	Interdisciplinary Success Stories: Team Teaching	Grand Ballroom II
1:20–2:30 p.m.	FC	Labs/Apparatus	Galleria III
1:20–2:30 p.m.	FG	Lecture/Classroom II	Pavilion East
1:20–2:50 p.m.	FH	Research on Teaching Assistants and Learning Assistants	Pavilion West
1:20–2:50 p.m.		Writing About Science in Children's Books, Magazines, Newspapers, Popular Prose?	Council Suite
2–2:50 p.m.	FI	Simulated Learning: Using Simulations to Teach Physics	Salon Ballroom II
3–4:40 p.m.	GA	Teacher Training/Enhancement	Galleria I
3–4:40 p.m.	GD	Urban/Rural Settings for High School Physics	Broadway I/II
3–4:50 p.m.	GC	PER: Problem Solving,Topical Understanding, and Attitudes	Galleria III
3–5 p.m.	GE	Reforming the Introductory Physics Courses for Life Science Majors III	Pavilion East
3–5 p.m.	GF	Interactive Learning with Electronic Response Systems	Grand Ballroom II
3–5 p.m.	GG	Panel: Interactive Methods for Teaching Mechanics	Broadway III/IV
3–5 p.m.	GH	The History of Two-Year College Physics	Pavilion West
3–5 p.m.	IC	Dealing with Mathematical Difficulties in Lower and Upper Division Physics Courses	Salon Ballroom II
5–6 p.m.		Great Book Giveaway	Registration Area
5–6:30 p.m.		Apparatus Committee	Directors Suite
5–6:30 p.m.		History and Philosophy Committee	Galleria 1
5–6:30 p.m.		Physics in Pre High School Committee	Council Suite
5–6:30 p.m.		Research in Physics Education Committee	Studio Suite
5–6:30 p.m.		Physics in Two Year College Committee	Senate Suite
6:30–8 p.m.		Summer Picnic	Performing Arts Center
8–9:10 p.m.		Gala Demo Show sponsored by Vernier	Performing Arts Center
9:20–10:50 p.m.		2nd screening of "Celebrating 50 Years of the Laser" video	Galleria I
9:20–10:50 p.m.	PST2	Poster Session 2 **(SNACKS)**	Exhibit Hall

WEDNESDAY, July 21

7–8:20 a.m.		Nominating Committee II	Forum Suite
7–8:20 a.m.		Programs Committee II	Council Suite
8 a.m.–3 p.m.		**REGISTRATION**	Plaza Foyer
8 a.m.–3:45 p.m.		TYC Resource Room	Grand Parlor A
8 a.m.–3:45 p.m.		PIRA Resource Room	Grand Parlor B/C
8:30–9:35 a.m.	**Plenary**	**Klopsteg Award, Distinguished Service Citations, AIP writing award**	Grand Ballroom I
9:40–10:30 a.m.	HB	Physics Education Research Around the World II	Galleria II
9:40–10:40 a.m.	HG	Education in a Planetarium	Broadway I/II
9:40–10:50 a.m.	HA	Online Workshops and Labs for HS Physics Programs	Galleria III
9:40–11 a.m.	HF	Student Understanding of Energy	Pavilion West
9:40–11:10 a.m.	HC	Innovative Microcomputer-based Laboratory Activities Utilizing Sensors or Hardware	Broadway III/IV
9:40–11:10 a.m.	HE	Upper-Level Undergraduate Physics	Pavilion East
9:40–11:10 a.m.	IH	Post-Deadline Session I	Galleria I
11:15 a.m.–12:30 p.m.	**Plenary**	**PTRA at its 25th Anniversary**	Grand Ballroom I
12:30–1:40 p.m.	CKB06	Crackerbarrel: Using History to Teach Physics	Galleria I
12:30–1:40 p.m.	CKB07	Web Resources for Teaching Astronomy	Galleria II
12:30–1:40 p.m.		Barbara Lotze Scholarship Committee	Executive Suite
12:30–1:40 p.m.		Committee on Governance (COGS)	Senate Suite
12:30–1:40 p.m.		PERLOC Committee	Council Suite
12:35–1:15 p.m.		3rd screening of "Celebrating 50 Years of the Laser" video	Galleria III
1:45–2:25 p.m.	IA	Teacher Preparation Around the World	Galleria II
1:45–2:35 p.m.	IB	Astronomy Teaching Innovations and Student Projects	Galleria III
1:45–2:35 p.m.	IJ	Post-Deadline Session III	Galleria I
1:45–3:45 p.m.	ID	PER: Problem Solving	Broadway III/IV
1:45–3:45 p.m.	IE	High-Performance Computing	Grand Ballroom II
1:45–3:45 p.m.	IF	Panel: Out of One, Many: Researchers Analyze the Same Student Video	Pavilion East
1:45–3:45 p.m.	IG	Science and Religion	Pavilion West
1:45–3:45 p.m.	II	Post-Deadline Session II	Broadway I/II
4–5:30 p.m.	JA	PERC Bridging Session	Pavilion East
4–7 p.m.		Portland Walking Tour	Offsite
4–8 p.m.		Executive Board	Forum Suite
6–8 p.m.		PERC Banquet	Grand Ballroom II
8–10 p.m.		PERC Poster Session	Pavilion West

Monday, July 19, 2010 – Session Schedule

Rooms are in the Portland Hilton Hotel – Poster Session I is in Exhibit Hall, 7:30 to 9:00 p.m.

	Galleria I	Galleria II	Galleria III	Broadway I/II	Broadway III/IV	Grand Ballroom II	Pavilion East	Pavilion West	Salon Ballroom I	Council Suite	Grand Ballroom I
8:20 a.m.	**AA** Upper Division Laboratories: Ideas, Equipment, and Techniques	**AB** Physics, Techno-logical Innova-tion & Careers in Pacific NW I	**AC** Using Literature and History to Teach High School Physics	**AD** PER: Student Reasoning	**AE** *Panel:* Bridging the Gap I	**AF** Multiple Models for Mentoring I	**AG** *Panel:* Online Science Education Resources	**AH** *Panel:* Promoting Diversity in Physics Education			
9:00 a.m.											
9:30 a.m.											
10:00 a.m.											
10:10 a.m.											
10:20 a.m.											*Plenary:* APS/DLS Symposium on Laser Physics
11:00 a.m.											
11:30 p.m.											
12:00 p.m.				**CKB01** *Crack-erbarrel for PER Solo Faculty*	**CKB02** *Crack-erbarrel on TYC Guidelines*						
12:30 p.m.											
1:00 p.m.											
1:10 p.m.	**BA** Biomedical Labs for Advanced Physics	**BB** PER: Investigat-ing Classroom Strategies	**BC** *Panel:* Multiple Models for Mentoring II	**BD** Physics, Techno-logical Innova-tion & Careers in the Pacific Northwest II	**BE** Best Practices for Teaching with Technology	**BF** Electric Circuits: From Batter-ies and Bulbs to Electronic Devices	**BG** State and Na-tional Initiatives and Effects on H.S. Physics	**BH** *Panel:* When Scientists Should Step In. Media, Politics, and Science		**HD** Teacher Educa-tion in Physics: Case Studies	
1:30 p.m.											
2:20 p.m.											
3:10 p.m.											*Plenary:* Lasers and the Eye (3:20-4:20 p.m.)
4:00 p.m.											
4:30 p.m.	**DA** Physics and Society	**DB** High School/ Middle School	**DC** Physics Educa-tion Research Around the World I	**DD** Teaching with Technology I	**DE** Lecture/ Classroom I	**DF** Teaching Physics Around the World	**DG** The Art and Science of Teaching		**CA** PIRA Session: The Wonderful World of PIRA	**FB** Video Analysis	
4:50 p.m.											
5:20 p.m.								**DH** Gender			
5:40 p.m.											
6:00 p.m.											

Tuesday, July 20, 2010 – Session Schedule

Rooms are in the Portland Hilton Hotel – Poster Session II is in Exhibit Hall, 9:20–10:50 p.m.

	Galleria I	Galleria II	Galleria III	Broadway I/II	Broadway III/IV	Grand Ballroom II	Pavilion East	Pavilion West	Salon Ballroom II	Grand Ballroom I
8:20 a.m.	**EG** *Panel:* Problem Solving: A Lever for Conceptual Change	**EA** Teaching with Technology II	**EB** Once a TIR Always a TIR	**EC** Action Research in the High School Classroom	**ED** *Panel:* An Interactive Guide to the Paradigms in Physics Programs	**EE** *Panel:* Importance of Mentoring and Professional Development to Increase Diversity in Graduate Education	**EF** *Panel:* What Is the Next Big Thing? Social Networking and Beyond	**GB** Biomedical Labs for Introductory Physics		
9:00 a.m.										
9:30 a.m.										
10:00 a.m.										
10:10 a.m.										
10:20 a.m.										*Awards:* Millikan Medal and AAPT teaching awards
11:00 a.m.										
11:30 p.m.										
12:15 p.m.	**CKB03** *Crackerbarrel for Advanced Lab. Personnel*	**CKB04** *Crackerbarrel on Prof. Concerns for H.S.Teachers*	**CKB05** *Crackerbarrel for PER Graduate Students*							
12:30 p.m.										
1:15 p.m.										
1:20 p.m.	**FA** Keeping it Real: Authentic Assessment in Physics		**FC** Labs/Apparatus	**FD** PER: Topical Understanding and Attitudes	**FE** Interactive Lecture Demonstrations	**FF** Interdisciplinary Success Stories: Team Teaching	**FG** Lecture/ Classroom II	**FH** Research on Teaching Assistants and Learning Assistants		
1:30 p.m.									**FI** Simulated Learning	
2:10 p.m.										
2:50 p.m.										
3:00 p.m.	**GA** Teacher Training/ Enhancement		**GC** PER: Problem Solving, Topical Understanding and Attitudes	**GD** Urban/Rural Settings for H.S. Physics	**GG** *Panel:* Interactive Methods for Teaching Mechanics: Tutorials, Computation, and Experimentation	**GF** Interactive Learning with Electronic Response Systems	**GE** Reforming the Introductory Physics Courses for Life Science Majors III	**GH** The History of Two-Year College Physics	**IC** Dealing with Mathematical Difficulties in Lower- and Upper-Division Physics Courses	
3:30 p.m.										
4:00 p.m.										
4:40 p.m.										
4:50 p.m.										
5:00 p.m.										
5:20 p.m.										
6:20 p.m.										

Wednesday, July 21, 2010 – Session Schedule

Rooms are in the Portland Hilton Hotel

	Galleria I	Galleria II	Galleria III	Broadway I/II	Broadway III/IV	Grand Ballroom II	Pavilion East	Pavilion West	Grand Ballroom I
8:30 a.m.									*Plenary:* Klopsteg Award & DSCs
9:00 a.m.									
9:15 a.m.									
9:35 a.m.									
9:40 a.m.	**IH** Post Deadline Session I	**HB** Physics Education Research Around the World II	**HA** Online Workshops and Labs for H.S. Physics Programs	**HG** Education in a Planetarium	**HC** Innovative Microcomputer-based Laboratory Activities Utilizing Sensors or Hardware		**HE** Upper-Level Undergraduate Physics	**HF** Student Understanding of Energy	
9:45 a.m.									
10:00 a.m.									
11:00 a.m.									
11:15 a.m.									*Plenary:* PTRA 25th Anniversary
11:30 a.m.									
12:30 p.m.	**CKB06** *Crackerbarrel: Using History to Teach Physics*	**CKB07** *Web Resources for Teaching Astronomy*							
1:00 p.m.									
1:40 p.m.									
1:45 p.m.	**IJ** Post Deadline Session IIII	**IA** Teacher Preparation Around the World	**IB** Astronomy Teaching	**II** Post Deadline Session II	**ID** PER: Problem Solving	**IE** High-Performance Computing	**IF** *Panel*: Out of One, Many: Researchers from Five Perspectives Analyze the Same Student Video	**IG** Science and Religion	
2:00 p.m.									
2:35 p.m.									
3:00 p.m.									
3:45 p.m.									
4:00 p.m.						**JA** PERC Bridging Session			
4:30 p.m.									
5:30 p.m.									

Workshops – Saturday, July 17

(All workshops held at Portland State University, except W01, at Reed College, and W05, at Vernier Software and Technology.)

T01: Teaching About Lasers and Their Uses: Lab and Demonstration

Sponsor: Committee on Laboratories
Cosponsor: Committee on Physics in High Schools
Time: 1–3 p.m. Saturday
Member Price: $35 **Non-Member Price**: $65
Location: Neuberger Hall 341

Richard W. Peterson, Dept. of Physics, Bethel University. St. Paul, MN 55112; petric@bethel.edu

Chad Hoyt

LaserFest 2010 commemorates the 50th anniversary of the construction of the first laser, and it encourages functions that make lasers and their applications visible to all. This tutorial will utilize demonstrations (with the assistance of written and video documentation) to review classroom demonstrations and lab exercises that help us teach about lasers. Examples will be chosen from both introductory and advanced classes. Workshop will be held at Portland State and is supported in part by a grant to Bethel University from SPIE LaserFest.

W01: LabVIEW Instruction for the Advanced Laboratory (ALPhA Laboratory Immersion Program)

Sponsor: Committee on Laboratories
Time: 8 a.m.–5 p.m. Saturday
Member Price: $100 **Non-Member Price:** $125
Location: Reed College

John Essick, Physics Dept., Reed College, 3203 SE Woodstock Blvd., Portland, OR 972025; jessick@reed.edu

This day-long workshop will be held on the Reed College campus in the Physics Department's Advanced Laboratory and will be of interest to professors seeking to include LabVIEW-based instruction in their instructional lab curricula. In advance of the workshop, each participant will be supplied with the book *Hands-On Introduction to LabVIEW for Scientists and Engineers* (Oxford University Press) and be asked to self-study selected chapters to learn the LabVIEW programming language (free trial versions of LabVIEW software can be downloaded from the National Instruments website). Then, during the workshop, participants will use their acquired programming skills on Reed's LabVIEW systems (Windows machines equipped with National Instruments Multifunction Data Acquisition and GPIB boards) to build several computer-based instruments (including a digital oscilloscope, spectrum analyzer, and digital thermometer) and to explore GPIB control of instrumentation. Reed College is located in Southeast Portland and is easily accessible from downtown hotels by public transportation.

W02: Learning Physics While Practicing Science

Sponsor: Committee on Physics in Undergraduate Education
Co-sponsor: Committee on Teacher Preparation
Time: 9 a.m.–5 p.m. Saturday
Member Price: $75 **Non-Member Price:** $100
Location: Cramer Hall 201

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

Alan Van Heuvelen, David Brookes

Participants will learn how to modify introductory physics courses to help students acquire a good conceptual foundation, apply this knowledge effectively in problem solving, and develop the science process abilities needed for real life work. We provide tested curriculum materials including: *The Physics Active Learning Guide* with 30 or more activities per textbook chapter for use with any textbook in lectures, recitations, and homework; (b) a CD 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. Please bring your own laptop to the workshop. Make sure it has QuickTime installed. If you do not own a computer you will be paired with somebody who does.

W03: Piaget Beyond "Piaget"

Sponsor: Committee on Teacher Preparation
Co-sponsor: Committee on Physics in Pre-High School Education
Time: 8 a.m.–5 p.m. Saturday
Member Price: $105 **Non-Member Price:** $130
Location: Cramer Hall 203

Dewey I. Dykstra, Physics Dept., MS 1570, Boise State University, Boise, ID 83725-1570; ddykstra@boisestate.edu

While early work of the Swiss Genetic Epistemologist, Jean Piaget, and co-workers in Geneva on developmental stages of reasoning was being shared in the 1970s in physics education, Piaget and his co-workers were advancing understanding of the origins and development of human understanding of the world. They explain how, why, and under what circumstances human understanding changes. Piaget's evidence collection methods became the origins of physics education research (PER) in student conceptions. The PbP workshop will explore the implications of Piaget's theory of cognitive equilibration for student learning and new teaching practices in physics applicable to all levels. This workshop is a companion to the original AAPT workshop, Physics Teaching and the Development of Reasoning (PTDR). Participants will receive the PbP manual, a book including the PTDR and boxed lunch as part of the fee.

W04: Research-based Alternatives to Traditional Problems in Introductory Physics

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on Physics in Two-Year Colleges
Time: 8 a.m.–5 p.m. Saturday
Member Price: $60 **Non-Member Price:** $85
Location: Neuberger Hall 385

Kathleen A. Harper, Dept. of Physics & Astronomy, Denison University, Granville, OH 43023; HarperK@denison.edu

David P. Maloney, Thomas M. Foster

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

W05: Research-based Curricula and Computer Supported Tools to Revitalize Your Introductory Course

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on Educational Technologies
Time: 9 a.m.– 4:15 p.m. Saturday
Member Price: $50 **Non-Member Price:** $85
Location: Vernier Software and Technology*

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

Priscilla Laws, Dickinson College; Ronald Thornton, Tufts University

This hands-on workshop is designed for those who want to introduce active learning and computer tools into their introductory courses. We will introduce new approaches to teaching based on physics education research (PER) in lectures, labs, and recitations as well as studio and workshop environments. Among the approaches presented will be Interactive Lecture Demonstrations (ILDs), Web-Based ILDs, RealTime Physics Labs, Activity Based Tutorials, Collaborative Problem-Solving Tutorials, Live Photo Assignments and Workshop Physics, as well as analytic modeling and video analysis tools. The computer tools used are available for both Macintosh and Windows computers. Results of studies on the effectiveness of these teaching strategies will also be presented. Current versions of the curricula, along with the book *Teaching Physics with the Physics Suite* by E.F. Redish will be distributed. Partially supported by the National Science Foundation.

*This off-site workshop will be held at Vernier Software and Technology, 13979 SW Millikan Way, Beaverton, OR 97005-2886. You will need to take the TriMet light rail (MAX) Blue line westbound (toward Hillsboro) from SW 5th and Morrison (3 blocks from the Hilton) to the Millikan Way Max stop (in the corner of the Vernier parking lot). The ride is 25 minutes, accessible and costs $2.30.

W06: Applied Critical Thinking: Science, Religion, and Asking Cogent Questions

Sponsor: Committee on Science Education for the Public
Co-sponsor: Committee on Professional Concerns
Time: 8 a.m.–12 p.m. Saturday
Member Price: $47 **Non-Member Price:** $72
Location: Neuberger Hall 241

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

Matthew B. Koss, College of the Holy Cross, Worcester MA

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 together in a number of 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.

W08: Critical Thinking in Astronomy

Sponsor: Committee on Space Science and Astronomy
Time: 8 a.m.–12 p.m. Saturday
Member Price: $35 **Non-Member Price:** $60
Location: Cramer Hall 159

Joe Heafner, 3990 Herman Sipe Road NW, Conover, NC 28613-8907; 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.

W09: Leadership Roles and Models in the Classroom, Academia, and Beyond

Sponsor: Committee on Graduate Education in Physics
Time: 8 a.m.–12 p.m. Saturday
Member Price: $40 **Non-Member Price:** $65
Location: Neuberger Hall 238

Juan R. Burciaga, Dept. of Physics and Astronomy, Denison University, Granville, OH 43023; burciagaj@denison.edu

As we adopt a more peer-oriented environment for our courses, faculty begin losing their traditional role as leaders in the classroom. In addition, more and more we are asked to participate in bringing about change in our classes and beyond—changes in pedagogy, changes in diversity and inclusion, and even to initiate/participate in research or teaching groups. How do we share the authority of learning in our classes without ceding the final responsibility for that learning? What models of leadership and participation exist that can help us adapt to the changing demands? And how do we model these roles so that students can effectively develop these leadership skills as well? Using discussions, readings, and case studies, we will explore these questions as we attempt to characterize effective leadership and our most appropriate response to the challenges and opportunities of leadership demands from our professional lives.

W10: PIRA Lecture Demonstrations 1 – Condensed

Sponsor: Committee on Apparatus
Time: 8 a.m.–12 p.m. Saturday
Member Price: $70 **Non-Member Price**: $95
Location: Science Building 1 – 107

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, Syracuse University

During this workshop, we will introduce you to the Physics Instructional Resource Association (PIRA) and the PIRA 200 (the 200 most important demonstrations deemed necessary to enhance an introductory physics course). We will show a subset of approximately 50 demonstrations explaining use, construction, acquisition of materials, and answer any questions in this highly interactive and dynamic environment. Ideas for organizing and building your demonstration collection will be presented. Lecture Demonstrations 1 – Condensed will cover demonstrations in Mechanics, Fluids, Oscillations, and Thermodynamics. It is recommended that both Lecture Demonstrations 1 and 2 – Condensed be taken as this will cover the complete year of demonstrations needed for a typical course.

W11: Using Graphing Calculators in the Classroom

Sponsor: Committee on Physics in High Schools
Time: 8 a.m.–12 p.m. Saturday
Member Price: $40 **Non-Member Price:** $65
Location: Cramer Hall 225

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

In this workshop participants will conduct a few classic kinematic experiments and analyze their data using TI 83/84 graphing calculators. Classroom-ready handouts (using TI key fonts) will be provided to work through entering the data into the calculators, graphing the data, and fitting equations to the data. The workshop will use lower tech data collection (stopwatches, tape timers, metersticks) to avoid the "black box" confusion often presented by computerized motion detectors—however teachers may also use photogates to generate the data that students enter into their calculators. We'll also explore using the "Draw Tangent" feature to calculate the instantaneous velocity of objects from an x/t graph. Calculators will be provided, but teachers are encouraged to bring their own if they have one. This workshop is Modeling friendly.

W12: Constructing Knowledge and Skills in Introductory Laboratories

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on International Physics Education
Time: 1–5 p.m. Saturday
Member Price: $60 **Non-Member Price:** $85
Location: Science Building 2 – 161

Paul van Kampen, Centre for the Advancement of Science Teaching and Learning & School of Physical Sciences, Dublin City University, Glasnevin, Dublin 9, Ireland; Paul.van.Kampen@dcu.ie

We have restructured the first year undergraduate physics labs, which cater to 300 non-physics students. The labs were designed to be an enjoyable experience in which students see science as a process of inquiry and develop scientific skills such as hypothesis testing, control of variables, interpreting and drawing conclusions from their own experimental data, and carrying out quasi-independent investigations. Conceptual difficulties are clarified based on experimental results. The first labs are quite prescriptive and are conducted within a framework of guided inquiry, but the amount of autonomy is increased rapidly as students acquire skills and experience. Online pre-tests along with weekly surveys highlight students' attainment, attitudes, experiences, and conceptual development. Feedback and pre-test/post-test comparison consistently show that the labs have been transformed into an enjoyable environment where deep learning takes place. In this workshop, we will give participants a flavor of the laboratories and the tutor training elements.

W13: Introductory Laboratory Workshop

Sponsor: Committee on Laboratories
Co-sponsor: Committee on Apparatus
Time: 1–5 p.m. Saturday
Member Price: $50 **Non-Member Price:** $75
Location: Science Building 1 – 424

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

Van Bistrow

This workshop is appropriate primarily for college and university instructional laboratory developers. At each of six stations, presenters will demonstrate an approach to an introductory 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.

W14: PIRA Lecture Demonstrations 2 – Condensed

Sponsor: Committee on Apparatus
Time: 1–5 p.m. Saturday
Member Price: $70 **Non-Member Price:** $95
Location: Science Building 1 – 107

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, Syracuse University

During this workshop, we will introduce you to the Physics Instructional Resource Association (PIRA) and the PIRA 200 (the 200 most important demonstrations deemed necessary to enhance an introductory physics course). We will show a subset of approximately 50 demonstrations explaining use, construction, acquisition of materials, and answer any questions in this highly interactive and dynamic environment. Ideas for organizing and building your demonstration collection will be presented. Lecture Demonstrations 2 – Condensed will cover demonstrations in Electricity & Magnetism, Optics, Modern Physics, and Astronomy. It is recommended that both Lecture Demonstrations 1 and 2 – Condensed be taken as this will cover the complete year of demonstrations needed for a typical course.

W15: Photovoltaic Kits

Sponsor: Committee on Science Education for the Public
Co-sponsor: Committee on Laboratories
Time: 1–5 p.m. Saturday
Member Price: $35 **Non-Member Price:** $60
Location: Neuberger Hall 238

Stanley J. Micklavzina, Dept. of Physics, University of Oregon, Eugene OR 97403; stanm@uoregon.edu

Asher Tubman, South Eugene High School

A photovoltaic PV lab kit and curricula are being developed for use in the classroom. This workshop will demonstrate the use of the kit and explore various experiments that can be conducted with the kit. These complete kits are being developed so they can be made available on a sign-out basis to regional high schools for use during their school year. THIS IS NOT A MAKE AND TAKE WORKSHOP. You will be provided an equipment list and curriculum materials to take with you from the workshop.

W16: Promoting Active Inquiry-based Learning with Computers in High Schools

Sponsor: Committee on Physics in High Schools
Time: 1–5 p.m. Saturday
Member Price: $47 **Non-Member Price:** $72
Location: Science Building 2 – 113

Maxine C. Willis, Dept. of Physics and Astronomy, Dickinson College, PO Box 1733, Carlisle, PA 17013; willism@dickinson.edu

Priscilla Laws, Dickinson College, Marty Bamberger, Chestnut Hill Academy

This is a hands-on workshop designed for teachers interested in engaging their students in inquiry-based active learning. Participants will work with classroom-tested kinematics, dynamics and other mechanics units selected from the Activity-Based Physics High School CD (ABP HSCD). These student-centered materials are based on the outcomes of physics education research and are linked to the national standards. The curricular materials combined with the use of computers for data collection and analysis enable students to learn physics by doing. The curricula on the ABP HSCD include: RealTime Physics, Tools for Scientific Thinking, Workshop Physics and Interactive Lecture Demonstrations. The data acquisition equipment and software used in this workshop are compatible with both Mac and Windows computers and the hardware and software systems from both PASCO and Vernier Software and Technology.

W18: What to Do About the First Day of School and Other Special Events

Sponsor: Committee on Physics in High Schools
Time: 1–5 p.m. Saturday
Member Price: $45 **Non-Member Price:** $70
Location: Cramer Hall 225

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

The first day of school can be daunting. But it might be the most important day of the school year. Back-to-School Night may be your only chance to really connect with parents. Open House can be a chore or an opportunity. Over the course of a 24-year career, I've developed solutions to these special events. Some are simple, others are more involved. But they're all effective. And they make the First Day, Back-to-School, and Open House events you'll look forward to. Participants will be provided with a binder of instructional information and a CD of video resources, presentations, and PDFs.

Workshops – Sunday, July 18

T02: Computational Physics Examples to Include in Physics Courses

Sponsor: Committee on Educational Technologies
Time: 1–3 p.m. Sunday
Member Price: $41 **Non-Member Price:** $66
Location: Cramer Hall 101

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

Examples of Computation to Use in Physics Courses Examples will be give, both in the talk and on a DVD, of computational physics problems that may be used to enhance existing physics classes. Although there are applets covering some of the examples, source codes in various languages will be given for all the examples so that students and instructors can extend them and customize them. In all cases, the physics, computational, and mathematical ingredients of the problem will be presented.

W19: What Every Physics Teacher Should Know About Cognitive Science

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on Physics in Pre-High School Education
Time: 8 a.m.–12 p.m. Sunday
Member Price: $35 **Non-Member Price**: $60
Location: Cramer Hall 228

Chandralekha Singh, 3941 Ohara St., Dept. of Physics and Astronomy, 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.

W20: Computer Modeling and 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: $55 **Non-Member Price:** $80
Location: Cramer Hall 159

Wolfgang Christian, Box 6926, Davidson College, Davidson NC 28035-6926704-663-1377; wochristian@davidson.edu

Bruce Mason

Creating good and thorough web resources that allow teachers to easily incorporate computer-based modeling into their curriculum requires the right tools. The ComPADRE National Science Digital Library (NSDL) provides curriculum material and tools that are easy to use, open, extensible, and free to solve this integration problem. This workshop will show participants how to combine curricular material in The Physics Classroom with simulations in the Open Source Physics Collection to improve the understanding of physics concepts and to make difficult topics more accessible to students. Participants will create personal resource collections that integrate these diverse ComPADRE materials for their students. Afternoon technical and non-technical breakout sessions will allow participants to develop their own simulations and learning resources. This workshop will benefit anyone teaching introductory physics. Information can be obtained from http://www.compadre.org/osp and http://www.physicsclassroom.com. Partial funding for this work was obtained through NSF grants DUE-0442581 & DUE-0840768.

W21: Enhancing Your Course with Activities Arising from Physics Educational Research

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on Physics in Undergraduate Education
Time: 8 a.m.–5 p.m. Sunday
Member Price: $65 **Non-Member Price:** $90
Location: Neuberger Hall 237

Calvin S. Kalman, Physics Dept./Concordia University, 7141 Sherbrooke St. West Montreal, Quebec, Canada H4B 1R6; Calvin.Kalman@Concordia.ca

Participants take part in five "miniclasses": 1) Use of Reflective Writing to engage students before class. 2) Critical Thinking – Feyerabend's view. 3) Use of Collaborative Groups to Promote Critical Thinking. 4) Critique: a writing tool to enhance Critical Thinking Skills. 5) The Course dossier: A supplement to or a replacement for a final essay/examination. This is based upon my book *Successful Science and Engineering Teaching in Colleges and Universities*. This workshop utilizes research in the classroom that I have been conducting and publishing for many years using qualitative and quantitative methods. Participation in reflective writing as a self-dialogue between the learner's prior knowledge and new concepts in the text was consistently reported in interviews. Comparison of pre- and post-tests indicate that in doing written critiques, students are not only more likely to undergo conceptual change, but also increase their critical thinking skills and thus are led to reevaluate their entire conceptual framework.

W23: Physics by Design

Sponsor: Committee on Physics in Pre-High School Education
Co-sponsor: Committee on Minorities in Physics
Time: 8 a.m.–5 p.m. Sunday
Member Price: $90 **Non-Member Price:** $115
Location: Science Building 2 – 161

Julia Olsen, Southern Arizona Science and Math Internship Center, The University of Arizona, College of Education, Tucson, AZ 85721; 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.

W24: Teaching Astronomy Effectively with Technology

Sponsor: Committee on Space Science and Astronomy
Time: 8 a.m.–5 p.m. Sunday
Member Price: $55 **Non-Member Price**: $80
Location: Neuberger Hall 341

Kevin M. Lee, 205 Ferguson Hall, University of Nebraska, Lincoln, NE 68588-0111; klee6@unl.edu

Edward E. Prather, University of Arizona

Educational research has clearly defined the characteristics of the optimal introductory astronomy classroom—one where students are actively engaged in the learning process and frequently receiving timely feedback on their learning progress. This CAE/CATS Tier 2 workshop will explore a variety of technologies that enable instructors to engage students and efficiently provide feedback. Instructors will be trained and provided with curriculum materials from multiple NSF grants on computer simulations, computerized databases of Think-Pair-Share questions, and a library of both animated and pencil-paper ranking and sorting tasks. All materials will be disseminated through the web (http://astro.unl.edu) before the workshop and attendees will bring their own laptops with the software already installed.

W25: Teaching Physics for the First Time

Sponsor: Committee on Physics in High Schools
Time: 8 a.m.–5 p.m. Sunday
Member Price: $95 **Non-Member Price:** $120
Location: Science Building 2 – 149

Mary M. Winn, 2623 W. Watrous Ave., Tampa, FL 33629; winnmmw@aol.com

Jan Mader

With the push for physics first, many middle school and high school instructors find themselves assigned to teach physical science and physics classes with little or no formal preparation in the content. Teaching Physics for the First Time is designed to provide a supply of lessons based on the learning cycle that are reliable and cost-effective. The labs, demonstrations, and activities emphasize the hands-on approach to learning physics concepts and include teaching strategies and address misconceptions students often have with respect to the concept. The workshop attendees will receive a copy of the book *Teaching Physics for the First Time.*

W26: Using RTOP to Improve Physics and Physical Science Teaching

Sponsor: Committee on Teacher Preparation
Co-sponsor: Committee on Physics in Pre-High School Education
Time: 8 a.m.–5 p.m. Sunday
Member Price: $60 **Non-Member Price**: $85
Location: Neuberger Hall 307

Kathleen A. Falconer, Elementary Education and Reading, Buffalo State College, Buffalo, NY 142227; falconka@buffalostate.edu

Paul Hickman, Dan MacIsaac

The Reformed Teaching Observation Protocol (RTOP) is a 25-item rubric that provides a percentile measure of the degree and type of student-centered, constructivist, inquiry-based engagement in an instructional situation. RTOP scores correlate very highly with student conceptual gains. In this workshop, we will score video vignettes of teaching to learn how to use RTOP for guiding personal reflection and improvement and change of our own teaching; for mentoring peers, novice teachers and student teachers; and to establish a vocabulary for discussing reformed teaching practices. If you wish, you may bring a DVD of your own teaching to score.

W27: Arduino Microcontrollers in the Physics Lab

Sponsor: Committee on Educational Technologies
Time: 8 a.m.–5 p.m. Sunday
Member Price: $110 **Non-Member Price:** $135
Location: Science Building 1 – 201

Eric Ayars, Physics Dept., California State University, Chico, CA 95929-0202530-898-6967; 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. Participants will gain their own datalogger and the software needed to customize and extend its capabilities, as well as all schematics, sources, software, and a basic skill-set for getting started with using Arduino microcontrollers as lab tools. Participants must bring a laptop. Prior experience in soldering and/or computer programming will be helpful, but is not required.

W28: A New Methodology for Using Clickers in Lecture Classrooms

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on Professional Concerns
Time: 8 a.m.–12 p.m. Sunday
Member Price: $40 **Non-Member Price:** $65
Location: Science Building 2 – 113

Neville W. Reay, Dept. of Physics, The Ohio State University, Columbus, Ohio 43210; reay@mps.ohio-state.edu

Thomas Carter, The College of DuPage; Lin Ding, Ohio State University; Albert Lee, Cal. State University–LA

Workshop participants will experience a new question sequence clicker methodology 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 evaluation 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 be given CDs containing all 167 sequences, relevant published papers and workshop slides.

W29: Biology Inspired Laboratories for the IPLS Course: Bridging the Gap Between the Physical and the Life Sciences

Sponsor: Committee on Physics in Undergraduate Education
Time: 8 a.m.–12 p.m. Sunday
Member Price: $55 **Non-Member Price:** $80
Location: Cramer Hall 103

Mark E. Reeves, Dept. of Physics, George Washington University, Washington, DC 20052; reevesme@gwu.edu

Tim McKay, Suzanne Amador Kane, Catherine Crouch

Recent high-level reports such as BIO2010 and the HHMI/AAMC's Scientific Foundations for Future Scientists have emphasized the need for life science undergraduate majors to be taught a much higher level of quantitative reasoning and further for them to make connections between material taught in biology with that taught in physics, chemistry, and mathematics. An important enabling and motivating factor for this is a laboratory experience that explicitly connects physics concepts and reasoning to important problems in the life sciences. In this ½-day workshop, we will make available, for hands-on use, a number of class-tested laboratories. Participants will acquire and analyze data on their own laptops (either mac or windows OS) and by so doing will take away software, their data, and other materials from the workshop. Participants without laptops will be paired with a partner bringing a laptop.

W30: Designing a Diagnostic Learning Environment: A Workshop for Teacher Educators

Sponsor: Committee on Teacher Preparation
Co-sponsor: Committee on Research in Physics Education
Time: 8 a.m.–12 p.m. Sunday
Member Price: $35 **Non-Member Price:** $60
Location: Neuberger Hall 375

Lane Seeley, Seattle Pacific University, 3307 3rd Ave. W., Ste. 307, Seattle, WA 98119-1957; seelel@spu.edu

Stamatis Vokos, Hunter Close

All students are capable of constructing scientific understanding. To support a Diagnostic Learning Environment, teachers must establish a classroom culture where initial and evolving student ideas are an essential part of instruction. In a Diagnostic Learning Environment, teachers elicit student ideas, use flexible teaching strategies, and perform ongoing assessments of student learning to guide instructional decisions. In this workshop we will study artifacts of student thinking in order to better understand the experiences, ideas, and intellectual resources from which learners can construct a personally owned scientific model. We will discuss how beliefs about learners and learning influence attitudes toward formative assessment. We will use classroom video to study efforts to informally assess student ideas and examine the efficacy of resulting instructional interventions. In addition, participants will learn about the Diagnoser Project's free tools to help diagnose precollege student thinking and inform instruction. Participants are invited to bring their own laptop.

W31: Energy in the 21st Century

Sponsor: Committee on Physics in Two-Year Colleges
Co-sponsor: Committee on Science Education for the Public
Time: 8 a.m.–12 p.m. Sunday
Member Price: $35 **Non-Member Price:** $60
Location: Cramer Hall 203

Pat Keefe, Clatsop Community College, 1653 Jerome Ave., Astoria OR 971034; pkeefe@clatsopcc.edu

Greg Mulder, Richard Flarend

We have found that engaging students in predictions of what form and how much energy will be used in the future is a very successful way to generate enthusiasm and further investigation of physics. We have developed three different projects that involve designing energy systems. One model requires students to do a home energy audit. Using the model allows students to adjust their energy use and compare the results. The other two modeling exercises look at past energy consumption patterns and develop a plan for energy usage in the 21st century. Other considerations such as population, costs and efficiencies are also used to further expand the discussion and decision making that takes place.

W32: LivePhoto Physics: Video-based Analysis Activities for the Classroom/Homework

Sponsor: Committee on Physics in High Schools
Co-sponsor: Committee on Educational Technologies
Time: 8 a.m.–12 p.m. Sunday
Member Price: $45 **Non-Member Price: $**70
Location: Cramer Hall 101

Robert B. Teese, Physics Dept., Rochester Institute of Technology, Rochester, NY14623; rbtsps@rit.edu

Patrick J. Cooney, Priscilla W. Laws, Maxine Willis

This workshop is for physics teachers who wish to explore the use of video-based motion analysis in a wide range of applications including the teaching laboratory, projects, and homework. Participants will learn how to make digital video clips for analysis, as well as how to use video analysis for homework problems and in the classroom. We will discuss educationally effective uses of video analysis being developed in the LivePhoto Physics project, the Workshop Physics project and in other settings. 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.

W33: Mining the Data: Writing Better Tests

Sponsor: Committee on Physics in High Schools
Time: 8 a.m.–12 p.m. Sunday
Member Price: $50 **Non-Member Price:** $75
Location: Neuberger Hall 209

Nathan A. Unterman, Science Dept., Glenbrook North High School, 2300 Shermer Rd, Northbrook, IL 60062-6700; nunterman@glenbrook.k12.il.us

This workshop is designed for teachers at all ranges of experience who want to learn how to improve the quality of their multiple-choice, short-answer, and extended-response questions. Teachers explore ways to create well-constructed assessments based on benchmarks, educational research, content limits, various representations, state and national goals, and local expectations. Mechanics of the test, including bias, use of names, page layout and design, use of illustrations, placement of answers, etc., are reviewed in the context of best practice. Teachers will learn techniques of item analysis and how to integrate these results into curricular revisions and evaluating student understanding. Basic educational research techniques with references for more advanced study will be discussed. Bring samples of existing questions, any resources, and texts that may help you revise or create items for tests, and a number 2 pencil.

W34: NTIPERS: Research-based Reasoning Tasks for Introductory Mechanics

Sponsor: Committee on Physics in Two-Year Colleges
Co-sponsor: Committee on Research in Physics Education
Time: 8 a.m.–12 p.m. Sunday
Member Price: $35 **Non-Member Price:** $60
Location: Cramer Hall 201

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

Curtis Hieggelke, Joliet Junior College; Steve Kanim, New Mexico State Univ

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.

W35: Playing the Game of Science

Sponsor: Committee on History and Philosophy in Physics
Time: 1–5 p.m. Sunday
Member Price: $35 **Non-Member Price:** $60
Location: Neuberger Hall 241

David P. Maloney, Physics Dept., Indiana Univ. Purdue Univ.–Fort Wayne, 2101 Coliseum Blvd. East, Fort Wayne, IN 46805; maloney@ipfw.edu

Mark Masters

One dilemma that is experienced in science classes is helping students understand how science works, what makes an activity scientific, and the characteristics of scientific reasoning. In an activity inspired by a quote from *The Feynman Lectures on Physics*, participants will use a strategy-game based analog of scientific reasoning to examine aspects of the nature of science. Participants will be given the playing pieces, the game board, and the histories of two players' moves while playing the game several times. Through the activity, and by using a variety of games, students can experience important scientific processes. The workshop will explore three different games that feature different aspects of scientific reasoning. We will also discuss the strengths and weaknesses of the activity as well as ideas for additional variations.

W36: Road Show Lecture Demonstrations

Sponsor: Committee on Apparatus
Time: 8 a.m.–12 p.m. Sunday
Member Price: $35 **Non-Member Price**: $60
Location: Science Building 1 – 107

David E. Sturm, 5709 Bennett, Orono ME 04469; sturmde@maine.edu

How do you organize apparatus for Physics on the Road? Structured like the PIRA Lecture Demonstration workshops, we invite folks who do, have done, and/or want to do physics outreach to join us for a workshop that focuses on top demonstrations for the road. We'll look at a top 50 list. For each, we'll cover design and construction, and using existing demonstrations found in most departments. Workshop leaders will discuss organizing using the PIRA Demonstration Classification Scheme. And of course, we'll network, share, and develop plenty of new ideas for cool road show gear.

W37: Web Tech Tools for Teachers

Sponsor: Committee on Physics in High Schools
Co-sponsor: Committee on Educational Technologies
Time: 8 a.m.–12 p.m. Sunday
Member Price: $45 **Non-Member Price:** $70
Location: Cramer Hall 196

Cathy Mariotti Ezrailson, University of South Dakota, 1301 Over Drive, Vermillion, SD 57069; cathy.ezrailson@usd.edu

Technology takes many forms in today's high schools—from smart board, to data acquisition devices to digital libraries with web-based lessons, simulations, and other interactive resources. As we prepare physics teachers, we need to integrate these web-based teaching resources that were not available even a few years ago. 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 will give examples of best teaching practices that incorporate these tools for high school and college instruction. Participants are encouraged to bring their own laptops.

W38: Advanced and Intermediate Laboratory Workshop

Sponsor: Committee on Laboratories
Co-sponsor: Committee on Apparatus
Time: 1–5 p.m. Sunday
Member Price: $130 **Non-Member Price:** $155
Location: Science Building 1 – 424

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.

W39: Falsification Labs Workshop

Sponsor: Committee on Laboratories
Co-sponsor: Committee on Apparatus
Time: 1–5 p.m. Sunday
Member Price: $38 **Non-Member Price:** $63
Location: Science Building 2 – 113

John Welch, Cabrillo Community College, 6500 Soquel Dr., Aptos, CA 95003; jowelch@cabrillo.edu

Verification labs are a staple in many physics courses, but what about falsification? It is important for students to be able to recognize and test wrong ideas as well as right ones. In this workshop, we will present a number of laboratory exercises based on plausible-but-wrong theories which can be tested in a typical lab period. All of the exercises can be performed with minimal equipment, and are appropriate for high-school or introductory college physics labs. Participants will have an opportunity to try the experiments, experience some of the pitfalls involved, and develop similar experiments of their own.

W40: Modeling Applied to Problem Solving: An Adoptable Pedagogy

Sponsor: Committee on Physics in Undergraduate Education
Co-sponsor: Committee on Research in Physics Education
Time: 1–5 p.m. Sunday
Member Price: $35 **Non-Member Price:** $60
Location: Cramer Hall 201

David E. Pritchard, Room 26-241, MIT, 77 Massachusetts Ave., Cambridge, MA 02139; dpritch@mit.edu

Analia Barrantes, Andrew Pawl, Saif Rayyan

This workshop will introduce participants to our modeling-based approach to problem solving, a pedagogy that enables students to attain significant expert-like improvement of their problem solving skills as well fostering dramatically more expert-like attitudes toward science, particularly in Problem-Solving Sophistication. Workshop participants will be introduced to MAPS and its central "System, Interactions, Model" procedure, then will sample and discuss the various instructional materials for in-class. These include: the Model Hierarchy, multi-concept problems, an expert inventory, classification tasks, Mastering Physics problems, and the open source WIKItextBOOK under development (bring your laptop for this). This new pedagogical approach is designed to be integrated into existing courses without dramatic changes to the syllabi, and the workshop goal is to enable participants to introduce it into their courses.

W41: Open Source Tutorials

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on Physics in Undergraduate Education
Time: 1–5 p.m. Sunday
Member Price: $42 **Non-Member Price:** $67
Location: Cramer Hall 103

Rachel E. Scherr, Seattle Pacific Univ., Seattle, WA 98119-1997; rescherr@gmail.com

Renee Michelle Goertzen

Instructors inevitably need to adapt even the best reform materials to suit their local circumstances. We offer a package of research-based, open-source, epistemologically focused tutorials, along with the detailed information instructors need to make effective modifications and provide professional development to teaching assistants. In particular, our tutorials are embedded with comments from the developers, advice from experienced instructors, and video clips of students working on the materials. Participants will take home a DVD that includes tutorials, homework, instructor's guides, pre-tests, exam questions, solutions, captioned video episodes, and video workshops that integrate tutorials with video episodes. Bring a laptop if it's convenient.

W42: PhET Simulations – Fun Tools to Help Your Students Learn Physics

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on Educational Technologies
Time: 1–5 p.m. Sunday
Member Price: $80 **Non-Member Price:** $105
Location: Neuberger Hall 222

Katherin K. Perkins, K.K. Perkins, University of Colorado, UCB 390, Boulder, CO 80309; Katherine.Perkins@colorado.edu

Simulations are fun and powerful learning tools that can be used in many ways in the classroom. We have found that students engage with simulations in a scientist-like way, asking their own questions and exploring at their own pace. This half-day workshop will include a brief presentation about the free interactive simulations from the PhET Project including the research behind their development and a classroom study or two. The bulk of the workshop allows participants to explore the simulations and consider ways to use them in their classroom including lecture demonstrations, in-class activities, homework, and/or labs. Later in the day participants will pair with a fellow teacher who has similar classroom goals so that the remainder of the time can be spent planning and creating activities around sims for your classroom.

W43: Physics and Performance

Sponsor: Committee on Apparatus
Co-sponsor: Committee on Science Education for the Public
Time: 1–5 p.m. Sunday
Member Price: $35 **Non-Member Price:** $60
Location: Cramer Hall 203

Stanley J. Micklavzina, Dept. of Physics, University of Oregon, Eugene, OR 97403541-346-4801; stanm@uoregon.edu

In this half-day workshop we will work on developing creative methods and ideas on how to present science principles and demonstrations on the stage. Bring your favorite demonstration or presentation (or we can provide one) and we will create a new way to present this to the public. The idea is to establish the performance aspect of public road shows. We will be joined by Performing Arts Prof John Schmor from the University of Oregon, who will offer instruction and feedback on how to incorporate performance and entertaining presentation methods into the science being displayed.

W44: Physics and Toys II: Energy, Momentum, Electricity and Magnetism

Sponsor: Committee on Physics in Pre-High School Education
Co-sponsor: Committee on Science Education for the Public
Time: 1–5 p.m. Sunday
Member Price: $45 **Non-Member Price:** $70
Location: Neuberger Hall 209

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

Raymond Turner

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

W45: Strategies to Help Women Succeed in Physics-Related Professions

Sponsor: Committee on Women in Physics
Time: 1–5 p.m. Sunday
Member Price: $35 **Non-Member Price:** $60
Location: Cramer Hall 225

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

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

Sunday, July 18

Section Officers Exchange	5:30–6:30 p.m.	Pavilion West
High School Share-a-thon	6–8 p.m.	Broadway I/II
Exhibit Hall Opens/ Reception	8–10 p.m.	Exhibit Hall

Session SUN: SPS Undergraduate Research and Outreach (Posters)

Location: Galleria III
Sponsor: Undergraduate Education Committee
Date: Sunday, July 18
Time: 6–8 p.m.

Presider: Gary White

SUN01: 6–8 p.m. Can Spatial Skills Training Improve Students' Understanding of Introductory Physics?

Poster – David I. Miller, Harvey Mudd College, Claremont, CA 91711; dmiller@hmc.edu

Diane F. Halpern, Peter N. Saeta

To understand physics concepts such as rotational inertia or Gauss's law, students must apply 3-D spatial visualization skills. We investigate the hypothesis that formal spatial skills training can improve these spatial skills and can also improve grades in undergraduate technical classes. Participants (28 female, 48 male, 1 unidentified) are first-year Harvey Mudd students (the middle 50 percent for this sample's SAT Math scores is 740-800) and are randomly assigned to two groups: a treatment group that completes six two-hour spatial training sessions, and a control group that does not receive treatment. Dependent measures of the training's efficacy include pre- and post-test measures of spatial skills, pre- and post-tests of the Force Concept Inventory, and grades in a broad variety of different technical classes including introductory mechanics. This presentation will highlight how physics educators can practically apply spatial training in their own teaching.

SUN02: 6–8 p.m. Simulation of Hyperthermia in Cancer Treatment Using Magnetic Nanoparticles

Poster – Guofen Yu, The University of Findlay, Findlay, OH 45840 ;yu@findlay.edu

Jennifer Smith

Treatment of cancer using the concept of hyperthermia is a promising, but still under development, technique. The premise of hyperthermic treatment is that cancer cells die at temperatures around 43°C while healthy cells survive at these temperatures. Magnetic nanoparticles injected locally into a tumor can absorb energy from an externally applied alternating magnetic field to heat and kill cancer cells. This project simulates the temperature variation around a tumor in a typical human liver after injection of magnetic particles and applying an alternating magnetic field for some time. The relationships between temperature change and particle properties as well as magnetic fields will be discussed.

SUN03: 6–8 p.m. Economical Magnetic Field Sensors for Introductory Physics

Poster – Timothy Lim, Colorado School of Mines, Golden, CO 80401; tlim@mines.edu*

Eric Weisgerber, Vince Kuo, Pat Kohl

Magnetic fields and interactions are important concepts for students in introductory physics, yet they are often extremely difficult to grasp. We believe that making physical measurements of magnetic fields produced by rare-earth magnets and various configurations of current will help make the abstract concepts more tangible. This poster presents the design of a magnetic field sensor with variable measurement ranges and electronics that are compatible with existing laboratory equipment. The sensor is robust, modular, portable, programmable, and expandable. The low cost of this sensor makes it feasible to outfit any large-enrollment introductory physics course. This senior design project is in satisfaction of Engineering Physics graduation requirement at Colorado School of Mines.

* Sponsored by Vince Kuo and Pat Kohl

SUN04: 6–8 p.m. Direct and Indirect Approaches to Increasing Conceptual Survey Gains

Poster - Charles Pearl, Colorado School of Mines, Golden, CO 80401; skarloey3001@gmail.com

Conceptual surveys such as the FCI and CSEM have become common. It is often the case that course reforms attempt to increase student gains on these surveys. There exist various approaches to improving student scores on these surveys, and while some approaches have been accused of "teaching to the test," such suggestions have generally been well-refuted. To our knowledge, there has been little direct experimentation on whether teaching to the test has the expected result. In this poster, we report the results of a two-semester experiment involving ~900 students in which we tried two different approaches to raise CSEM gains in an introductory E&M class. First, we directly inserted select CSEM questions into the lecture portion of the class as Peer Instruction-style clicker questions (explicitly teaching to the test). In a different semester, we revised Studio Physics activities to use scaffolding to more effectively teach the concepts. We compare the CSEM results from each experimental semester to previous year's results.

SUN05: 6–8 p.m. Dynamics of a Forced One-Degree-of-Freedom Arm with Visco-elastic Muscles Exhibiting Deterministic Chaos

Poster - Anish Chakrabarti, Drury University, Pleasant Hope, MO 65725; achakrabarti@drury.edu

Sayan Patra, Andy Chase, Dalton Sivils, Brian Shipley

In order to improve our understanding of how the brain controls the human arm, we have developed a one-degree-of-freedom robotic arm which is driven by a single pair of servo-actuated visco-elastic muscles. Our robotic arm exhibits planar motion with one degree of freedom about a single joint. The computer-controlled servos mimic the contractive action of the sarcomeres, while sections of elastic tubing represent the elastic behavior of actual muscles. In the present experiment, we have sought to induce chaotic motion by driving the servos in a sinusoidal manner. The system represents a driven physical pendulum, with additional elastic energy components. We have found that the Hamiltonian dynamics of the system are characterized by several non-dimensional parameters, which can be independently varied. We have numerically integrated the Hamiltonian equations of motion for the system, and have thus identified regions of parameter space where chaos is expected.

Monday, July 19			
	AAPT 5K Run/Walk	6:45–8 a.m.	offsite
	First Timers' Gathering	7–8 a.m.	Salon Ballroom II
	Spouses' Gathering	9–10 a.m.	Alexander's
	Exhibit Hall	10 a.m.–6 p.m.	Exhibit Hall
	50 Years of the Laser film	6:15–7 p.m.	Galleria I

Celebrating 50 Years of the Laser

▶ APS/DLS Symposium on Laser Physics

Monday, July 19, 10:30 a.m.–12 p.m. • GRAND BALLROOM I

Presider: Chandralekha Singh

Warren S. Warren

Breasts and Brains, Similarities and Differences: Using Novel Physics to Enhance Clinical Molecular Imaging

Warren S. Warren, Duke University

Molecular imaging—the use of targeted molecular and chemical signatures to visualizing function instead of just structure—is one of the most rapidly growing fields in biomedical science. Applications range from molecular medicine, to early and improved disease diagnosis, to reducing health-care costs. The major techniques in common use (positron emission tomography, CT, magnetic resonance imaging, optical imaging) often have quite complementary strengths and applications. Here I will give an overview of the physical principles behind these methods, then focus on optical imaging—specifically on approaches that exploit optical nonlinearity to enable microscopic resolution without excision. For example, we use shaped femtosecond laser pulses to explore the different types of melanin in a pigmented lesion, using less power than a laser pointer; such pulses can image the bottom of even opaque lesions as well as the top (as that morphology is clinically significant). The theme in most of this work is endogenous contrast, using sophisticated laser technology to reveal previously inaccessible signals, such as two-photon absorption of molecules that do not fluoresce.

Steven T. Cundiff

Femtosecond Optical Frequency Combs

Steven T. Cundiff, NIST and University of Colorado

The ability to detect the carrier-envelope phase evolution of the pulse train emitted by a mode-locked laser has led to the field of femtosecond combs. Femtosecond combs have solved the problem of optical frequency metrology, enabled optical atomic clocks and been essential to the development of attosecond technology. I will give an introduction to the basic concepts of femtosecond combs. I will then discuss their applications, both current and future possibilities.

▶ Lasers and the Eye

Monday, July 19, 3:20–4:20 p.m. • GRAND BALLROOM I

Presider: David Sokoloff

Vasudevan (Vengu) Lakshminarayanan, University of Waterloo

Vengu Lakshminarayanan

We celebrate the 50th anniversary of the laser which now has a huge range of applications, from consumer electronics to optical metrology. One of the very first applications of the laser was in biomedicine—namely photocoagulation process to weld a detached retina back into place in the eye.

In this talk, I will discuss laser applications in ophthalmology and deal with laser-tissue interaction, laser safety and more recent work on photorefractive procedures, such as LASIK which offer the possibility of vision without glasses. This will include studies of optical/wavefront aberrations of the eye and their correction. I will conclude the talk with some recent work from my laboratory on predicting vision from measurement of wavefront aberrations and its use in predicting post-operative vision following photorefractive procedures.

Session AA: Upper Division Laboratories: Ideas, Equipment, and Techniques

Location: Galleria I
Sponsors: Laboratories Committee, Apparatus Committee
Date: Monday, July 19
Time: 8:20–9:50 a.m.

Presider: Eric Ayars, California State Univ.-Chico; ayars@mailaps.org

AA01: 8:20–8:50 a.m. Creating a Sophisticated Single Photon Interference Device for $3K-$5K

Invited – Dean G. Hudek, Brown University, Providence, RI 02912; Dean_Hudek@Brown.edu

Young's double-slit experiment done at the single photon level has long been a favorite of physicists. Historically, though, this experiment required photographic film, very long scan times with a photomultiplier connected to an MCA or, if you wanted to watch the process live, an extremely expensive image intensifier (~$50K) coupled to an expensive video processing computer (~$10K). It has now been over 20 years since high-performance image intensifying devices have been available and today these earlier models can be found at scientific surplus suppliers for under $3K. In addition, over the last 20 years digital cameras and computers have become ubiquitous. In this talk, I will demonstrate our single photon double-slit apparatus and provide instructions for building a comparable device for $3-$5k.

AA02: 8:50–9:20 a.m. What's a Lab for? A Decade of Continuous Laboratory Revision

Invited – Mark F. Masters, IPFW, Fort Wayne, IN 46805; masters@ipfw.edu

In undergraduate physics education, the theoretical physics curriculum is relatively standardized and coherent. In the laboratory it is much less so. What is the purpose of a physics laboratory? What are the goals for student learning through the laboratory? How do we teach experimental physics? I will describe a decade of continuous revision of the IPFW physics laboratories, from the introductory to the Advanced Laboratory in an effort to produce an overall laboratory curriculum. The basic tenets of this curriculum have been to develop the students' experimental skills, their independence, and to help them understand and apply physics to their investigations. The methods adopted to achieve these goals in a variety of venues will be discussed and the success (or failure) of these approaches will be presented with special focus on the Advanced Laboratory.

AA03: 9:20–9:30 a.m. Assessing and Enhancing Student Learning in the Advanced Physics Lab

Jason E. Dowd, Harvard University, 17 Oxford St., Cambridge, MA 02138; jedowd@gmail.com

Julie Schell, Eric Mazur, Harvard University

Efforts to reform instructional physics labs—by defining measurable goals and improving student learning—have led to several innovations (i.e. rubrics for enhanced formative assessment) at the introductory level. However, researchers have yet to explore similar innovations in advanced laboratory courses. In an effort to fill this void, we investigated the observable aspects of student learning, culled from submitted written work and discussions between students and faculty, in light of specific changes to the advanced lab course (clear statement of learning goals, better-defined activities, and rubrics). Course goals related primarily to improving experimentalist laboratory skills and enhancing scientific writing ability. Student work was compared to written work from prior years using rubric-based evaluation. The objective of this study was to respond to the following research question: How do students exhibit learning when novel teaching strategies are implemented in an advanced laboratory course, and how does student performance compare to prior semesters?

AA04: 9:30–9:40 a.m. Enhancing Students: Understanding of Electronics and Instrumentation Through Capstone Projects*

Nasser Juma, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506-2601; mhuninas@phys.ksu.edu

Elizabeth Gire, Kristan Corwin, Brian Washburn, N. Sanjay Rebello, Kansas State University

It is essential for experimental physicists to understand the conceptual basis of experiments and the techniques of modern instrumentation, data collection and analysis. We describe a set of new capstone projects in an electronics course for physics majors. Students apply their knowledge of electronics, instrumentation, and LabVIEW to experiments from previous upper-division physics laboratory courses. This opportunity allows students to apply their newly learned electronics knowledge and skills and also offers students an opportunity to solve real-world problems associated with instrumentation, control, and data acquisition. The capstone projects therefore, not only give the students an opportunity to put into practice the electronics knowledge and ideas that they have learned, but also help the students see the applicability of the electronics in actual measurements that can be done in the laboratory. We will describe the course and students' comments on their capstone project experiences.

*Supported by NSF grant DUE-0736897.

AA05: 9:40–9:50 a.m. Bridging the Gap between Introductory and Upper-Division Electronics Laboratories

David Smith, Physics Education Group, University of Washington, University of Washington, Dept. of Physics, Box 351560, Seattle, WA 98195-1560; dsmith4@uw.edu

Christos P. Papanikolaou, National and Kapodestrian University of Athens

Mackenzie R. Stetzer, Lillian C. McDermott, Physics Education Group, University of Washington

For many years, the Physics Education Group at the University of Washington has been examining student understanding of electric circuits. The findings continue to inform the development of curriculum for introductory students and K-12 teachers. This ongoing investigation has also been extended to electric circuits laboratories, both at the introductory and upper-division levels. In particular, we are developing new laboratory experiments designed to bridge the gap between the treatment of this material at both levels. Critical to this effort is an in-depth analysis of student learning in the introductory laboratories. Findings from representative pre- and post-tests will be presented and compared to those from other universities.

Session AB: Physics, Technological Innovation, & Careers in the Pacific Northwest I

Location: Galleria II
Sponsors: Physics in Undergraduate Education Committee, Educational Technologies Committee
Date: Monday, July 19
Time: 8:20–9:50 a.m.

Presider: Mary Lowe, Loyola College in Maryland; mlowe@loyola.edu

AB01: 8:20–8:50 a.m. Flat Panel Optics

Invited – Adrian Travis, Microsoft Corporation, One Microsoft Way, Redmond, WA 98052; adriant@microsoft.com

A conventional lens has to be spaced away from an object in order to form its image so that, for example, a book has to be opened before we can read it. But it has recently become possible to focus light to a point at the edge of the lens, using total internal reflection. This makes it possible to produce flat panel displays that can see and this can greatly change the user/computer interface.

AB02: 8:50–9:20 a.m. Physics and Commercialization ... What Could be Better?

Invited – David McFeeters-Krone, Intellectual Assets Corp., 1831 NE Thompson, Portland, OR 97212; dmk@intelassets.com

You've got a kid in your class who loves science and he asks you, "What can I do with a physics degree"? Learn about how a physics background translates into a career in business, specifically technology commercialization and business development. Hint: it all happens at the interface.

AB03: 9:20–9:50 a.m. Doodles, Quantum Physics, and Grandma's Email

Invited – Kelin J. Kuhn, Intel Corp., 20280 SW Clarion St., Aloha, OR 97006; kelin.ptd.kuhn@intel.com

For the past 40 years, relentless focus on Moore's law transistor scaling has provided ever-increasing transistor performance and density. A decade ago, Moore's law transistor scaling meant "classic" Dennard scaling where oxide thickness (Tox), transistor length (Lg) and transistor width (W) were scaled by a constant factor (1/k) in order to provide a delay improvement of 1/k at constant power density. However, "classic" Dennard scaling became less influential after the 130nm node. In subsequent generations (90nm, 65nm, 45nm, 32nm, etc.) a variety of new techniques have been introduced to drive the transistor roadmap forward. This talk will explore (with some humor) the physics of high-k metal gate devices, NMOS and PMOS strain, and advanced materials—as they are applied to advanced transistor architectures.

Session AC: Using Literature and History to Teach H.S. Physics

Location: Galleria III
Sponsor: Physics in High Schools Committee
Date: Monday, July 19
Time: 8:20–10:10 a.m.

Presider: Diane Riendeau, Deerfield High School; dmrwkr@aol.com

AC01: 8:20–8:50 a.m. Seuss Science or Learning Physics Through Children's Literature

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

Somewhere between the age when picture books first unleashed the magic of "I wonder ..." in our students and the time the students arrive in our physics classroom, they have often lost their curiosity and imagination. We can recapture some of the excitement if we reopen the classic books and allow those to guide us as we explore the real world. Listen as I tell a tale of how I have used children's books in my high school classroom. A tale in which we discover how children's literature reveals: 1. How we Construct Knowledge 2. Modeling Science Processes with Picture Books 3. Stories that Lead to Science Questions and Investigations 4. Literature as Starters/Closers: Books as Motivation 5. Children's Literature as Assessment 6. "Books don't have to be flat" 7. Children's Literature can be Literature by Children.

AC02: 8:50–9:20 a.m. Using Physics Principles to Help Solve Two Literary Landscape Mysteries

Invited – Jim Hicks, Barrington High School, Retired, Barrington, IL 4701; ujhicks@juno.com

The real world is a physics laboratory. Students should be able to recognize phenomena they see beyond the classroom that they had already witnessed and discussed in class. Can physics principles be used to discover unknowns in literature, especially literary landscapes? Two literary landscape unknowns found in children's literature will be addressed in this paper. The presenter feels physics principles helped solve their locations. Physics laboratory experiments and curriculum that extend to the classroom will be suggested. An audience feedback session to assess the author's findings and procedures will be encouraged.

AC03: 9:20–9:30 a.m. Electrostatic Toys

Thomas B. Greenslade, Jr., Kenyon College, Dept. of Physics, Gambier, OH 43022; greenslade@kenyon.edu

Some fortunate lecture demonstrations can also be entertaining. Nineteenth-century physics teachers developed an arsenal of electrostatic demonstrations that can be classified as toys-that-teach. I will show pictures of thunder houses, electrical sportsmen, electrostatic pinwheels, spotted tubes, and a number of other shocking demonstrations.

AC04: 9:30–9:40 a.m. Important News on the Elements of the Periodic Table

Monica Halka, Georgia Institute of Technology, University Honors Program, Atlanta, GA 30075-0740; monica.halka@gatech.edu

Brian Nordstrom, Embry Riddle Aeronautical University

The authors present a new resource to help teachers refresh their knowledge of the elements of the periodic table. A set of six volumes, "The Periodic Table of the Elements" presents the most current understanding of the chemical elements, which is crucial to the advancement of technology, commerce, and medicine. Fields as diverse as astronomy, computer science, and energy innovation rely on understanding the elements of the periodic table and how they relate to each other. Some of the most important concerns of the public, like agriculture, health care, and national defense, cannot be addressed without recently enhanced scientific knowledge about phosphorus, mercury, and plutonium, for example. This set directly addresses the levels 9-12 physical science standard and the history and nature of science standard. The reasoning proceeds from simple to more complex, giving the reader a better handle on the connections among nuclear, atomic, and chemical physics.

AC05: 9:40–9:50 a.m. Tapping into the Power of Physics: Impacting Students' Lives

Tracy G. Hood, Plainfield High School, 1 Red Pride Dr., Plainfield, IN 46168; thood@plainfield.k12.in.us

Learning physics concepts and problem solving approaches is helpful to prepare students for later physics classes. But some of our students will at best take one more class in the subject and many will never grace the walls of a physics class again. But it should still be true that learning physics helps prepare students for something later: success in any college class, science literacy, informed decision-making, for example. Over the course of a 10-year teaching career, I have tried and refined many assignments, activities, and projects to accomplish this goal. I will share ideas for implementation, guidelines for students, rubrics for grading, and my philosophy behind why each is important.

AC06: 9:50–10 a.m. Noticeable Errors in Artificial Gravity of Rotating Space Stations

James J. Lincoln, Tarbut V' Torah High School, 5 Federation Way, Irvine, CA 92603; ihatephysics@gmail.com

Theodore W. Hall, Chinese University of Hong Kong

It has long been discussed that a rotating space station could supply artificial gravity for weary astronauts. But how should it be constructed? What would be the errors, physical issues, and psychological costs of having too short a radius? too low a rotation rate? I have studied some forgotten research and provided some fresh mathematical analysis of my own; highlighting interesting phenomena.

AC07: 10–10:10 a.m. Movie Physics: Rolling the Black Pearl Over

Carl E. Mungan, U.S. Naval Academy, Physics MS 9c, Annapolis, MD 21402; mungan@usna.edu

John D. Emery, U.S. Naval Academy

In the third movie ("At World's End") in the Pirates of the Caribbean series, Jack Sparrow and his crew need to roll their ship (the Black Pearl) over in order to bring it back to the living world during a green flash at sunset. They initially attempt to do so by running back and forth from one side railing to the other. When that fails, Capt Barbossa orders that the 32 cannons be cut loose to add mass to the running crew. In the movie, they then succeed. But would that strategem work in real life? The rolling of the cannons is not in perfect phase with the running of the crew so an analytic solution is complicated. Instead a numerical solution is developed by making suitable approximations. Analysis of such movie physics (after displaying a clip from a film) can quickly pique student interest.

Session AD: PER: Student Reasoning

Location: Broadway I/II
Date: Monday, July 19
Time: 8:20–10:10 a.m.

Presider: Jeff Marx, McDaniel College. jmarx@mcdaniel.edu

AD01: 8:20–8:30 a.m. Investigating Student Understanding of Classical Analogs of Quantum Concepts

Brian M. Stephanik, University of Washington, Dept. of Physics, Seattle, WA 98195-1560; bsteph@uw.edu

Peter S. Shaffer, Lillian C. McDermott, University of Washington

Many introductory physics courses include an introduction to basic quantum mechanics. A number of the relevant concepts (e.g., probability density and energy diagrams) have classical analogs but these are seldom taught in the introductory curriculum. Moreover, there is relatively little research on student learning that can serve as a guide to instruction. We present results from preliminary research that probes the extent to which introductory and second-year students develop a functional understanding of these and related ideas.

AD02: 8:30–8:40 a.m. If Mathematics Is the Language of Physics, Does it Have a Grammar?

David T. Brookes, Florida International University, Miami, FL 33199; dbrookes@fiu.edu

David H. Landy, University of Richmond

Jose P. Mestre, University of Illinois at Urbana Champaign

In physics equations, each symbol stands for a physical quantity, and mathematical expressions define relationships between these physical quantities. How do physicists and physics students make sense of these abstract equations? We suggest a theoretical approach to this question that marries ideas and methods of functional grammar and perceptual symbol systems. In short, we propose that mathematics, as used in physics, shares many identifiable elements with those of the grammar of human languages. Moreover, these elements seem to play a similar cognitive/symbolic purpose to their equivalent linguistic structures. Consequently, although many mathematical expressions may validly describe a given physics situation, few are contextually appropriate. We present a study revealing how physics students interpret mathematical structure. For example, different forms of the same equation influence students' models of the physical reality that the equation describes. We discuss the implications of this research for how students interpret mathematics in physics.

AD03: 8:40–8:50 a.m. Development of Scientific Reading Skills – Preliminary Results

Paul J. Camp, Spelman College, 350 Spelman Lane, Box 373, Atlanta, GA 30312; pcamp@spelman.edu

Derrick Hylton, Michael Burns-Kaurin, Spelman College

Our group is in the early stages of studying the development of the skill of reading scientific text as distinct from narrative text. We are employing a verbal analysis protocol in which participants articulate their thought process out loud as they read through a selection of text. This investigation is currently looking at individuals at all levels of professional development, from entering freshmen through working faculty at research institutions in an effort to detect intermediate states of development and to determine what other factors influence the decoding of and extraction of meaning from scientific text. This work is in the very early phases but fills a significant gap in the research literature. We will present the theoretical basis of our work along with some preliminary data.

AD04: 8:50–9 a.m. Understanding the Nature of Missed Learning Opportunities during Tutorial Instruction

Brian W. Frank, University of Maine, 5709 Bennett Hall, Orono, ME 04469; bwfrank@umit.maine.edu

Adam Kaczynski, Michael C. Wittmann, University of Maine

Tutorial-style instruction is becoming commonplace in introductory college physics. At the University of Maine, we are conducting research to identify missed learning opportunities that occur during tutorial instruction. By analyzing video of our tutorial classrooms, we are working to define, identify, and characterize different kinds of missed opportunities. One kind of missed learning opportunity involves students failing to recognize or orient to the particular conceptual struggles a tutorial presents. A second involves tutorials failing to provide support for students in resolving conceptual struggles they encounter on their own. In this sense, we see ways that both the tutorial and students generate valuable opportunities that are missed by the other. We describe several mechanisms by which students fail to take up opportunities provided by the tutorial, and also discuss the limitations of tutorial instruction for helping students to capitalize on their own self-generated opportunities for conceptual growth and development.

AD05: 9–9:10 a.m. What Does Epistemological Priming Look Like?

Paul S. Hutchison, Grinnell College, Dept. of Education, Grinnell, IA 50112; hutchiso@grinnell.edu

Mary McDonald, Grinnell College

Renee Michelle Goertzen, University of Maryland

We previously reported the results of a large-n survey study showing statistical differences in student responses to a dynamics question when different lead-in questions were used to prime different stances toward knowledge. Subsequently several "think-aloud" interviews using the same questions as the large-n study were conducted to investigate student reasoning under the different priming conditions. Analysis of the think-aloud interviews shows when students encounter the dynamics question most initially employ reasoning strategies similar to those they used on the priming questions. Different types of priming questions result in different initial reasoning strategies. In most interviews students became dissatisfied with their initial reasoning strategy and switched to a different one, but the priming effect on the initial reasoning strategy may explain the statistical difference we observe in the large-n survey study.

AD06: 9:10–9:20 a.m. Analysis of Student Modes of Communication in Intermediate Mechanics Tutorials

Adam C. Kaczynski, University of Maine, 5709 Bennett Hall, Orono, ME 04469-5709; a.kaczynski@gmail.com

Michael C. Wittmann, Brian Frank, University of Maine

Damped harmonic motion is a core topic in the University of Maine's sophomore-level mechanics course. In the Intermediate Mechanics Tutorials,[1,2] we have a series of tutorials that address this topic from two different perspectives: first by reasoning conceptually about the dynamics of the physical situation, and later by examining the differential equation of its motion. We will present analysis of videotaped student interactions to illustrate the different modes of communication (gestures, language, mathematics, and graphing) that are used by students during these activities as they construct a shared understanding.This work is supported in part by NSF grant DRL-0633951.

1. B.S Ambrose, "Investigating student understanding in intermediate mechanics: Identifying the need for a tutorial approach to instruction," *American Journal of Physics* **72**, 453–459 (2004).

2. M.C. Wittmann and B.S. Ambrose, Intermediate Mechanics Tutorials, available under a Creative Commons License at http://perlnet.umaine.edu/imt/ .

AD07: 9:20–9:30 a.m. Investigating Student Reasoning Difficulties with the Reflection of Pulses

Mila Kryjevskaia, North Dakota State University, Dept. of Physics, Fargo, ND 58108-6050; mila.kryjevskaia@ndsu.edu

MacKenzie R. Stetzer, Paula R.L. Heron, Lillian C. McDermott, University of Washington

As a part of an ongoing investigation of student understanding of wave behavior at a boundary, we have been examining student ability to develop and apply models for the reflection of pulses from fixed and free ends. The context for this investigation has been the development and refinement of two sets of research-based instructional materials by the Physics Education Group at the University of Washington. *Physics by Inquiry*[1] provides teachers with the subject-matter background needed to teach science effectively. Tutorials in Introductory Physics[2] supplements standard lecture-based courses and is designed for small-group discussion sessions. At North Dakota State University, we have also recently begun adapting tutorials for use in interactive lectures. Analysis of student performance on pre-tests and post-tests administered to a variety of different populations continues to deepen our understanding of student reasoning difficulties associated with pulse reflection from a boundary.

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

2. *Tutorials in Introductory Physics,* L.C. McDermott, P.S. Shaffer and the Physics Education Group at the University of Washington, Prentice Hall (2002).

AD08: 9:30–9:40 a.m. Using a Backward Design Process in Evaluating Students' Reasoning

Mojgan Matloob Haghanikar, Kansas State University, 403 Cardwell Hall, Manhattan, KS 66506; mojgan@phys.ksu.edu

Sytil Murphy, Dean Zollman, Kansas State University

While investigating the impact of interactive learning strategies on in-service elementary education majors, we categorized different levels of reasoning represented in students' responses to written examination questions and devised a protocol for developing a content question that elicits reasoning. Using previous research,[1,2,3] we constructed a framework allowing us to determine levels of thought process for questions. Although questions are different contexts or disciplines, they follow a pattern of concept links, knowledge types and cognitive processes. We compare the structure of example questions and discuss how this thought process can be applied to other disciplines, contexts and scenarios. Supported by NSF grant ESI-055 4594.

1. G. Wiggins & J. McTighe, *Understanding by Design*,Virginia:ASCD (1998)

2. M. Nieswandt & K. Bellomo, *Journal of Research in Science Teaching* **46** (3), 333–356 (2009).

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)

AD09: 9:40–9:50 a.m. How Students Promote and Discourage Each Other's Answer Making

Mary McDonald, Grinnell College, 1115 8th Ave., Box 4034, Grinnell, IA 50112; mcdonald@grinnell.edu*

Paul Hutchison, Grinnell College

"Framing" describes an individual's ongoing interpretations of the kind of activity they are engaged in. This interpretation is based in part on social cues from people around them. Therefore, framing implies that interactions with peers can inform students' framing during groupwork. To investigate this relationship, we studied video of group activity in an inquiry-based introductory physics class for elementary education majors. We created case studies of episodes with at least one change in a student's framing. In particular, we focus on transitions into or out of a framing we call "answermaking." We typically consider answermaking detrimental to student learning in its overemphasis of school tasks. Our analysis identifies student activities that may discourage (or support) answermaking. Our cases present researchers a starting place for continued scholarship as well as data available for analysis. To teachers we offer ideas of what to look for and support during groupwork.

*Sponsored by Paul Hutchison.

AD10: 9:50–10 a.m. Student Difficulties with Material Science Engineering Concepts: Materials Properties

Rebecca J. Rosenblatt, The Ohio State University, 1040 Physics Research Building, Columbus, OH 43210-1117; rosenblatt.rebecca@gmail.com

Andrew F. Heckler, The Ohio State University

We report on initial findings of a project to identify, study, and address student difficulties in a university-level introductory materials science course for engineers. Here we describe a number of student difficulties in understanding macroscopic properties of materials, the basic definitions that describe these properties, and the effects of simple processing on these properties. For example, many students have difficulty with the notion that yield strength is independent of the cross-sectional area of a material; they have difficulty differentiating between the definitions of a material's stiffness and its strength; and they have difficulty with the differences between a material's density, its atomic bond length, its bond strength, and the yield strength of the material. While some of these concepts are unique to materials science, they are similar to, and perhaps related to, difficulties students have with basic physics concepts.

Session AE: *Panel:* Bridging the Gap I

Location: Broadway III/IV
Sponsor: Physics in Pre-High School Education Committee
Date: Monday, July 19
Time: 8:20–10:20 a.m.

Presider: Julia Olsen, University of Arizona, jkolsen@u.arizona.edu

AE01: 8:20–10:20 a.m. Teaching Physics to First Graders: The Little Shop of Physics

Panel – Brian Jones, Colorado State University, Physics Dept., Fort Collins, CO 80523; bjones@lamar.colostate.edu

The Little Shop of Physics is a hands-on science outreach program at Colorado State University. We've presented programs to more than 250,000 K-12 students since we hit the road in the early 1990s. The program didn't start with a defined plan, but grew organically—each year, we did more of what worked, and less of what didn't. We discovered that the best approach was to let people explore and experiment in their own way, something that isn't a surprise given the research on formal physics education. Our student-centered approach to informal education lets us match the experience to the students we visit, students of all ages and all cultures. It also provides a wonderful opportunity for the undergraduates who develop and present our programs to learn how to describe and explain material at different levels, and to serve as role models for the younger students we visit.

AE02: 8:20–10:20 a.m. There's Plenty of Room at the Bottom: Pre-High-School Outreach

Panel – James Reardon, University of Wisconsin-Madison, 1150 University Ave., Madison, WI 53706; reardon@physics.wisc.edu

Each of the two physics outreach efforts that have recently been most durable at my institution started out as solo efforts. The two are quite different: "The Wonders of Physics," originated by Clint Sprott, and "Nine Experiments for a Third-Grade hour," by Connie Blanchard, both of the University of Wisconsin-Madison. "Wonders" seeks to give an overview of classical physics, and is well-suited to a large audience. The nine experiments in "Nine" are small, inexpensive, home-built, and invite the students to think carefully about everyday things. There are enough pre-high-school classrooms that would eagerly accept any offer of physics outreach that there is plenty of room for both styles of outreach, and many more besides.

AE03: 8:20–10:20 a.m. So, How Do We Communicate with Children, Teens, the Public?

Panel – Patricia Sievert, Northern Illinois University, 3940 E. Sievert Dr., Byron, IL 61010; psievert@niu.edu

Outreach. For some it may seem simple, just take a few demos out to a school and say whatever comes to mind. Others spend time worrying about state standards and become overwhelmed. A few don't want to bother because they don't like to "dumb it down." What's the correct balance? How do you communicate with 6-year-olds, 9-year-olds, teenagers, or the public? Do we have to teach a concept to be successful, or can we consider it a success if people come away from the experience with an interest in or enthusiasm for physics? I've been professionally involved in physics outreach for eight years. My philosophy is to know your audience members, your learners, and meet them where they are. Demonstration shows, camps, hands-on activities, after-school programs, haunted labs, and family workshops all have value as outreach. What's the best fit for you and your intended audience? www.niu.edu/stem

AE04: 8:20–10:20 a.m. How to Talk About Science to Teachers Who Fear Science

Panel – Steve L. Shropshire, Idaho State University, Dept. of Physics, MS 8106, Pocatello, ID 83209; shropshi@physics.isu.edu

As evidenced by a recent study published in the Proceedings of the National Academy of Sciences, negative attitudes and anxiety of female elementary teachers toward mathematics can have a negative influence on the mathematical abilities of their female students. This influence surely extends to the physical sciences, where teacher discomfort is often greater. Such negative influences can only be improved through professional development or retirement. However, elementary teachers with discomfort toward physical science are the least likely to seek professional development in physical science. Strategies and techniques on how to reach such teachers to improve attitudes, comfort levels, and content knowledge in physical science will be discussed.

AE05: 8:20–10:20 a.m. Bridging the Gap I

Panel – Thomas J. Senior, Lake Forest College, 355 Dell Lane, Highland Park, IL 60035-5310; tomseniorphysics@yahoo.com

When talking to someone about science, it is best to first find out, if possible, their understanding of the subject. One way is to demonstrate some phenomenon to them to raise questions and inspire curiosity, and then ask them for their explanation. I feel it is best to lead them from where they are to where you would want them to be with questions and praise for their explanations.

Session AF: Multiple Models for Mentoring I

Location: Grand Ballroom II
Sponsors: Minorities in Physics Committee, Physics in Pre-High School Education Committee, Physics in High School Education Committee, Teacher Preparation Committee, Women in Physics Committee, Graduate Education Committee
Date: Monday, July 19
Time: 8:20–10:20 a.m.

Presider: Kathleen Falconer, Buffalo State College, falconka@buffalostate.edu

AF01: 8:20–8:50 a.m. Why Does Mentoring End?

Invited – Barbara L. Whitten, Colorado College, 14 E. Cache la Poudre, Colorado Springs, CO 80903; bwhitten@coloradocollege.edu

Cynthia A. Blaha, Carleton College

Amy L.R. Bug, Swarthmore College

Anne J. Cox, Eckerd College

Linda S. Fritz, Franklin and Marshall College

In the broadest and most useful sense, mentoring connotes an activity that does not necessarily flow from an older, more experienced mentor to a younger mentee. As part of an NSF Advance project, we (five of us) were invited to form a Mentoring Alliance of senior women physics faculty from liberal arts colleges for mutual mentoring. The premise behind the project was that horizontal mentoring between individuals of similar rank, field, academic environment, and perhaps also matched by race and gender, is a highly beneficial enterprise particularly for under-represented and/or isolated groups within a profession. Our experience has been very successful primarily because it is a resonant phenomenon--we feel that the other members of the group "get it"(whatever the issue) right away because they've had similar experiences. We will discuss our experiences and suggest ways similar Mentoring Alliances might be established and supported.

AF02: 8:50–9:20 a.m. Mentoring Initiatives at AAPT

Invited – Philip W. Hammer, American Association of Physics Teachers, One Physics Ellipse, College Park, MD 20740; pwhammer@aapt.org

The American Association of Physics Teachers is launching a number of mentoring initiatives designed to provide one-on-one professional development and support. The goals are to improve teaching as a personally fulfilling and professionally successful career path, and ultimately to improve student learning. AAPT's mentoring initiatives will leverage ongoing successful programs such as PTRA and PhysTEC, and will take advantage of the internet and emerging social networking platforms such as Facebook.

AF03: 9:20–9:50 a.m. Science and Math Internship Center: A Business/Education Collaboration

Invited– Julia K. Olsen, The University of Arizona, 1430 E. Second St., Tucson, AZ 85721; jkolsen@u.arizona.edu

The University of Arizona and Tucson Values Teachers (TVT) are collaborators on a unique internship program for science, technology, engineering, and math (STEM) teachers in Arizona middle and high schools, focusing primarily on those in their first five years of teaching. The goals of the program are to increase the retention of science and math teachers and to improve science and math teaching and learning. The internship is linked with a focused three-year Master's Degree program that transforms the practical workforce experience into classroom curriculum, providing a critical bridge between education and businesses. The program creates a unique opportunity for business and teacher collaboration. Businesses benefit from the contributions of a high-quality, Master's level K-12 teacher who will bring top-level STEM skills into the workplace. And, as part of the Master's program, the teachers incorporate these first-hand business skills into curriculum and classroom teaching techniques.

AF04: 9:50–10 a.m. Science and Mathematics Teacher Campus Student Groups: Communities of Support

Marcia Fetters, Western Michigan University, 2425 Sangren Hall, Kalamazoo, MI 49008; marcia.fetters@wmich.edu

Deciding to be a science or mathematics teacher can often be an isolating choice at most universities. In the typical large-lecture science or mathematics course, those going into teaching are the minority. Most members of the class are either going into engineering, or they are mathematics or science majors. Developing and supporting campus student groups dedicated to science and mathematics teachers can increase the visibility of this profession and aid in the recruitment and retention of future science and mathematics teachers. Western Michigan University's student group called ScMaTA (Science and Mathematics Teacher Association) is celebrating 10 years as a student group. Targeting pre-service K-16 mathematics and science teachers, this group actively forms a support community on campus and beyond with local schools and alumni. This presentation highlights: organization structure(s), recruiting members, meeting topics, group activities, connections to professional organizations and meetings, fundraising, and issues of sustainability.

AF05: 10–10:10 a.m. Outcomes of Mutual Mentoring I: Impact of Mutual Mentoring on Research

Linda S. Fritz, Franklin & Marshall College, PO Box 3003, Lancaster, PA 17604; linda.fritz@fandm.edu

Cynthia A. Blaha, Carleton College

Amy L.R. Bug, Swarthmore College

Anne J. Cox, Eckerd College

Barbara L. Whitten, Colorado College

"Why Does Mentoring End"?, presented in Multiple Models of Mentoring I, explained the nature of the mutual mentoring alliance, sponsored by NSF ADVANCE, which we have been part of for the past three years, and touched upon the impact the alliance has had on our research activities. In this talk we will give some specific ways that we have supported and helped to expand each other's research. For some new areas of research were opened, for others new focus was brought to existing areas, and still others found acceptance for where they were.

AF06: 10:10–10:20 a.m. Outcomes of Mutual Mentoring II: Mutual Mentoring Makes Better Mentors

Cynthia A. Blaha, Carleton College, 1 N. College St., Dept. of Physics & Astronomy, Carleton College, Northfield, MN 55057; cblaha@carleton.edu

Amy L.R .Bug, Swarthmore College

Anne J. Cox, Eckerd College

Linda S. Fritz, Franklin and Marshall College

Barbara L. Whitten, Colorado College

"Why Does Mentoring End?", presented in Multiple Models for Mentoring Session I, explained the nature of our three-year mutual mentoring alliance, sponsored by NSF ADVANCE. Our cohort of five women physicists at liberal arts colleges has found that mutual mentoring has had a profound impact on our research activities (see previous talk) as well as on our ability to be effective mentors. In this talk we will describe how our peer-to-peer mentoring has enabled us to become better mentors for our undergraduate students, for recent graduates beginning their careers and for colleagues at local and neighboring institutions.

Session AG: *Panel:* Online Science Education Resources

Location: Pavilion East
Sponsors: Educational Technologies Committee, Physics in Undergraduate Education Committee
Date: Monday, July 19
Time: 8:20–10:20 a.m.

Presider: Robert V. Steiner, American Museum of Natural History, rsteiner@amnh.org

Panelists Include:

Kevin Lee, University of Nebraska, Lincoln; klee6@unl.edu

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

Bruce Mason, University of Oklahoma, Norman, OK; bmason@ou.edu

Karim Gangli

Robert V. Steiner, American Museum of Natural History

Session AH: *Panel:* Promoting Diversity in Physics Education

Location: Pavilion West
Sponsors: Graduate Education Committee, Physics in Undergraduate Education Committee
Date: Monday, July 19
Time: 8:20–10:20 a.m.

Presider: Chandralekha Singh, University of Pittsburgh, clsingh@pitt.edu

AH01: 8:20–10:20 a.m. Developing an Instructional Approach that Builds on the Resources of the Urban Physics Student*

Panel – Mel S. Sabella, Chicago State University, Dept. of Chemistry and Physics, 9501 S. King Drive, SCI 241, Chicago, IL 60628; msabella@csu.edu

The physics programs at Chicago State University, Harold Washington College, and Olive Harvey College are in the process of developing instructional environments that support the learning resources of the urban populations we serve. In many cases, these resources facilitate the implementation of diverse PER-based instructional approaches. By integrating components such as Clicker Question Sequences, Tasks Inspired by Physics Education Research, problem solving and discussion questions, Research-based Laboratories, Thinking in Physics Activities, and Interactive PowerPoint Lectures, students are constantly placed in situations where they need to apply and synthesize the physics concepts they are learning. This environment, which builds on the strong sense of community, the comfort in engaging in scientific debate, and the appreciation of guided questioning creates a unique instructional environment as well as a rich setting for understanding the specific needs and resources of our students. A description of how specific education research projects guided the development of our instructional approach will be discussed.

*Supported by the National Science Foundation CCLI Program (Award #s DUE 0632563 and 0618128).

AH02: 8:20–10:20 a.m. Teaching Underrepresented Groups with Peer Instruction

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

Jessica Watkins, Harvard University and University of Maryland

Eric Mazur, Harvard University

This talk will discuss the performance of traditionally underrepresented groups (women and underrepresented racial and ethnic minority groups) when taught introductory physics using Peer Instruction, either with traditional discussion sections or combined with other interactive engagement strategies. On average, students from these underrepresented groups enter with weaker preparation; for data obtained at Harvard University, we will examine end-of-semester performance results, both end-of-semester conceptual inventory data and student grades, controlling for student background. We will also summarize results of studies at other institutions.

AH03: 8:20–10:20 a.m. The Role of the NSHP in Promoting Diversity and Inclusion

Panel – Juan R. Burciaga, Denison University, Dept. of Physics and Astronomy, Granville, OH 43023; burciagaj@denison.edu

As an advocacy group, the National Society of Hispanic Physicists approaches the issues of diversity and inclusion in the physics community with a less-cluttered, more focused agenda than is possible for the major societies. But the challenges confronting those working to bring about lasting, permanent change in the diversity of the physics community are formidable, and the resources of any advocacy group are dwarfed in comparison. How does the NSHP, a volunteer society with limited resources, participate in the work to bring about change? What are our goals for our membership and for the physics community? What program and activities have we pursued?— are pursuing?

AH04: 8:20–10:20 a.m. Toward Comprehensive Diversity in Physics: From Birth to Retirement

Panel – Lawrence S. Norris, National Society of Black Physicists, 1100 N Glebe Road, Ste. 1010, Arlington, VA 22201; lnorris@nsbp.org

In her paper given at AIP's 75th anniversary symposium, Shirley Malcom highlighted the weak diversity performance in the physics profession. Physics stands out among the sciences for its inability to diversify its domestic workforce. Staudinger recently used metrics called relative representation (RRL) and representation gap (RG) to quantify the fact that in baccalaureate degree production amongst underrepresented minorities, physics does relatively poorer than chemistry, math, computer science, and most subdisciplines of engineering. In fact to reach the level of performance of the other sciences and engineering, the African American degree production in physics would have to more than double. Malcom asks how does people's natural curiosity with the physical universe translate into the legion of professional physicists being one of the most exclusive of the sciences. The answers are many-fold and autocatalytic. At the college level, until recently most African American physics students receive their first degree at the nation's HBCUs. But declining enrollment and declining government (state and federal) spending at those programs has led to a relative decline in the diversity of physics baccalaureate earners as the total number of physics degrees awarded has increases. In this talk we will synthesize results from various lines of inquiry from primary, secondary and informal education, to research on college physics teachers, to study of professional lives of practitioners, and organizational dynamics to suggest a comprehensive set of principles to improve diversity and broaden participation in physics and astronomy.

Session TYC: Two-Year College Resource Room Posters

Location: Grand Parlor A
Date: Monday, July 19
Time: 8 a.m.–5 p.m.

Poster authors will be present from 12–1 p.m.

TYC01: 8 a.m.–5 p.m. Clicker Question Exchange for Introductory Physics Classes

Poster – Tom Carter, College of DuPage, 425 Fawell Blvd. Glen Ellyn, IL 60137; carter@fnal.gov

Albert H. Lee, Lin Ding, Neville W. Reay, Lei Bao, Ohio State University

I would like this poster to form a central point for people to swap question sets, discuss what makes a good question and show off their own favorites. I will specifically make available the electricity and magnetism questions in serial format written by the Ohio State PER group.* Additional clicker questions I have accumulated over the past seven years using Peer Instruction in my introductory physics class will also be available for swapping and discussion.

* Production of this material supported in part by NSF grant DUE-0618128

TYC02: 8 a.m.–5 p.m. Rockets in the Introductory Physics Classroom

Poster – Dwain M. Desbien, Estrella Mountain CC, 3000 N Dysart Road, Avondale, AZ 85392; dwain.desbien@emcmail.maricopa.edu

This poster will discuss the use of model rockets (up to a F motor) in my classroom. I will discuss the way they are used in conceptual physics up to university physics. Examples of the assignments to each will be done along with results from the assignments. A brief description of the physics involved will also be included.

TYC03: 8 a.m.–5 p.m. A Free Body Diagram Activity Using Connected Moving Masses

Poster – Michael C. Faleski, Delta College, 1961 Delta Road, University Center, MI 48642; michaelfaleski@delta.edu

Objects sliding on surfaces and the Atwood machine represent standard problems in introductory physics, and free-body diagrams are one of the essential ways to analyze such problems. As a way to develop student ability to create the free-body diagram, this poster will show an activity performed by students using equipment available in most laboratories. Starting with simple activities for friction, students later have to relate free-body diagrams for masses connected together for the half-Atwood machine and eventually for a mass hanging over a pulley connected to a second mass on an inclined surface. The check of the student analysis comes when they construct the system under consideration and observe the results of their calculations.

TYC04: 8 a.m.–5 p.m. Using Ranking Tasks to Convince Students that Normal Force is NOT Always Equal to Weight

Poster – William P. Hogan, Joliet Junior College, 1215 Houbolt Rd., Joliet, IL 60431; whoganjjc@gmail.com

This poster will present a series of Ranking Tasks that I have used every semester in all levels of introductory physics since first learning of Ranking Tasks from Hieggelke, Maloney, and O'Kuma. These ranking tasks have been very effective in confronting students misconceptions about normal force and remain a favorite activity of mine.

TYC05: 8 a.m.–5 p.m. Prescriptive Analysis Integral Techniques for Introductory Physics

Poster – Thomas L. O'Kuma, Lee College, Lee College; Physics Dept., Baytown, TX 77522-0818; tokuma@lee.edu

Prescriptive Analysis Techniques (PAT) can be used to aid students in setting up integral to solve a number of physics problems; e.g., electric fields and magnetic fields. In this poster, I will illustrate some of the PATs used in Spiral Physics (developed by Paul D'Alessandris - Monroe Community College, Rochester, NY), show some student work, and some additional examples.

TYC06: 8 a.m.–5 p.m. SCC Advance Program for STEM Majors

Poster – Sherry L. Savrda, Seminole State College, 100 Weldon Blvd., Sanford, FL 32773; savrdas@scc-fl.edu

Seminole State College of Florida (formerly Seminole Community College) has developed a program with the goal of increasing interest in STEM careers. The program is a partnership with the University of Central Florida, and is modeled after UCF's successful EXCEL program. SCC Advance recruits students in College Algebra, Trigonometry, and Precalculus to participate in a weekly one-hour session in addition to their regular math course. In these sessions, professors of physics, chemistry, and biology present students with topics from their respective disciplines, showing students how the mathematics they are learning applies to science and providing opportunities to practice applying the mathematics. Students participating in the SCC Advance program then transfer to UCF's EXCEL program. The purpose of both programs is to show students the relevance of the mathematics they are learning to scientific applications, and to help ease the transition to STEM major courses. NSF CCLI 0837307

TYC07: 8 a.m.–5 p.m. Effective Refraction Demonstration for Classroom Viewing

Poster – Sherry L. Savrda, Seminole State College, 100 Weldon Blvd., Sanford, FL 32773; savrdas@scc-fl.edu

Demonstrating refraction phenomena in a large classroom setting can be challenging. While the traditional Blackboard Optics set-ups do work, they are limited in size and can be difficult to see in large classroom settings. Individual refractive elements designed for use at student tables are often too small, making accurate measurements a challenge. A simple method that utilizes standard Blackboard Optics elements and makes refraction easily visible even to students in the back of large classes will be described and illustrated.

TYC08: 8 a.m.–5 p.m. Classroom Investigation of the Physics of Giant Swings

Poster – Scott F. Schultz, Delta College, 1961 Delta Road, University Center, MI 48642; sfschult@delta.edu

Amusement rides are often studied in introductory physics when studying centripetal motion. Not having access to a local amusement park while studying this with my students, we use a simple model to turn our exploration of Giant Swings into a hands-on laboratory exorcise in the classroom.

TYC09: 8 a.m.–5 p.m. I Did WHAT???

Poster – David Weaver, Chandler-Gilbert Community College, 7360 E. Tahoe Ave., Mesa, AZ 85212-0908; david.weaver@cgcmail.maricopa.edu

For reasons not completely clear to me, I decided to offer a section each of our two-semester algebra-based college physics courses totally on line--during summer school--this summer! This poster will detail my motivations, my preparations, successes, challenges, and lessons learned. As I will be presenting the poster during the final week of both classes, I may even be able to ask some of your questions to my students.

Plenary: APS/DLS Symposium on Laser Physics

Location: Grand Ballroom I
Date: Monday, July19
Time: 10:30 a.m.–12 p.m.

➢ *(see details on page 41)*

CKB01: Crackerbarrel for PER Solo Faculty

Location: Broadway I/II
Sponsors: Research in Physics Education Committee, Professional Concerns Committee
Date: Monday, July 19
Time: 12–1 p.m.

Presider: Jennifer Blue, Miami University, Oxford, OH 45056; bluejm@muohio.edu

This crackerbarrel is for PER faculty who are alone at their institutions, whether we're the one physicist in an education department or the one education researcher in a physics department (or both!). We come to AAPT meetings to connect with one another. Bring your own questions, ideas, and concerns to share.

CKB02: Crackerbarrel on TYC Guidelines

Location: Broadway III/IV
Sponsor: Physics in Two-Year Colleges Committee
Date: Monday, July 19
Time: 12–1 p.m.

Presider: William P. Hogan, Joliet Junior College, whoganjjc@gmail.com

AAPT's Guidelines For Two Year College Physics Programs were last revised in 2002. This crackerbarrel will be a discussion of how the guidelines need to be modified to reflect changes affecting physics programs at two-year colleges.

Session BA: Biomedical Labs for Advanced Physics

Location: Galleria I
Sponsors: Laboratories Committee, Apparatus Committee
Date: Monday, July 19
Time: 1:10–2:20 p.m.

Presider: Nancy Beverly, Mercy College, Dobbs Ferry, NY, nbeverly@mercy.edu

Sophisticated biological research and medical techniques, as well as biophysics research, present opportunities for exciting labs appropriate for an Advanced Physics Lab course, especially for students with an interest in applying physics to the biological or medical realm.

BA01: 1:10–1:40 p.m. Understanding Biology with Advanced Physics Lab Experiments

Invited – Steven K. Wonnell, Johns Hopkins University Dept. of Physics and Astronomy, Baltimore, MD 21218; wonnell@pha.jhu.edu

Daniel H. Reich, Johns Hopkins University

Teaching lab experiments on biological physics are of two main types: those where physics is used as a technique in the observation, manipulation, or analysis of biological samples, and those where physical concepts are used to explain or model a biological process or phenomenon. Hopkins offers a year-long upper-level course in biological physics, and its accompanying experiments of the first type are connected by an underlying theme of spectroscopy. These include the Fourier analysis of sound; the interference and diffraction of light by slits and 2D patterns including DNA optical transforms; microscope optics; and pulsed NMR. Accompanying experiments of the second type aim to explain biological behaviors at the molecular level. These now include Brownian motion, diffusion, and laminar flow; the development of experiments on osmosis and the elasticity of polymers is under way. I will highlight interesting aspects of these experiments.

BA02: 1:40–2:10 p.m. Introducing Biophysics In Berkeley's Advanced Lab

Invited – Thomas F. Colton, Physics Dept., University of California Berkeley, 366 LeConte Hall, #7300, Berkeley, CA 94720-7300; tcolton@berkeley.edu

Opportunities are expanding for physical scientists to apply their techniques and perspectives to problems in biology and medicine. Physics undergraduates may not see a clear path to learn about and prepare to enter this emerging multidisciplinary field. The demands of a physics major preclude a double major in biology, while upper-level biology courses exclude physics students lacking numerous biology pre-requisites. Physics advanced lab courses offering a choice of biophysics experiment options allow students to explore the techniques and questions of biophysics. At Berkeley, two biophysics experiments have been introduced. (1) Students investigate Brownian motion of polystyrene microspheres with an inverted microscope and contrast this with directed intracellular transport by myosin motor molecules in living onion cells. (2) Optical tweezers are calibrated with microspheres and used to manipulate swimming bacteria and organelles transported by myosin motors. A proposed lab course to introduce physics students to oncology research will be discussed.

BA03: 2:10–2:20 p.m. Designing and Building a Computed Tomography Scanner

Steve Lindaas, Minnesota State University Moorhead, 1104 7th Ave. South, Moorhead, MN 56563; lindaas@mnstate.edu

Fenner Colson, Matthew Mumm, Minnesota State University Moorhead

CT scanners are now ubiquitous devices in hospitals. However, most students do not have the opportunity to delve into the physics of these devices. Our goal was to provide students with experience in computed tomography. Our department has a student grade x-ray apparatus that includes a fluorescence screen for radiography. While this apparatus now has a CT scan attachment available, the additional cost is prohibitive for our department. However, the apparatus came equipped with a goniometer and has a LabView interface. Hence with a modest equipment purchase we were able to construct a CT scanner. We will discuss the design and implementation of our device. We will also discuss its use in a medical physics course as well as less expensive optical analogues.

Session BB: PER: Investigating Classroom Strategies

Location: Galleria II
Sponsors: Laboratories Committee, Apparatus Committee
Date: Monday, July 19
Time: 1:10–2:50 p.m.

Presider: Warren Christensen, North Dakota State, warnpeace1414@hotmail.com

BB01: 1:10–1:20 p.m. Large Scale Assessment of the Introductory Courses: Mechanics

Kwan Cheng, Texas Tech University, Physics Dept., MS 41051, Lubbock, TX 79409; kelvin.cheng@ttu.edu

Beth Thacker, Amy Pietan, Hani Dulli, Texas Tech University

We discuss a large-scale assessment of the introductory physics courses in Mechanics. We report our work on the assessment of four interventions: 1) the introduction of new research-based laboratories and teaching pedagogies , 2) training the teaching assistants in the new pedagogies and the use of grading rubrics, 3) the synergy of the lecture and the lab and 4) a completely laboratory-based, interactive engagement course as a small, independent section of the course. We focus on the learning gain of the students from the net and categorized results of the Force Concept Inventory and Mechanics Baseline Test.

*Sponsored by Beth Thacker

BB02: 1:20–1:30 p.m. PER-based Introductory Physics Reform at Oregon State University

Dedra Demaree, Oregon State University, 301 Weniger Hall, Physics Dept., Corvallis, OR 97331; demareed@physics.oregonstate.edu

At Oregon State University, innovative curriculum and pedagogy choices have been in place for more than a decade with the Paradigms in Physics project. The past few years have focused on extending this reform to the lower-division large lecture courses. Our reform has been implemented in phases, starting with changes to the large lecture, then changes to the lab, and most recently, with the incorporation of a studio-based portion of the course in a SCALE-UP room. This talk will discuss our team-based reform model which involves graduate students, a large fraction of our faculty, and all of our full-time course instructors. We find holding regular reform group meetings and post-instructional team meetings to be a highly valuable reform tool for refining the curriculum and building/transferring pedagogical content knowledge. How we use these meeting times will also be discussed.

BB03: 1:30–1:40 p.m. Processes of Student Understanding: Standard vs. Remedial Sections

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

Eleanor C. Sayre, Wabash College

Jessica Clark, Rochester Institute of Technology

Rochester Institute of Technology is in the midst of a pilot project to address remediation of engineering majors unprepared for the standard Introductory physics sequence. Students are identified by the Institute math placement exam, or by previous difficulty with the physics sequence, and receive two additional hours of workshop instruction per week (8 hrs vs. 6 hrs for the regular sections). All instruction of both standard and remedial sections is in a workshop environment. Students participated in RIT's between-students study of conceptual understanding. The method, involving weekly conceptual assessments, allows real-time tracking of student understanding. We present demographic information on the two populations, as well as preliminary results on each group's conceptual understanding, including learning, forgetting, and interference effects.

BB04: 1:40–1:50 p.m. Instructor Facilitation of PI as a Mediator for Student Participation

Sissi L. Li, Oregon State University, 301 Weniger Hall, Corvallis, OR 97331; lisi@onid.orst.edu

Dedra Demaree, Oregon State University

At Oregon State University, we have undergone curriculum reform in our large-enrollment introductory calculus-based physics sequence including the remodeling of a lecture classroom to facilitate student discussions in small groups. Preliminary quantitative analyses suggest that classroom physical features do not change participation in terms of time on task and group size. However, there appear to be qualitative differences in student participation during social learning activities that are not fully accounted for in quantitative measures. We propose that activity facilitation by the instructor may be a more significant mediating factor for prolonged and deepened engagement during social learning activities. To examine the relationship between instructor activity facilitation and the nature of student engagement, we analyzed student interactions and discourse in audiovisual recordings of lectures and coded instructor reflective journals. This talk will showcase our findings on the relationship from the perspective of the students as well as the instructor.

BB05: 1:50–2 p.m. A Tool to Aid Instructors and Students to Negotiate Learning Environments*

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

David Brookes, Yuhfen Lin, Eric Brewe, Laird Kramer, Florida International University

This pilot study examines interactions between instructors and students in an introductory university physics class. The goal was to study how they construct and communicate their perceptions and expectations of a learning environment. Ultimately, we would like to develop a tool for instructors and students to use to investigate and reflect upon elements of learning that are important to them—while using their own language and conceptions to do so. Through such a reflection, participants in this study were empowered to mutually describe, inform, negotiate, and reconstruct any parameters of their classroom and learning environment they saw fit. Students and instructors may also use this tool for multiple purposes, such as action research planning, initiating cogenerative discourse, increasing situational awareness, or clarification of language for better communication. The tool's framework is constructed so as to be adaptable to any mode of instruction, curriculum, environment, or amount of teaching experience.

*Supported by NSF Grant #0802184

BB06: 2–2:10 p.m. Drawing Out the Expert Learner in Physics Students

Yuhfen Lin, 8941 SW 142nd Ave., Apt. 225, Miami, FL 33186; fireflylin@gmail.com

Natan Samuels, David T. Brookes, Florida International University

Trigwell and Prosser's studies suggest that even when a learning environment supports a deep learning approach, students may still adopt a surface approach because of their prior learning experiences. Concomitantly, it is hard for students to start a conversation about learning. In addition the idea of meta-cognition is somewhat abstract. In order to help students to construct a meaningful learning approach, we invited students to bring in their own experience of learning in fields/activities at which they excel. We also asked them to construct a framework of learning for mastery based on how they handled difficulties and how they progressed to higher levels of expertise. With the discussion based on students' fields/activities of interest, they were able to create sophisticated models of learning cycles. When students were asked to transfer those ideas into physics learning, they were able to focus more on a deep learning approach.

BB07: 2:10–2:20 p.m. Processes of Student Understanding: Traditional vs. Workshop Classes

Eleanor C. Sayre, Wabash College, PO Box 352, Crawfordsville, IN 47933; le@zaposa.com

Scott V. Franklin, Rochester Institute of Technology

Pre-/post-testing is a coarse measure of student learning: it shows only before and after snapshots of knowledge, not the dynamics of student learning. Using a between-students design to probe the knowledge of a large class of students weekly, we can observe rapid learning and forgetting, as well as destructive interference between related topics. In this talk, we discuss how this response curve methodology illuminates learning differences and similarities between traditional and reformed introductory calculus-based physics classes for engineering majors. The traditional students are enrolled at The Ohio State University; the reformed students are enrolled at Rochester Institute of Technology. For some topics, both traditional and reformed classes learn the same amount. However, the reformed students fail to forget afterwards, leading to familiar large gains.

BB08: 2:20–2:30 p.m. Large Scale Assessment of the Introductory Courses: Electricity and Magnetism

Beth Thacker, Texas Tech University, Physics Dept., MS 41051, Lubbock, TX 79409; beth.thacker@ttu.edu

Kwan Cheng, Amy Pietan, Hani Dulli,Texas Tech University

We discuss a large-scale assessment of the introductory physics courses in

Electricity and Magnetism. We report our work on the assessment of four interventions: 1) the introduction of new research-based laboratories and teaching pedagogies , 2) training the teaching assistants in the new pedagogies and the use of grading rubrics, 3) the synergy of the lecture and the lab and 4) a completely laboratory-based, interactive engagement course as a small, independent section of the course. We focus on the learning gain of the students from the net and categorized results of the Brief Electricity and Magnetism Assessment and Conceptual Survey of Electricity and Magnetism.

BB09: 2:30–2:40 p.m. Assessing Introductory Algebra-based Studio Physics at an Urban University

Brian D. Thoms, Georgia State University, 29 Peachtree Center Ave., Suite 400, Atlanta, GA 30303; bthoms@gsu.edu

Brianna Upton, John R. Evans, Cherilynn A. Morrow, Georgia State University

Previous studies have shown that many students have misconceptions about basic concepts in physics. Moreover, it has been concluded that one of the challenges lies in the teaching methodology. To address this, Georgia State University (GSU) has begun teaching studio algebra-based physics. Although many institutions have implemented studio physics, most have done so in calculus-based sequences. Additionally, the unique environment of GSU's population as a diverse, urban, research institution is considered. A four-semester study assessing the effectiveness of studio and traditional lecture approaches to teaching algebra-based introductory physics has been performed. This study presents demographic survey results and compares the results of student pre- and post-tests using the Force Concept Inventory. Using the results from these assessment tools, we will discuss the effectiveness of the studio and traditional lecture approaches to teaching algebra-based physics at ethnically diverse, mostly nonresidential, urban institution.

BB10: 2:40–2:50 p.m. Evaluation of the Inquiry Style Curriculum: Evidence from Retrospective Data

Jing Wang, Eastern Kentucky University, 351 Moore Building, Richmond, KY 40475; jing.wang@eku.edu

Jerry Cook, Garett Yoder, Eastern Kentucky University

In the past 10 years, the Department of Physics and Astronomy at Eastern Kentucky University (EKU) has incorporated the inquiry teaching style into the curriculum to replace the traditional lecture/laboratory course format in both the algebra-based and the calculus-based introductory physics sequences. The courses use an integrated approach, transitioning seamlessly between inquiry-style laboratory activities, lectures and problem-solving sessions. This study evaluates the curriculum development from a quantitative perspective: Does inquiry teaching produce positive results at EKU? We have developed the analysis based on four types of assessment data accumulated in the past five years: the course exam data, in-semester formative assessment data, research based assessment data and General Education assessment data. We believe the results will be a unique addition the existing literature of inquiry-based learning. This work has been supported by NSF CCLI grant #0633126.

Session BC: *Panel:* Multiple Models for Mentoring II

Location: Galleria III
Sponsors: Women in Physics Committee, Physics in Pre-High School Committee, Physics in High Schools Committee, Teacher Preparation Committee, Graduate Education Committee
Date: Monday, July 19
Time: 1:10–3:10 p.m.

Presider: Monica Plisch, American Physical Society, plisch@aps.org

There are many views of mentoring and these definitions and perspectives have been changing, especially over the last decade. Mentoring has always been a part of education but now mentoring can be a much more formal process. Our distinguished panel will discuss mentoring, both informal and formal from their unique personal perspectives.

Panelists:

Patricia E. Allen, Appalachian State University

Tom Foster, Southern Illinois University

Laird H. Kramer, Florida International University

John Layman, University of Maryland

Chandralekha Singh, University of Pittsburgh

Session BD: Physics, Technological Innovation, & Careers in the Pacific Northwest II

Location: Broadway I/II
Sponsors: Physics in Undergraduate Education Committee,Teacher Preparation Committee
Date: Monday, July 19
Time: 1:10–2:40 p.m.

Presider: Lili Cui, University of Maryland Baltimore County; lili@umbc.edu

BD01: 1:10–1:40 p.m. Novel Flexible Media Integrated with Transparent Metal Oxide TFT Backplane

Invited – Tim Koch, Hewlett-Packard, 1000 NE Circle Blvd., Corvallis, OR 97330; tim.koch@hp.com

Jeff Mabeck, John Yeo, Hewlett-Packard

A novel flexible media has been developed with a new roll-to-roll manufacturing platform. The thin, reflective electronic media with electrically addressable ink enables print-like color using low-power. To enable a digital reflective display, the flexible electronic media has been integrated with transparent multi-component oxide (MCO) thin-film transistor (TFT) backplane.

BD02: 1:40–2:10 p.m. One Engineer's Story: Technology in High-Tech

Invited – Jim Fister, Intel, 2111 NE 25th, Hillsboro, OR 97124; james.d.fister@intel.com

Deciding on a technical career is one thing. Actually DOING something with it is completely another. A typical Intel geek will participate in the panel to describe a personal journey thorough technology and how that translates to job types and a full career at one of the most prestigious high-tech companies in the world.

BD03: 2:10–2:40 p.m. Physics, Technical Innovation, and Commercialization at PNNL

Invited – Peter M. Martin, Columbia Basin Thin Film Solutions LLC, 7703 W 13th Ave., Kennewick, WA 99338; totsmartin@aol.com

One major mission of Pacific Northwest National Laboratory is to drive basic physics to technical innovation and eventually to commercialization. Several examples are presented, including an artificial lung device, ultra-barrier technology, thin film batteries, molecular organic devices, quantum well thermoelectric materials and p-type transparent conductive thin films. PDEC (photolytic derived electrochemistry) technology employs micro-technology and photocatalytic production of excitons to generate oxygen for an artificial lung device that can be placed ex vivo or in vivo. Ultrabarrier technology utilizes nanolaminates to create tortuous diffusion paths as diffusion barriers. PNNL is developing the next generation of thin film battery, including lithium-polymer and sulfur ion with the ultimate goal of large area production by vacuum web coating. Second-generation organic materials are being developed for flexible organic light emitting devices (OLED) and solid state lighting. Thin film quantum well thermoelectric devices are being developed to convert waste heat to electrical energy.

Session BE: Best Practices for Teaching with Technology

Location: Broadway III/IV
Sponsor: Education Technologies Committee
Date: Monday, July 19
Time: 1:10–3:10 p.m.

Presider: Andy Gavrin, IUPUI, Indianapolis, agavrin@iupui.edu

BE01: 1:10–1:40 p.m. Tools for 21st Century Teaching: Using Digital Libraries, Blogs, Wikis and More

Invited – Cathy Mariotti Ezrailson, University of South Dakota, 1301 Over Dr., Vermillion, SD 5069; Cathy.Ezrailson@usd.edu

Technology takes many forms in today's high schools—from smart board, to data acquisition devices to digital libraries with web-based lessons, simulations, and other interactive resources. As we prepare physics teachers, we need to integrate these web-based teaching resources that were not available even a few years ago. 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 paper illustrates examples of best teaching practices that incorporate these tools for high school and college instruction.

BE02: 1:40–2:10 p.m. Effectively Using Technology: The Interplay Between Technology, Practices, and Pedagogy

Invited – Edward Price, California State University, San Marcos, 333 S. Twin Oaks Valley Rd., San Marcos, CA 92096; eprice@csusm.edu

In thinking about education technology and its impact in the classroom, it is useful to distinguish between practices and tools. Practices include patterns of behavior, rules, or norms. Tools are physical artifacts used in carrying out practices; examples include flashcards, clickers, whiteboards, and computers. In our classrooms, we utilize tools to support our pedagogical practices; that is, tools mediate practices. This view is useful when determining which tools best support our pedagogical goals, and how tools and practices can be changed to better support each other. This talk will describe how this approach has been used to understand and refine the use of Tablet PCs, digital cameras, and photosharing websites to support lecture and small group collaboration in the physics classroom.

BE03: 2:10–2:40 p.m. Using Computer Simulations in Introductory Astronomy

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

Mario Belloni, Davidson College

Astronomy is a popular science course for nonscience majors and it provides a unique opportunity for teaching students about the nature of science. In this presentation I will discuss how I use computer simulations to teach students about the nature of science in a course on the history of planetary astronomy. Students work with planetarium software to gather observational data that must be explained by astronomical theory. Then they work with computer simulations of historical theories, from the Ancient Greeks to Isaac Newton. Working with these simulations allows students to visualize abstract geometrical theories and compare specific predictions of the theories with observations. Students are then in a position to make evidence-based judgments about the strengths and weaknesses of each theory in the context of contemporary scientific knowledge. The simulations were created using the open-source Easy Java Simulations authoring tool and are available for free on the ComPADRE digital library.

BE04: 2:40–3:10 p.m. PhET Interactive Simulations Student Engagement and Learning*

Invited – Wendy K. Adams, University of Colorado, UCB 390, Boulder, CO 80309; wendy.adams@colorado.edu

Katherine K. Perkins, University of Colorado

PhET Interactive Simulations (sims) are now being widely used in teaching physics and chemistry. Sims can be used in many different educational settings, including lecture, individual or small group inquiry activities, homework and lab. Here we will highlight a few examples of how sims can be effectively incorporated into courses, guided by our research and experiences using them in high school and college classes. Our research has included hundreds of individual student interviews during which the students talk aloud as they interact with simulations. These studies reveal that the simulations contain implicit scaffolding in the form of affordances and constraints that help students build a mental framework about the concepts. Then students can construct their own understanding within this framework. Much of our work has focused on understanding how students use simulations to construct this mental framework and the effect that different levels of guidance have on students' use of simulations.

*The PhET Project is funded by the Hewlett Foundation, NSF CCLI Grant #0817582, JILA, University of Colorado at Boulder, and King Saud University.

Session BF: Electric Circuits: From Batteries and Bulbs to Electronic Devices

Location: Grand Ballroom II
Sponsor: Research in Physics Education Committee
Date: Monday, July 19
Time: 1:10–3:10 p.m.

Presider: Lillian C. McDermott, University of Washington, lcmcd@phys.washington.edu

BF01: 1:10–1:40 p.m. Identifying and Addressing Student Difficulties with DC and AC Circuits

Invited – Christian H. Kautz, Hamburg University of Technology, Eissendorfer Str. 38, Hamburg, Germany 21073; kautz@tu-harburg.de

We report on an investigation of student understanding of basic concepts in the context of first-year undergraduate DC and AC circuits courses. Through analysis of student responses to mostly qualitative questions, we have identified frequent difficulties with a number of topics, including phase relationships between AC signals. We interpret these results as an indication of an incomplete understanding of Kirchhoff's voltage and current laws in the context of AC circuits, and note that the observed difficulties mirror similar misconceptions that have been identified in the context of DC circuits. On the basis of our findings we have developed instructional materials that are intended to help students gain a better conceptual understanding of DC and AC circuits. Preliminary assessment indicates that after the use of these materials in various settings, the prevalence of certain difficulties is substantially reduced while others continue to pose a challenge.

BF02: 1:40–2:10 p.m. Enhancing Student Understanding of Electric Circuit Concepts with Active Learning Strategies Supported by Microcomputer-based Tools

Invited – David R. Sokoloff, University of Oregon, Dept. of Physics, Eugene, OR 97403-1274; sokoloff@uoregon.edu

The availability of carefully designed microcomputer-based data acquisition tools[1,2] has enabled the development of active learning curricula that enhance student understanding of basic electric circuit concepts. This talk will demonstrate these tools, provide examples of their effective use with RealTime Physics Labs[3] and Interactive Lecture Demonstrations,[4] and provide research evidence for their effectiveness. This work has been supported by various NSF and U.S. Department of Education, FIPSE grants.

1. Vernier Software and Technology (vernier.com).
2. Pasco scientific (pasco.com)
3. David R. Sokoloff, Priscilla W. Laws and Ronald K. Thornton, *RealTime Physics: Active Learning Laboratories*, *Module 3: Electric Circuits*, 2nd ed. (Wiley and Sons, Hoboken, N.J., 2004).
4. David R. Sokoloff and Ronald K. Thornton, *Interactive Lecture Demonstrations* (Wiley and Sons, Hoboken, N.J., 2004)

BF03: 2:10–2:40 p.m. Investigating Student Understanding in an Upper-Division Analog Electronics Course*

Invited – MacKenzie R. Stetzer, University of Washington, Dept, of Physics, Box 351560, Seattle, WA 98195-1560; stetzer@phys.washington.edu

The Physics Education Group at the University of Washington has recently extended our investigation of student understanding of electric circuits to an upper-division laboratory course on analog electronics. As part of this work, we have been administering written questions on fundamental electric circuits concepts (typically covered in introductory physics courses) and on canonical topics in analog electronics (e.g., filters, diodes, transistors, and operational amplifiers). Drawing on the results from such questions, we are examining the impact of the analog electronics course on student conceptual understanding. Specific examples will be used to illustrate how the findings from this investigation have implications for instruction in both introductory and upper-division courses.

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

BF04: 2:40–3:10 p.m. Batteries, Bulbs, and Beyond: Electric Circuits by Guided Inquiry

Invited – Paul van Kampen, Centre for the Advancement of Science and Mathematics Teaching and Learning, Dublin City Univ., Ireland; Paul.van.ampen@dcu.ie

David Smith, Centre for the Advancement of Science and Mathematics Teaching and Learning

We have developed research-based and research-validated curriculum for pre-service teachers and for first-year undergraduate physics students concerning basic electric circuits. The curriculum for pre-service teachers builds on the Physics by Inquiry curriculum[1] and extends it to include circuits with multiple batteries, the concept of potential, and RC circuits. Pretest/post-test analysis shows that the curriculum helps students understand these topics. The curriculum for first-year undergraduate labs consists of a 10-hour curriculum. The concepts of current, resistance, and voltage are introduced in that order, and students conclude with comparing the I,V-characteristics of bulbs and resistors. Pre-test/post-test analysis shows that considerable improvements are made.

1. L.C. McDermott et al, *Physics by Inquiry* (Wiley and Sons, 1996).

Session BG: State and National Initiatives and Effects on H.S. Physics

Location: Pavilion East
Sponsor: Physics in High Schools Committee
Date: Monday, July 19
Time: 1:10–3:10 p.m.

Presider: Karen Jo Matsler, kjmatsler@gmail.com

The secrets of combining politics, money, and professional development to increase student achievements ... No Child Left Behind requires teachers to be highly qualified yet there are few professional development opportunities addressing areas of content and pedagogy. There are funds available through Math Science Partnership grants to help high school physics programs. These MSP grants have partnered with PTRA to successfully provide training for secondary teachers. This session will feature universities that have been involved with these grants and will provide useful information regarding the procedures, challenges, and successes of these initiatives.

BG01: 1:10–1:40 p.m. Georgia MSP-funded PTRA Workshops: Getting and Keeping

Invited – Bob Powell, University of West Georgia, Dept. of Physics, Carrollton, GA 30118; bpowell@westga.edu

Ann Robinson, University of West Georgia and Paulding County Schools (retired)

Sharon Kirby, Cherokee County Schools

The University of West has received two grants (renewable for a second year) from the Math Science Partnership Program of the Georgia Department of Education. In the original grant in 2007, the PTRA units of Kinematics and Dynamics were offered first and Energy, Momentum, and Impulse were offered in the second year. In the second grant in 2009, Electricity and Magnetism were offered during 2009-2010. The study of optics and waves is planned for the second year. Each study involves a week-long study of the topics with two follow-up sessions during the academic year. The original funding was obtained because of the demonstrated need for improved physics instruction in area schools, the quality of the PTRA curriculum, and letters of support. Continued funding has been obtained because of project evaluation showing content improvement and compliance with the state MSP requirements.

BG02: 1:40–2:10 p.m. Maryland TOPPS

Invited – Eric Moore, Frostburg State University, 101 Braddock Rd., Frostburg, MD 21532; ejmoore@frostburg.edu

Katya Denisova, Baltimore City Public Schools

Francis Tam, Frostburg State University

Jane Nelson, PTRA

Improving Teaching Quality (ITQ)/ Through Opportunities for Physics and Physical Science (TOPPS) Institute at Frostburg State University (FSU) has enjoyed a track record of success for 10 years in teacher education and development across Maryland. The Institute has just finished its third year under a grant of $300,000 from Maryland Higher Education Commission (MHEC). We have covered the topics of Kinematics, Dynamics, Energy, Momentum, and Electricity. A grant of $172,000 from MHEC has just been awarded to the Institute to continue our effort to cover Optics, Sound and Wave Motion for a fourth year. The Institute is modeled after the proven PTRA curriculum of AAPT. Its formula for success includes strong institutional leadership, talented and caring faculty, fun and discovery evening activities. The success stories of our teacher scholars will be discussed including gains and challenges, as well as project goals and objectives.

BG03: 2:10–2:40 p.m. AAPT + PTRA + TEA + TRC = Success

Invited – Karen Matsler, 3743 Hollow Creek Rd., Arlington, TX 76001; kjmatsler@gmail.com

Tom O'Kuma, Lee College

Janie Head, Foster HS

Texas had four sites utilizing the funding provided by NSF to help teachers in rural areas gain deeper understanding about physics content knowledge, use of technology, and pedagogy. Although Texas has many rural schools, there are also large urban areas with teachers needing similar opportunities. Collaboration between AAPT/PTRA and the State Education Agency helped provide funding for training and equipment to both teachers and professional service providers. The logistics, challenges, successes, and evolution of the four-year million dollar project will be presented.

BG04: 2:40–3:10 p.m. AAPT/PTRA Center for Eastern Idaho

Invited – Steve L. Shropshire, Idaho State University, Dept. of Physics, MS 8106, Pocatello, ID 83209; shropshi@physics.isu.edu

Jan L. Mader, Great Falls High School

The AAPT, the nation's leading provider of professional development services to physical science teachers, developed the Physics Teaching Resource Agent (PTRA) model for successful physical science and physics teacher professional development. This model includes development of peer mentors and professional development leaders, systemic infrastructure, assessment instruments, and a curriculum based on experienced mentors and physics education research. With the support of the NSF and the APS from 2004 to 2008, a rural regional center for teacher professional development was established in Idaho. This center is now supported through the MSP program. An overview of the AAPT/PTRA model for professional development and how it was modified to obtain state funding will be presented, and the impact of the program in Idaho on teacher content knowledge and confidence will be summarized. Plans for future MSP-funded professional development for middle school and elementary teachers using the AAPT/PTRA model will be discussed.

Session BH: *Panel:* When Scientists Should Step In. Media, Politics, and Science

Location: Pavilion West
Sponsor: Science Education for the Public Committee
Date: Monday, July 19
Time: 1:10–3:10 p.m.

Presider: John Roeder, The Calhoun School, New York, JLRoeder@aol.com

Practitioners in the media and physicists concerned about science literacy will discuss and respond to questions from the audience about how and when scientists should involve themselves in discussing or debating public issues on which their science has a bearing.

Panelists include:

Peter Bhatia, editor The Oregonian

Willie Smith, District Director of the staff of Congressman Earl Blumenauer

Elaine Barnes, Ohio School Facilities Commission

Gordon Aubrecht II, The Ohio State University

Session HD: National Task Force on Teacher Education in Physics: Case Studies

Location: Council Suite
Sponsor: Teacher Preparation Committee
Date: Monday, July 19
Time: 1:10–3 p.m.

Presider: Ted Hodapp, APS, College Park, MD, hodapp@aps.org

HD01: 1:10–1:40 PM T-TEP Report: Findings and Recommendations

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

The National Task Force on Teacher Education in Physics (T-TEP) concluded its two-year investigation of the professional preparation of teachers of physics in the U.S. T-TEP, formed by APS, AAPT, and AIP, was charged with (a) identifying generalizable, yet flexible, strategies that institutions, and in particular physics departments and schools or colleges of education, can employ to increase the number of qualified physics teachers, (b) identifying effective strategies in recruitment, models of professional preparation, and higher education systems of support during the first three years of teaching, and (c) articulating research, policy, and funding implications. In this talk, the major findings and recommendations of the T-TEP report will be discussed and ways to leverage the report to transform the physics teacher education system will be outlined.

HD02: 1:40–1:50 p.m. SKyTeach Physics: The Case of Physics Teacher Preparation at WKU*

Scott W. Bonham, Western Kentucky University, 1906 College Heights Blvd., Bowling Green, KY 42101; scott.bonham@wku.edu

Recent experience at Western Kentucky University resonates strongly with the findings and recommendations of the National Task Force on Teacher Education in Physics. In 2008 WKU became an UTeach replication site, bringing about a number of changes in the university and the physics department related to physics teacher preparation. Partially as a result, we expect to graduate five new physics teachers in the next two years, up from a rate of about one every other year. Changes included active recruitment of students, formal collaboration between the schools of education and science, professional education courses with science and math specific pedagogical knowledge, a strong support network for pre-service teachers, and faculty in the department with formal roles in physics teacher preparation. Interviews with the five students confirm that the new approach is an important factor, as the majority would probably not have entered or remained in the old program.

*Supported in part by the National Math and Science Initiative.

HD03: 1:50–2 p.m. Physics by Inquiry: A Research-based Approach to Teacher Preparation

Paula R.L. Heron, University of Washington, Dept. of Physics, Box 351560, Seattle, WA 98195-1560; pheron@phys.washington.edu

Lillian C. McDermott, Peter Shaffer, MacKenzie Stetzer, Donna Messina, University of Washington

The Physics Education Group at the University of Washington has been helping prepare pre-service and in-service teachers to teach physics and physical science for more than 35 years. Based on this experience, and on systematic research, *Physics by Inquiry* (Wiley, 1996) has been developed to help college and university faculty conduct courses, workshops, and institutes for K-12 teachers. Physics by Inquiry is intended to help teachers acquire a deep understanding of fundamental concepts while developing important scientific reasoning skills. Evidence of effectiveness will be presented. The development of Physics by Inquiry has been supported by a series of grants from the National Science Foundation.

HD04: 2–2:10 p.m. Preparation of Out-of-Field Physics Teachers at Arizona State University

Jane Jackson, Arizona State University, Dept. of Physics, Tempe, AZ 85287-1504; jane.jackson@asu.edu

The Department of Physics at Arizona State University has demonstrated the feasibility and effectiveness of a university-based graduate program dedicated to professional development of in-service physics, chemistry, and physical science teachers. Twenty courses have been developed, including nine Modeling Workshops. In nine years, 785 different teachers have participated, including 340 out-of-field (crossover) physics teachers. Program strengths, weaknesses, and future challenges will be summarized. http://modeling.asu.edu/MNS/MNS.html

HD05: 2:10–2:20 p.m. What Physics Departments Can Do for K-12 Science Education Reform

David Hestenes, Arizona State University, 2416 South Palm Drive, Tempe, AZ 85282; hestenes@asu.edu

The National Academy of Sciences recognizes that the key to science education reform is cultivating teacher expertise, but the resources to keep teachers up-to-date with advances in science curriculum materials and pedagogy reside mainly in the nation's universities. The Physics Department at Arizona State University has established a successful graduate program for sustained K-12 teacher professional development and support. This program is presented as a model for what other universities can do to promote science education reform in local schools.

HD06: 2:20–2:30 p.m. Impacts of Informal Science Education University: Community Partnerships*

Laurel M. Mayhew, University of Colorado, Physics Dept., UCB 390, Boulder, CO 80309; Laurel.Mayhew@colorado.edu

Noah D. Finkelstein, University of Colorado

The University of Colorado Partnerships for Informal Science Education in the Community (PISEC [1]) establishes partnerships between University and K-12 institutions to create an informal science education program designed to positively impact all participants. We continue to explore the

University-Community Partnership Model impact on children (3rd-8th grade students under-represented in STEM), university educators (undergraduate, graduate and postdoctoral students), and institutions (university and community / school based centers). We measure gains in university participant attitudes about informal science education, abilities to communicate about science in everyday language, and approaches to teaching. For the children, we measure gains in content knowledge and attitudes about science and the nature of science. We also investigate how these efforts transform the university to focus and sustain components of NSF-funded outreach programs that persist beyond the term of the grant.

1. http://spot.colorado.edu/~mayhew/PISEC.

*This work is supported, in part, by NSF # 0551010, the JILA AMO PFC.

HD07: 2:30–2:40 p.m. Brigham Young University's Efforts to Prepare Physics Teachers

Duane B. Merrell, Brigham Young University, N-143 ESC, Provo, UT 84602; duane_merrell@byu.edu

Highlighted will be the move of the program back to the College of Physical Science from the College of Education. With efforts explaining how it is now being housed in the physics department. Efforts to train physics teachers in the physics department and a few key things that we have learned along the way.

HD08: 2:40–2:50 p.m. UNI Physics Teacher Preparation Programs for Undergraduates and Existing Teachers

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

Jeffrey Morgan, University of Northern Iowa

The University of Northern Iowa (UNI) physics teacher preparation programs include those specifically designed for undergraduates and those for existing secondary science teachers. Undergraduate secondary science teaching majors like the BA Physics Major-Teaching are within the appropriate departments of the College of Natural Sciences. Secondary science teaching majors are required to complete Professional Teacher Education courses offered by the College of Education which involve extensive field experiences at the university laboratory school and at local schools. Professional development programs have been offered to existing secondary science teachers to provide them a means of completing the requirements for the state of Iowa high school physics teaching endorsement. Teachers are provided professional development in physics content and pedagogy as well as the classroom resources on loan to implement research-based interactive techniques in their classrooms. These programs will be described along with their strengths, weaknesses, and future challenges.

HD09: 2:50–3 p.m. Physics Teacher Preparation Programs at SUNY-Buffalo State College

Daniel L. MacIsaac, Buffalo State College, 1300 Elmwood Ave., Buffalo, NY 14222; macisadl@buffalostate.edu

Luanna Gomez, David Abbot, Buffalo State Physics

Kathleen Falconer, Dave Henry, Buffalo State Elementary Education and Reading

We describe the physics teacher preparation programs of the SUNY- BUffalo State College Department of Physics. In particular, we feature the two graduate MSEd programs leading to physics teacher certification for crossover science teachers and for career changing STEM professionals seeking the initial teacher certification as physics teachers (Alternative Certification). We will recount some of the salient and unusual features of the programs and present and briefly discuss some of our comprehensive data from the first five years of program activity.

Plenary: Lasers and the Eye

Location: Grand Ballroom I
Date: Monday, July 19
Time: 3:20–4:20 p.m.

➢ *(see details on page 41)*

Session CA: PIRA Session: The Wonderful World of PIRA

Location: Salon Ballroom I
Sponsor: Apparatus Committee
Date: Monday, July 19
Time: 4:30–6 p.m.

Presider: Dale Stille, University of Iowa, dale-stille@uiowa.edu

A session celebrating 25 wonderful years of the Physics Instructional Resource Association (PIRA); its influence on the art and apparatus of demonstration, innovation in laboratory, resources for faculty and students, and outreach to the public. The speakers for this session will address the changes in demonstration, laboratory and outreach that have resulted from the national interaction of instructional resource physicists and specialists.

CA01: 4:30–5 p.m. What Has PIRA Done for You in the Last 24 Years?

Invited – Keith Warren, North Carolina State University, Campus Box 8202, Raleigh, NC 27695; keith.warren@ncsu.edu

The Physics Instructional Resource Association (PIRA) was officially organized in 1986 during the AAPT Summer Meeting. Since that time dedicated individuals from around the world have collaborated on numerous projects intended to support those who support physics education. These projects have evolved into a collection of immensely valuable resources for the entire physics community. Whether you are adding demonstrations, upgrading your educational laboratories, trying to host a public demonstration show, or almost anything dealing with the support of your institutions physics instruction, PIRA is your place to find the information you need. This talk will review the many of resources PIRA has made available to everyone. Topics will include the Demonstration Classification Scheme (DCS), the Demonstrations Bibliography, TAP-L, Global Demo Web Spider, PIRA Resource Room and more.

CA02: 5–5:30 p.m. The History of PIRA According to the Collective General Knowledge

*Invited – Zigmund Peacock, University of Utah, Physics Dept., Salt Lake City, UT 84112-0830; peacock@physics.utah.edu – (***MARSHA HOBBS will speak for Zig Peacock)**

It's been 25 years already and we still have a lot to do to keep the momentum and drive. My view will be a general historic perspective with a historical snapshot of the people and places that made PIRA what it is today and its general goals.

CA03: 5:30–6 p.m. Let's Review! PIRA's Past & Current Influence and Future Goals

Invited – David P. Maiullo, Rutgers University, 136 Frelinghuysen Road, Piscataway, NJ 08854; maiullo@physics.rutgers.edu

Over the past 25 years PIRA has been an integral part of the evolution and growth of physics laboratories and demonstrations. This influence stems not only from the tireless work of our members at the national and local meetings of AAPT, but is also evident in the way PIRA is disseminating this evolution at all levels of physics teaching and outreach. Past and current efforts will be examined, and future goals and ideas will be explored.

Session DA: Physics and Society

Location: Galleria I
Sponsor: Science Education for the Public Committee
Date: Monday, July 19
Time: 4:30–5:20 p.m.

Presider: Paul Williams, Austin Community College; pwill@austincc.edu

DA01: 4:30–4:40 p.m. Experimental Evidence of Quantum Physics Model of Mind-Brain Interaction

Lou Cadwell, Providence College, 1 Cunningham Square, Providence, RI 02918; lcadwell@providence.edu

For many decades, many physicists have attempted to explain life, and in particular, the mind-brain interaction in terms of quantum theory. This presentation will deal with both a brief history of using quantum theory to explain life, and in particular focus on current papers that assert that quantum physics in neuroscience and psychology can explain a model of the mind-brain interaction, and determine from an experimental physicist's view whether it makes sense.

DA02: 4:40–4:50 p.m. Application of Physics to Environmental Concerns, Part III, Geothermal Energy

Celia Chung Chow, CSU, 9 Andrew Drive, Weatogue, CT 06089-9726; cchungchow@comcast.net

We are looking very hard to find various green energy resources. This discussion of geothermal energy system is concentrated on heating and cooling in buildings and homes. Some examples in Connecticut will be introduced. The ultimate goal is to be green and energy independent. (A brief discussion on safety will be included, if time permits.)

DA03: 4:50–5 p.m. Renewable Energy for Grades 6-12: Activities from The Science House*

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

The Science House at NC State University is a partner in a Gen-III Engineering Research Center, the FREEDM Systems Center. This center is researching the challenges of smart grid, green power, and renewable energy, intriguing real-life issues for today's middle and high school students. Activities for learning basic electricity, batteries, capacitors, and transformers are the building blocks for understanding wind and solar power generation. Lab activities, multimedia, tour ideas, assessments, and additional sources of materials and ideas will be presented. See http://www.science-house.org/freedm/ for information and resources.

* Sponsored in part by NSF Award #0812121, Division of Engineering Education and Centers.

DA04: 5–5:10 p.m. Starting a Lighter than Air Vehicle Competition at Community College

Daniel Loranz, Truckee Meadows Community College, 7000 Dandini Blvd., Reno, NV 89512; dloranz@gmail.com

Jason Brass, David Susman, Truckee Meadows Community College

We present the details of how we implemented a Lighter than Air Vehicle Competition at Truckee Meadows Community College in Reno, NV. These kinds of student competitions are visually dramatic and can provide excellent marketing/recruitment opportunities for one's school. Our implementation significantly minimizes the hurdles for student participation (cost, skill requirements, etc.) while preserving both the excitement and the experiential learning benefits obtained by engaging with the project.

DA05: 5:10–5:20 p.m. Bridging the Gap between Science And Society: Debating Science Policy

Shannon Mayer, University of Portland, 5000 N. Willamette Blvd., Portland, OR 97203; mayers@up.edu

It is critically important that we educate future scientists and engineers to be both technically competent and effective communicators of science. This paper describes three science policy debates developed for the upper-division physics classroom aimed at encouraging students to draw connections between their developing technical expertise and important issues in science policy. The first debate considers the proposal for a 450-megawatt wind farm on public lands in Nantucket Sound and fits naturally into the curriculum related to alternative forms of energy production. The second debate considers national fuel-economy standards for sport-utility vehicles and can be incorporated into curriculum related to heat engines. The third debate considers solid state lighting and implications of recent United States legislation placing stringent new energy-efficiency and reliability requirements on conventional lighting and fits naturally into the undergraduate optics curriculum.

Session DB: High School/Middle School

Location: Galleria II
Date: Monday, July 19
Time: 4:30–5:30 p.m.

Presider: Kathleen Falconer, Buffalo State College, falconka@buffalostate.edu

DB01: 4:30–4:40 p.m. Photonics Leaders II: Preparing High School Students for the Global Workplace and STEM Experiences.

Joyce O. Hilliard-Clark, North Carolina State University, Research Building IV, Suite 1200, Raleigh, NC 27695; hilliard_clark@ncsu.edu

Geraldine Cochran, Pamela Gilchrist, Stacey Kaufman, Susy Heckman, North Carolina State University - The Science House

The National Science Foundation (NSF) Innovative Technology Experiences for Students and Teachers (ITEST) Photonics Leaders II (PL2) program has collected data over 10 months by embedding formative and summative assessments (such as writing prompts, content assessments, student aspirations, NSF Labwrite and science presentation rubrics) into program activities to measure the impact of PL2 programming on the development of students' writing skills and conceptual knowledge of photonics. The presentation will provide an overview of the types of data collection instruments employed, share program findings, and challenges experienced using a mixed method approach. It will focus on the program claims and examine the impact of a PL2 program on students' skills, knowledge, and dispositions by highlighting short, intermediate, and long-term outcomes. This session is appropriate for program evaluators and program coordinators.

DB02: 4:40–4:50 p.m. Physics in an Active Learning Studio at the Secondary Level

Simon Huss, Windward School, 11350 Palms Blvd., Los Angeles, CA 90066; shuss@windwardschool.org

Thomas Haglund, James Bologna, Windward School

Windward School's Science and Technology Department adapted the MIT Technology Enhanced Active Learning model to secondary curriculum. Windward faculty will describe the use of the studio active learning model for physics at the secondary level. We will discuss the available technologies, methodologies for student assessment, and teacher training, and design of learning spaces for secondary education. Active learning shifts the focus of responsibility for learning to students allowing them to develop enhanced comprehension while providing the teacher with more accurate and timely feedback of the students' understanding. This model is increasingly used at the university and college level, but it has not yet been widely adopted in secondary education.

DB03: 4:50–5 p.m. Developing Scientific Reasoning in Middle School Students*

Kathleen M. Koenig, Wright State University, Dayton, OH 45435; kathy.koenig@wright.edu

Lei Bao, The Ohio State University

Student development of scientific reasoning is at least as important as certain science content knowledge. Our prior assessment of middle school student reasoning abilities, as measured in part by the Lawson Classroom Test of Scientific Reasoning, indicates students are weakest in skill domains associated with proportional reasoning, ability to identify and control variables, and hypothesis testing. We have previously implemented college-level curricular activities that have been successful in developing student reasoning skills. As part of a pilot study, we adapted portions of this college curriculum for middle school use. The presentation will include descriptions of the piloted activities as well as data on middle school student development of targeted skills.

*Supported in part by NIH Award Number RC1RR028402 from the National Center For Research Resources.

DB04: 5–5:10 p.m Learning Graphs and Physics with Sensors in Grades 5-6

Ed van den Berg, AMSTEL Institute, University of Amsterdam, c/o De Achtkant 25, Heiloo,1852 BV; edberg51@planet.nl

Frank Schweickert, Gerda Manneveld, AMSTEL Institute, University of Amsterdam

The interface "Sense allows for measuring and graphing temperature, light, and sound motion" measures distance. We developed activities with minimal text and a focus on the use of graphs as a tool for communication. Forty children ages 10-12 participated in a temperature activity and a distance-time graphing activity. Children's ability to read and interpret and communicate with graphs was tested in a pre/post-test and a post-interview. Children could work productively with sensors and graphs, read graphs, and provide simple interpretations of events. Four weeks after the activities 2/3 of the children could also sketch a graph of the interviewer walking with correct representation of movement, speeds/slopes and time. Confronted with a sound sensor and sound graphs they had never seen before, 60 percent of the children were able to suggest ways to use these as tools to determine the winner in a fast hand-clapping contest.

DB05: 5:10–5:20 p.m. Particle Physics Masterclass: Possibility for Student Learning About the Nature of Science?

Michael J. Wadness, Medford High School/UMass Lowell/QuarkNet, 7 Morse Lane, Natick, MA 01760; mjwadness@verizon.net

This research addresses the problem of science literacy, focusing specifically on students' understanding of the nature of science. In 2009 and 2010, research was conducted to determine if QuarkNet's U.S. Particle Physics Masterclass provided a fruitful context for students to learn about the nature of science. The U.S. Particle Physics Masterclass is a national program in which students come to a local area research institute and interact with particle physicists through lectures, tours, informal discussions, and work together to analyze real particle physics data. The U.S. Masterclass is inspired by EPPOG's International Particle Physics Masterclass and therefore the results of this study may have implications for EPPOG. This presentation highlights the preliminary results of this study.

Celebrating 50 Years of the Laser

Video Screening

6:15–7 p.m., Monday
9:20–10:50 p.m., Tuesday
12:35–1:15 p.m., Wednesday

Galleria I or III

a production of SPIE, the international society for optics and photonics, as part of its Advancing the Laser celebration

DB06: 5:20–5:30 p.m. Bringing Technology into Physics Classrooms*

Nouredine Zettili, Jacksonville State University, 700 Pelham Rd., N., Jacksonville, AL 36265; nzettili@jsu.edu

Through our outreach initiative at JSU, we have been supporting a number of school districts to bring technology into their high school physics classrooms. This initiative is part of Project IMPACTSEED (IMproving Physics And Chemistry Teaching in SEcondary EDucation), a grant funded by the Alabama Commission on Higher Education. This project is motivated by a major local need: A large number of high school physics teachers teach out of field. The main aim of IMPACTSEED is to help high school teachers learn and master the various physics topics required by the Alabama course of study. Teachers are offered year-round support through a rich variety of programs: a two-week long summer institute, a series of technology workshops, and onsite year-round support. Through our hands-on approach and the technology workshops, we have identified a number of ways of bringing technology into physics classrooms. A number of technology projects were assigned to the teachers so as to show their students how physics connects to our daily lives and to the technological devices around us. IMPACTSEED aims at providing our students with a physics education that enjoys a great deal of continuity and consistency from high school to college.

*Supported by the Alabama Commission on Higher Education (ACHE) as part of a NCLB grant.

Session DC: Physics Education Research Around the World I

Location: Galleria III
Sponsors: International Physics Education Committee, Research in Physics Education Committee
Date: Monday, July 19
Time: 4:30–6 p.m.

Presider: Genaro Zavala,Tecnológico de Monterrey, genaro.zavala@itesm.mx

DC01: 4:30–5 p.m. Thermal Physics Going Soft – New Approach to Introduce Contemporary Science in High School

Invited – Edit M. Yerushalmi, Weizmann Institute of Science, Weizmann Institute of Science, Rehovot, 76100, Israel; edit.yerushalmi@weizmann.ac.il

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

The concepts of thermal and statistical physics, traditionally used to understand ordering in simple systems (e.g. gases and solids) are nowadays used by scientists working at the interface of physics, chemistry, and biology to understand soft and biological matter such as polymers, membranes and even biological cells. We have developed an interdisciplinary program to teach this new approach to high school students majoring in physics or chemistry, awarding 40 percent of the matriculation credit. The statistical-thermodynamics is first established using a lattice gas model to count states, calculate entropy, and explore the meaning of temperature; using a mean-field approximation simplifies the presentation of the free energy of systems with interactions, needed to predict the structure and phase behavior of many soft matter systems. We also describe how the implementation of the program was facilitated in the Israeli educational system and analyze the performance of the students in carrying out sample tasks.

DC02: 5–5:30 p.m. Maintaining Interest: Retention of First Year Physics Students

Invited – Ian Bearden, Niels Bohr Institute, University of Copenhagen, Blegdamsvej 17, København Ø, Denma3DK-2100; bearden@nbi.dk

Camilla Ø. Rump, Bjørn F. Johannsen, Dept. of Science Education, University of Copenhagen

What makes students drop out during their first year of studies and what makes them stay? A qualitative interview study of attrition at a Scandinavian university (Johannsen 2007) revealed that students used an introspective discourse to explain why they left their programme, i.e., they ascribed the reason for leaving primarily to things within themselves. From an educational perspective, this is unsatisfactory since it gives educators no direction for action in order to increase retention. Therefore a longitudinal interview study of retention and attrition was initiated at the University of Copenhagen. We followed 26 physics students from acceptance to a physics programme and all through the first year in order to uncover possible causal structures of attrition and retention in relation to the physics programme. Results show that the vast majority of students are intrinsically interested in physics as a science on entrance to the programme, but their notion of physics as a science is rather vague.

DC03: 5:30–5:40 p.m. Correlation between FMCE Scores and Mathematics Skills in Japan

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

Studies conducted in the United States have shown that math skills are related to college students' physics performance. We investigated this relationship in Japanese engineering students. In high school, Japanese students are required to study mathematics but not physics. Most students sampled here wrote a math placement test in their first freshman quarter and took an introductory mechanics course in their first sophomore quarter. Using the math placement test and the FMCE scores, we investigated whether correlations exist between high school mathematics skills and introductory physics conceptual performance. We found that (1) the math scores correlated strongly with those for acceleration and Newtonian laws on the pre-FMCE; (2) the math scores correlated with those for kinematics, Newtonian laws, and energy in the FMCE gain; and (3) very low math scores correlated strongly with very low FMCE scores. We conclude that high school mathematics skills play an important role in learning physics concepts.

DC04: 5:40–5:50 p.m. Pre-concepts in Electromagnetism of Students in the School of Physics, UAZ, Mexico

Jesús Madrigal-Melchor, Unidad Académica de Física, Universidad Autónoma de Zacatecas, Zacatecas, Mexico 98060; jmadrigal.melchor@fisica.uaz.edu.mx

Juan M. Rivera-Juárez, Agustín Enciso-Muñoz, Juan López-Chávez, Unidad Académica de Letras, Universidad Autónoma de Zacatecas

The objective of the present work is the evaluation and analysis of previous knowledge regarding certain aspects of electricity and magnetism of new entry students in the School of Physics (UAF) of the University of Zacatecas (UAZ), Mexico. In order to determine the new entry students' previous physics knowledge, we applied an evaluation consisting of 13 questions relating to some basic concepts of electricity and magnetism. The results obtained confirm the main hypothesis of our investigation: students do have previous knowledge of physics but it is not necessarily accurate.

DC05: 5:50–6 p.m. Exploring Student Understanding of Uncertainty in Measurement

Manjula D. Sharma, University of Sydney, School of Physics (A28), Camperdown, NSW 2006; m.sharma@physics.usyd.edu.au

Jo McKenzie, Les Kirkup, University of Technology, Sydney

Paul Francis, Australian National University

Darren Pearce, Queensland University of Technology

Understanding and quantifying uncertainties in measurements are often key elements of undergraduate experimental physics. In this study we explore what students make of uncertainty and to what extent they appreciate its omnipresence. Twenty-one first-year students from four Australian universities were interviewed after they had completed at least a semester of a physics laboratory program. Each interview was approximately an hour long and contained two data sets. The first data set was on measurements of the Earth's magnetic field while the second was on battery lifetimes. During the interview students were probed on their understanding of uncertainties. An adaptation of phenomenographic analysis was used and the results indicate that the integration of three elements is critical for understanding uncertainty: pattern relating to comprehending variations in data; formal relating to deploying equations and techniques for manipulating data; and meaning relating to how conclusions are drawn and why uncertainty is important.

Session DD: Teaching with Technology I

Location: Broadway I/II
Sponsor: Educational Technologies Committee
Date: Monday, July 19
Time: 4:30–6 p.m.

Presider: Todd Leif, Cloud County Community College, tleif@cloud.edu

Technology gives physics students new ways to get data, analyze it, and communicate their results; it helps teachers present concepts and perform demonstrations; and it spawns unprecedented logistical nightmares. What does technology make possible? How can it work well in a real classroom? These presentations describe new insights into how to use technology effectively to promote student learning.

DD01: 4:30–4:40 p.m. An eTextBook Providing Blended, Multimodal Access to Computational Physics Curricula

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

Manuel J. Paez, University of Antioquia, Medellin, Colombia

Cristian C. Bordeianu, University of Bucharest, Bucharest, Romania

Modules have been created that encapsulate video recordings of lectures and animated slides covering individual topics from the previously published paper text, "A Survey of Computational Physics, Introductory Computational Science" (Princeton 2008), with the Python version now made into an eBook. These modules have been included into a new electronic textbook integrating the developed video-slide modules, text materials, interactive programs, animations, sounds, and dynamic mathematics (MathML) into a highly accessible form destined for the National Science Digital Library/Compadre, and perfect for tablet computers. The video modules as well as the eTextbook will be demonstrated.

DD02: 4:40–4:50 p.m. Facebook and YouTube in Introductory Project-based Physics for Architects Course

Marina Milner-Bolotin, Faculty of Education, University of British Columbia, 2125 Main Mall, Vancouver, BC V6T 2K9; mmilner@interchange.ubc.ca

The Physics for Architects Course at Ryerson is an introductory course. It aims at: (a) helping students understand basic physics principles relevant to architecture; (b) teaching them to communicate these principles; (c) helping the students gain confidence in their ability to understand physics. Course topics include elements of structural loads, vibrations, resonance, heat transfer, etc. It culminates with a group project Physics at Ryerson Architecture Demo Exhibit (PARADE) that showcases students' projects. During the first two years of the course, PARADE was presented to the entire faculty and the general public and the photographs taken during the project were uploaded on Facebook. During the third year, the students were asked to create short video clips and upload them on YouTube. We report on the results of the Project implementation and discuss the challenges and benefits of the technology-enhanced project-based instruction in a large introductory physics course for non-physics majors.

DD03: 4:50–5 p.m. Loudspeaker Line Array Educational Demonstration

Brad D. Moser, Webb City High School, 621 Madison St., Webb City, MO 64870; mophysics@gmail.com*

Brian E. Anderson, Kent L. Gee, Brigham Young University

This presentation presents a user-friendly method for educators to provide a physical demonstration of line arrays (or the interference of multiple sources). This demonstration allows students to experience the interference patterns that result from line arrays to deepen their understanding. LabVIEW is used to control a line array output and steering in real time, though other software may be used. Controls of the array include varying the frequency, angular steering by phase shading, and side lobe reduction through amplitude shading. An inexpensive, eight-element, loudspeaker array has been constructed to test the control program. Measurements of the directivity of this array in an anechoic chamber and in a large classroom will be presented. These measurements agree well with theoretical directivity predictions. This array control tool may also be used in exploratory classroom laboratory assignments or to create a directional source for various research applications.

*Sponsored by Brian E. Anderson.

DD04: 5–5:10 p.m. Physvids: The Great Physics Video Contest

Edgardo L. Ortiz Nieves, The Pennsylvania State University, 104 Davey Lab, PMB 194, University Park, PA 16802; elo3@psu.edu

Daniel J. Costantino, John Hopkins, Stephen Van Hook, The Pennsylvania State University

To motivate students in our introductory physics courses, we created the Great Physics Video Contest in which groups of students develop short videos presenting a physics concept applied to a phenomena that they see in their everyday life, preferably with a local angle. The videos are posted on the web for other students in the class to view and then vote for their favorites. We award prizes to the contest winners in class at the end of the semester. Students benefit from the development of the videos and by observing the work from their peers. Furthermore, the movies also provide a resource for instructors to use in lectures, and to make real-world homework problems and video-analysis laboratories.

DD05: 5:10–5:20 p.m. Vancouver Olympic Physics and Other Physics Applications from the NY Times

John P. Cise, Austin Community College, 1212 Rio Grande St., Austin, TX 78701; jpcise@austincc.edu

The New York Times during this past winter's Olympics 2010 in Vancouver was rich in physics application articles: kinematics, projectiles, Newton's second law, centripetal force, momentum conservation both linear and angular, PE , KE, energy conservation, friction work, coefficient of friction, normal forces, heat, etc. I have developed printable web one-page physics application questions based on Times articles rich in physics graphics and parameters. The website is: http://CisePhysics.homestead.com/files/NYT.htm. The site has 11 pages with 40 Times physics applications single page questions per primary page. Page 10 is the newest based on 2010 events. Total printable web pages now is 450 single pages. The Vancouver Olympics provided great physics applications from New York Times articles. The Times is now adding great physics-based videos to point and click on. Videos even have conceptual equations as L = I (angular velocity). The focus is on physics applications happening currently in the world. These pages can be used: to introduce new concepts, quizzes, extra credit. The site is listed at ComPADRE as a resource. NYTimes physics applications site: http://CisePhysics.homestead.com/files/NYT.htm

DD06: 5:20–5:30 p.m. Designing an Independent Study Physics Course

Harold T. Stokes, Brigham Young University, Dept. of Physics, Provo, UT 84602; stokesh@byu.edu

Our department was asked to design introductory physics courses for Independent study at Brigham Young University. Students throughout the world enroll in this course, and they work over the Internet at their own pace. We will discuss the structure of the course and some of the Internet tools we developed to deal with the problems encountered with distance learning.

DD07: 5:30–5:40 p.m. Collegial Video Conferences Enriching High School Physics

David W. Trapp, Sequim Science, 1382 Holland Rd., Sequim, WA 98382; dtrapp@mac.comokoloff

Monthly video conferences between high school teachers involved in QuarkNet programs supported by NSF and DOE via FermiLab and Notre Dame University are pioneering new ways for otherwise isolated teachers to have ongoing conversations with colleagues. Such video conferences have provided a mechanism to disseminate the latest scientific research discoveries and findings, for teachers widely distributed about the country to coordinate student research projects, to arrange and optimize student participation in national and international instructional activities, and to discuss other challenges, problems, and solutions involving teaching physics. The videoconferences appear to be a cost- and time-effective technology for addressing some of the problems facing high school physics instruction.

DD08: 5:40–5:50 p.m. Using DynamicBooks to Teach Physics to Life-Science Students

Paul P. Urone, California State University, Sacramento, PO Box 587, Citrus Heights, CA 95611; paulpeterurone@comcast.net

Kim Dirks, University of Auckland

Roger A. Hinrichs, State University of New York, Oswego

Manjula Sharma, University of Sydney

DynamicBooks are the latest innovation in electronic textbooks. We will discuss the advantages of this format in teaching college (algebra-based) physics to life science students. DynamicBooks are fully editable by instructors. This feature allows instructors to customize the content in their book, and helps them avoid the hassle of frequently retooling courses and syllabi to keep up with textbook revisions. Students can download books as electronic files or order print copies that incorporate these edits. An updated version of our College Physics textbook will debut later this year in this format. This book will contain several unique elements that will help focus students' attention on problem-solving, build their estimation skills, and link physics concepts to material they will study in future biology and pre-med courses.

DD09: 5:50–6 p.m. Testing the Effectiveness of an Online Homework System

Shannon D. Willoughby, Montana State University, PO Box 173840, Bozeman, MT 59717; willoughby@physics.montana.edu

Online homework systems are becoming more sophisticated and also more popular across U.S. college campuses. But to what extent are claims of improved learning realized in a real classroom setting In order to test the hypothesis that online homework increases student understanding, we had our 400 Astronomy 101 students use "masteringastronomy.com" for the spring 2010 semester. With several semesters worth of matched ADT pre- and post-test data to serve as the control, the only change we made this semester was the addition of the online homework. During this semester students were given online homework assignments once a week and it counted for 10% of their overall course grade. We report on ADT data collected this spring during the experiment, and compare it to our historic ADT data in order to see the effect (if any) the use of online homework has on student understanding of key astronomy concepts.

Session DE: Lecture/Classroom I

Location: Broadway III/IV
Date: Monday, July 19
Time: 4:30–5:50 p.m.

Presider: Pat Viele, Cornell University, ptv1@cornell.edu

DE01: 4:30–4:40 p.m. How Is Range of a Baseball Affected by Performance Enhancement?

Blane Baker, William Jewell College, Campus Box 1130, 500 College Hill, Liberty, MO 64068; bakerb@william.jewell.edu

Previous workers have performed analyses to determine how an increase in muscle mass due to anabolic steroid use could affect the bat speed of an elite baseball hitter. From these results, the range of a baseball is determined for the case of a batter who is doping versus one who is not. The model used here assumes optimal conditions (including the fact that the ball is being struck at the "sweet spot" of a bat). For the case of a non-spinning ball, the range for a hitter who is doping is found to exceed that of one who is not by the order of 10 meters. This presentation includes details of the physical analysis and a discussion of an activity developed for students. The activity guides students through a series of computations that lead to a comparison of the two cases discussed above.

DE02: 4:40–4:50 p.m. Quantum Mechanical Aspects of Porous Bilipid Layer: Cation Passive Transport

David I. Blackman, Retired UC Berkeley, 307 W 2nd St., Phoenix, OR 97535-7733; gribear@mac.com

Because of spatial and geometric considerations, typical Schrödinger equation treatment of the fermion in vicinity of and layer is inappropriate. Potential energy does not change with changes in the relative position of the cation relative to the membrane. What changes with time is the membrane potential energy otherwise referred to as the membrane voltage. There exists a gradient potential caused by divergent ion concentrations in accordance with the Nernst equation. The result is a Hamiltonian dynamic between membrane potential and Nernst potential. Applying this dynamics to the Fermi distribution and with a little mathematical manipulation, one gets a surprising result, a single equation description of the passive component to cellular time-based polarization. Since the dominant current for T-wave is passive transport, the theory explains T-wave shape and the leakage cessation.

DE03: 4:50–5 p.m. Iconic Problems in the Undergraduate Physics Curriculum

Juan R. Burciaga, Denison University, Dept. of Physics and Astronomy, Granville, OH 43023; burciagaj@denison.edu

Physics has a well-known spiral structure where we are introduced to problems early in the curriculum and revisit these problems again and again, each time approaching a given problem in greater depth and complexity. But what are these problems? Why do we study them in this manner? Does an understanding of the nature of these iconic problems lead to an insight into the flexibility, or inflexibility, of the undergraduate curriculum? Does this "iconic problem" paradigm offer a perspective for curricular/pedagogical change?

DE04: 5–5:10 p.m. The Elementary Physics in Four Bridge Failures

Bernard J. Feldman, University of Missouri-St. Louis, Dept. of Physics and Astronomy, St. Louis, MO 63121; feldmanb@umsl.edu

I will very briefly talk about the failures of four bridges: the Tacoma Narrows Bridge, the Nimitz Freeway, the I35W Bridge in Minneapolis, and the London Millennium Footbridge.There were alternate explanations for the failure of all four bridges. These alternate explanations (forced harmonic oscillations vs. aerodynamic self-excitation, static vs. dynamic mechanisms, engineering design failure vs. maintenance failure, and synchronous lateral excitation vs. human balance response) can all be understood using elementary physics concepts and provide wonderful examples for introductory physics classes.

DE05: 5:10–5:20 p.m. Thinking-Skills Curriculum and SCALE-UP in Algebra-based

Larry Medsker, The George Washington University, 725 21st St., NW, Washington, DC 20052; lrm@gwu.edu

Gerald Feldman, The George Washington University

Nawal Benmouna, Montgomery College

We report on our research, supported by an NSF CCLI grant, to extend SCALE-UP to algebra-based physics classes. This research goal includes a study of the cognitive aspects of physics instruction in the framework of our GWU structured problem-solving protocol using a taxonomy of cognitive skills. We are partnering with Montgomery College (MC) to study the hybrid SCALE-UP and thinking skills pedagogy in a broader population. SCALE-UP has been widely disseminated within university calculus-based curricula, but few implementations exist for this collaborative approach at the algebra-based level, especially for such diverse student backgrounds as in our study. Our progress for algebra-based SCALE-UP will be discussed, including our data from the first year of implementation (both at GWU and MC).

DE06: 5:20–5:30 p.m. A Thinking-Skills Curriculum Using SCALE-UP Implemented In Algebra-based Physics Courses at a Community College

Nawal Benmouna, Montgomery College, 51 Mannakee St., Rockville, MD 20850; nawal.benmouna@montgomerycollege.edu

Gerald Feldman, Larry Medsker, The George Washington University

The SCALE-UP student-centered active learning approach is being implemented in algebra-based physics courses at Montgomery College. This effort is supported by an NSF CCLI grant to focus on the cognitive aspects of physics instruction in the framework of a structured problem-solving protocol. This collaborative pedagogy is being incorporated into a "thinking skills" curriculum based on a taxonomy of cognitive skills. This work is being developed in partnership with The George Washington University, and current progress at Montgomery College will be discussed.

DE07: 5:30–5:40 p.m. Implementation of PER Methods at a Research-Intensive University

Chaya Nanavati, Stanford University, Physics Dept., 252 Varian Physics, Stanford, CA 94305-4060; nanavati@stanford.edu

Jonathan T. Shemwell, Patricia R. Burchat, Stanford University

Over the past two years, we have been implementing pedagogical changes in the way the introductory physics sequences are taught at Stanford. Instead of the previous instructor-centered approach, we use student-centered, active-learning strategies in discussion sections and laboratories. Weekly meetings to train the teaching assistants (TAs) on the new pedagogy are now in place. There is renewed emphasis on teaching and hallway discussions on "best teaching practice" are more common; student attendance in discussion sections has increased; students are leaving labs with better mastery of concepts. Although a few individuals have played an active role in this transformation, the additional time commitment required on the part of the instructors or TAs has been minimal. We will show clips from lab demonstrating increased student engagement; will discuss both successful and failed attempts at assessing student learning; and will share the hurdles we faced and our strategies for overcoming them.

DE08: 5:40–5:50 p.m. Atoms Are Fictions of the Chemists

Sharon L. Rosell, Central Washington University, Physics Dept., MS 7422, 400 E. University Way, Ellensburg, WA 98926; rosells@cwu.edu

At the beginning of the 20th century the existence of atoms was still a matter of contention and dispute. Atoms had never been observed experimentally. They were looked upon as a working hypothesis, as mere models to explain various chemical phenomena. A new hypothesis might arise that explained chemical reactions better. Many physicists simply refused to accept the fictions of chemists as an acceptable basis of physics. This paper explores how significant work by prominent scientists of the day, such as Albert Einstein, changed this perception.

Session DF: Teaching Physics Around the World

Location: Grand Ballroom II
Sponsor: International Physics Education Committee
Date: Monday, July 19
Time: 4:30–6 p.m.

Presider: Lei Bao, The Ohio State University, lbao@mps.ohio-state.edu

DF01: 4:30–5 p.m. Physics Education in Germany

Invited – Knut H. Neumann, Leibniz-Institute for Science and Mathematics Education (IPN) Kiel, Olshausenstrasse 62, Kiel, SH, Germany 24098; neumann@ipn.uni-kiel.de

Large-scale assessments have revealed particular differences in students' mathematics and science achievement across countries, whereas analyses of respective instruction provided evidence that instruction is culturally specific. It therefore seems that different traditions of instruction each carry advantages and disadvantages as well. So, why not learn from each other. However, merely copying how others design instruction might not be successful as instruction is embedded in a greater cultural context, the education system. It is therefore necessary to understand the specific culture of education of a country first before comparing instruction. Based on a description of the German tradition of education, the German education system and the role of physics education within this system, the presentation will describe the strengths and weaknesses of German physics instruction when compared to physics instruction in other countries.

DF02: 5–5:30 p.m. Physics Education in Chinese Universities

Invited – NiaLe Wu, CASTU Tsinghua University, Haidian District, No. 9, Dong Dan San Tiao, Beijing, P.R. China 100084; nwu@tsinghua.edu.cn

In China, there are about 6.3 million new students enter college every year. Among them, there are about 40,000 majoring in physics or applied physics. Each year, 2 million college students would take one or two introductory physics courses. In this talk, I will introduce the general course structures for students majoring in physics, applied physics and non-physics fields. I will also give an overview of the developmental history of Chinese college physics curricula and the challenges we are facing now. New development and course reforms will also be discussed.

DF03: 5:30–6 p.m. A Dialogue-based Teaching Model for Effective Learning

Invited – Hongbin Huang, Dept. of Physics, Southeast University, Nanjing 210096, P.R. China, Nanjing, Jiangsu; huanglphb@seu.edu.cn

Hui Zhong, Fang Gu, Ying Yun, Southeast University

The course "Introduction to Bilingual Physics" has been established for 10 years and resulted in fruitful success, the foremost of which is that there have been 26 students being qualified to attending international conferences in the past five consecutive years. A dialogue-based teaching model for effective learning appears to emerge out of our many years' practice and experience. We have adopted "4P" approaches: the plug-in student presentation, problem-based discussion, project-orientated cooperation and platform-supported forum, to increase the dialogue and communication between students and teachers, aiming at intriguing higher-level thinking in personnel and in-depth cooperation between students, which would finally lead to the effective learning and innovative study. Some of the student papers and their reflective essays on the course have been collected in the new published book *Sailing* for future, which indicates partly the effectiveness and success of the dialogue-based model in our bilingual physics course.

Session DG: The Art and Science of Teaching

Location: Pavilion East
Sponsors: Research in Physics Education Committee, Physics in Undergraduate Education Committee
Date: Monday, July 19
Time: 4:30–6 p.m.

Presider: Ray Burnstein, Illinois Institute of Tech., burnsteinr@iit.edu

DG01: 4:30–5 p.m. Facilitating Thinking and Learning in the Physics Classroom

Invited – Chandralekha Singh, University of Pittsburgh, Dept. of Physics, Pittsburgh, PA 15260; clsingh@Pitt.edu

Despite our best and most sincere efforts, there is an alarming disconnect between what we teach and what students learn and understand. Cognitive research indicates that students must be actively engaged in extending, organizing, and restructuring their knowledge. To acquire usable knowledge, students must be given an opportunity to connect what they are learning with what they already know. Instructional design needs to take into account students' prior knowledge, because the cognitive load during learning depends upon the expertise, and experience of the learner. Cognitive load can be reduced by scaffolding, i.e., by designing instructional tools and learning communities that provide support and guidance to students with a focus on gradually helping them develop self-reliance. I will give examples from my own research in physics education of how students' prior knowledge can be assessed, and how learning exercises can be designed and assessed that provide scaffolding and help students develop a robust knowledge structure and critical thinking skills. This work is supported by the National Science Foundation.

DG02: 5–5:30 p.m. The Magic of Teaching Middle-Division Physics Students*

Invited – Corinne A. Manogue, Oregon State University, Dept. of Physics, Corvallis, OR 97331-6507; corinne@physics.oregonstate.edu

"Teaching is the art of leading students into a situation in which they can only escape by thinking." – *Dr. C. T. Bassoppo-Moyo*
All of us have experienced the "teachable moment," both in ourselves and in our students. The magic of teaching, like all magic, arises from knowing how your audience will respond to particular cues and knowing how to direct the audience's attention where you want it. I will discuss some standard and some not-so-standard items from my physics teacher's bag-of-tricks. I'll also discuss some of the things that I have learned about how middle-division physics students respond to particular classroom situations and how these understandings can be used to promote the teachable moment. How can we best lead our students into situations that they can only escape by thinking? And how can we structure these situations so that a reasonable amount of thinking will result in productive learning rather than unproductive frustration.

*This work was funded in part by NSF Grants: DUE 9653250, 0088901, 0231032, 0231194, 0618877, 0837829.

DG03: 5:30–6 p.m. Education Research Employing Operational Definitions Can Enhance the Teaching Art*

Invited – Richard R. Hake, Indiana University, Emeritus, 24245 Hatteras St., Woodland Hills, CA 91367; rrhake@earthlink.net

The OPERATIONAL definition of terms such as "inquiry," "discovery," and "direct instruction" is required if research findings are to be meaningfully conveyed to the education community and the general public. For example, in 2004 Klahr & Nigam demonstrated the superiority of what they defined as "direct instruction" over what they defined as "discovery learning." But their research was widely misinterpreted as showing that "direct instruction" in all its various forms was superior to "discovery learning" in all its various forms. Then, in 2006, Kirschner, Sweller, & Clark added to the confusion by incorrectly: (a) identifying constructivist, discovery, problem-based, experiential, and inquiry-based teaching methods as all "minimally guided," and (b) proclaiming them all to be failures. Paraphrasing Klahr and Li "those engaged in discussions about implications and applications of educational research should focus on clearly defined instructional methods and procedures, rather than vague labels and outmoded '-isms."

*Supported in part by NSF grant #DUE/MDR-9253965. Based in part on "Language Ambiguities in Education Research," submitted to the *Journal of Learning Sciences* on 21 August 2008; online at http://www.physics.indiana.edu/~hake/LangAmbigEdResC.pdf (1.2 MB)

Session DH: Gender

Location: Pavilion West
Date: Monday, July 19
Time: 5:30–6 p.m.

Presider: Jill Marshall, University of Texas, marshall@mail.utexas.edu

DH01: 5:30–5:40 p.m. Gender Differences in Student Homework Habits*

CANCELED

*Caryn A. Burnett.** University of Colorado at Boulder, 390 UCB, Boulder, CO 80309; Caryn.Burnett@colorado.edu*

Lauren E. Kost, Michael A. Dubson, University of Colorado at Boulder

The large, introductory physics courses at the University of Colorado use CAPA—an online, personalized homework system. Weekly assignments consist of 10-18 questions; students have up to six tries to get each question correct. The CAPA system records when and what students submit each time they submit an answer. In prior studies, we found gender differences in how long students wait before starting their homework, the amount of time between their first and last submissions, and the amount of time between their last submission and the due date. While females tend to do worse on exams, they perform better on the CAPA homework and appear to have better homework habits than males. In the current study, we extend these findings, looking at a range of physics professors and examining data collected from an online survey that asked students about their homework habits beyond what is recorded by the CAPA system.

*This research is supported by a Noyce Fellowship.

**Sponsored by Lauren Kost.

DH02: 5:40–5:50 p.m. Studies of the Gender Gap Across the Introductory Physics Year

Lauren E. Kost, University of Colorado at Boulder, 390 UCB, Boulder, CO 80309; Lauren.Kost@colorado.edu

Steven J. Pollock, Noah D. Finkelstein, University of Colorado at Boulder

Our previous work on gender differences in introductory physics [1] has focused on student performance in the first-semester, calculus-based mechanics course. We found that males outperformed females on the FMCE by about 10% on average over seven semesters. Regression analyses suggest that by accounting for differences in the backgrounds of males and females, the gender gap is reduced to 3%. We continue these analyses in the second-semester electricity and magnetism course. We examine retention from Physics 1 to Physics 2, with a specific focus on physics majors. We look at the conceptual performance and grades of males and females in the course. Despite performing equally on the BEMA pre-test (M?F=1.6%), males outperform females on the BEMA post-test by 6% and on exams by 4%. Course grades of males and females are not significantly different. Additionally, we begin to identify the roles that identity and self-efficacy play in course performance.

1. L. E. Kost, S. J. Pollock, & N. D. Finkelstein, PRST-PER, 5, 010101.

DH03: 5:50–6 p.m. Gender, Mental Rotations, and Introductory Physics

Jessica Watkins, Harvard University, 9 Oxford St., Cambridge, MA 02138; jessica.e.watkins@gmail.com

Jason Dowd, Eric Mazur, Harvard University

In this talk we examine an often-cited claim for gender differences in STEM participation: cognitive differences on tests of spatial ability explain achievement differences in physics. We specifically investigate the role of mental rotations in physics achievement and problem-solving, viewing mental rotations as a tool that students can use on physics problems. We first look at student survey results for lower-level introductory students, finding a small, but significant correlation between performance on a mental rotations test and course achievement. In contrast, we find no such relationship for students enrolled in the honors introductory course. To understand the role that mental rotations plays in physics problem-solving, we examine how students use this tool on highly spatial physics problems in student interviews and find that mental rotation is neither necessary nor sufficient. These results suggest that the robust sex differences on mental rotation tests are of little relevance for achievement in introductory physics.

FB: Video Analysis

Location: Council Suite
Sponsor: Educational Technologies Committee
Date: Monday, July 19
Time: 4:30–5:20 p.m.

Presider: Robert Teese, Rochester Institute of Technology, rbtsps@rit.edu

FB01: 4:30–4:40 p.m. Video Analysis in Large Introductory Physics Courses*

Tetyana Antimirova, Ryerson University, Dept. of Physics, FEAS, 350 Victoria St., Toronto, ON M5B 2K3; antimiro@ryerson.ca

Video-based motion analysis is the technique of analyzing motion from the recorded digital videos. Video-analysis can be used to turn traditional lectures into a more interactive environment, and to extend student learning beyond the classroom by creating meaningful homework assignments based on the live classroom demonstrations. This is particularly important for the introductory physics courses that do not have a formal lab component. New classroom and homework activities based on demos recorded by the instructors and their students will be presented.

*This work is supported by Faculty of Engineering, Architecture and Science, Ryerson University, Canada.

FB02: 4:40–4:50 p.m. LivePhoto Physics: The Impact of Video-Analysis Activities on Learning*

Patrick J. Cooney, Millersville University, Dept. of Physics, Millersville, PA 17551; pjcooney@hotmail.com

Robert Teese, Rochester Institute of Technology

Priscilla Laws, Maxine Willis, Dickinson College

The LivePhoto Physics Project team has published[1] a collection of 33 classroom-tested activities and associated short digital videos clips to enhance introductory physics lecture demonstrations, in-class exercises, laboratories, and homework. To assess the effectiveness of this approach, the team has also developed a brief conceptual evaluation on projectile motion. We invite interested instructors to join this investigation. Our next NSF-funded professional development workshop on how digital video analysis can be used in conjunction with physics education research to help students overcome learning difficulties will be in June 2011 in Rochester, NY. This presentation will describe a new video-analysis activity that the team has developed in the last year based on feedback from instructors using our materials in their introductory courses.

*This project has been supported by National Science Foundation grants 0089380, 0424063 and 0717699 (http://livephoto.rit.edu/)

1. *Physics with Video Analysis* (Vernier Software & Technology, 2009)

FB03: 4:50–5 p.m. Video Analysis: Model of a Collapsing Star et alii

Jonathan C. Hall, Penn State Erie - The Behrend College, 5091 Station Rd., Erie, PA 16563; jch12@psu.edu

Paul G. Ashcraft, Penn State Erie - The Behrend College

Video analysis is used by introductory physics students at Penn State Erie to analyze and learn about rotational kinematics, dynamics, energy, and angular momentum. Examples include (1) the motion of a stopper on a platform rotating with constant angular acceleration, (2) a model of spinning skater changing from an extended to a tuck position, and (3) a spinning and collapsing Hoberman sphere, which models the collapse of a rotating star.

FB04: 5–5:10 p.m. Using Digital Assisted Analysis in Teaching Motion

Yuanjia Hong, 420 Heller Rd., Apt. 315, Menomonie, WI 54751; toyuanjia@gmail.com

Students in our intro-physics lab class use a digital camera to take motion pictures of various motion experiments. Students choose between using a ruler or a caliper or Photoshop software to analyze the photos displayed on the laptop immediately after filming. Hands-on participation is emphasized, rather than passive use of computer software and pre-existing films. This approach represents a viable alternative for departments without motion detectors and corresponding computer software.

FB05: 5:10–5:20 p.m. Computer-based Video/Audio Analysis in Physics: Understanding the Doppler Effect

David A. Spero, Long Trail School, 1045 Kirby Hollow Dr., Dorset, VT 05251; dspero@longtrailschool.org

Based on our experience, students often have difficulty understanding fundamental concepts related to the Doppler Effect. In particular, students have problems visualizing the shifting of a sound's frequency due to the relative motion between the sound source and an observer. In order to facilitate student understanding, digital video and audio recordings were made of a car equipped with a siren at rest and moving toward an observer at three different velocities. In a lab setting, students analyzed the sound recordings using a computer with Fast Fourier Transform (FFT) analysis and determined the main sound frequency associated with each velocity. Based on the sound frequency determinations, students calculated the velocities of the sound source (car) using the Doppler Effect equations. Finally, students used video analysis software to measure the actual velocities of the car and determined the accuracy of their frequency-derived velocity measurements. The effect of this activity on learning and student perceptions will be presented.

Session PST1: Poster Session I

Location: Exhibit Hall
Date: Monday, July 19
Time: 7:30–9 p.m.

Odd number poster authors will be present 7:30–8:15 p.m.
Even number poster authors will be present 8:15–9 p.m.

(Posters should be mounted by 8:30 a.m. Monday and taken down by 9 p.m. Monday night)

ASTRONOMY

PST1A01: 7:30–8:15 p.m. Construction and Operation of Simple Sundial-Calendar-Clock

Robert C. Mitchell, 11 W. Aloha #519, Seattle, WA 98119; jbddmc49@brc-res.com

I have designed a simple sundial in which an analemma is rotated around a sphere of some convenient radius whose axis is aligned with the polar axis. A small hole, at the center of the polar axis, projects a solar image on the analemma giving the approximate date directly. The time of day is read on a regular clock dial. Materials required and construction aids will be discussed.

PST1A02: 8:15–9 p.m. Using the Big Ideas in Cosmology to Teach College Students

Janelle M. Bailey, University of Nevada, Las Vegas, 4505 S Maryland Pkwy., Box 453005, Las Vegas, NV 89154-3005; janelle.bailey@unlv.edu

Kim Coble, Geraldine Cochran, Virginia Hayes, Donna Larrieu, Chicago State University

Recently, powerful new observations and advances in computation and visualization have led to a revolution in our understanding of the origin, evolution, and structure of the universe. These gains have been vast, but their impact on education has been limited. We are bringing these tools and advances to the teaching of cosmology through research on undergraduate learning in cosmology as well as the development of a series of web-based cosmology learning modules. In order to investigate student ideas about the structure, composition, and evolution of the universe, our group has developed an open-ended cosmology survey. We administered the survey prior to instruction and conducted follow-up student interviews using the survey. Preliminary results regarding student misconceptions in cosmology, student attitudes toward inquiry, and directions for instruction in cosmology will be presented.

PST1A03: 7:30–8:15 p.m. Hands-on Astronomy for GE Students, TAs, and Astronomy Majors

Eric G. Hintz, Brigham Young University, Dept. of Physics and Astronomy, Provo, UT 84602; doctor@tardis.byu.edu

Jeannette Lawler, Brigham Young University

As expected, hands-on experiences in introductory astronomy can have a significant impact on the student's enjoyment and learning experience. However, it can be a challenge to ensure the quality of hands-on experiences for all levels of astronomy students. As part of our astronomy program at BYU we have created an interwoven set of real-world experiences that encompass the general education students, the teaching assistants, and our astronomy majors. Our astronomy majors take an extensive observing class that prepares them for real-world astronomy research, but not necessarily for TAing. To better prepare our students to TA for the descriptive astronomy class, we have created a new hands-on class that teaches students to operate our campus planetarium and our smaller public telescopes. Because of the extensive training our TAs receive, they are better prepared to offer high-quality experiences for the GE students.

PST1A04: 8:15–9 p.m. Researching Effective Methods for Teaching the Phases of the Moon

Heather P. Jones, Brigham Young University, Dept. of Physics and Astronomy, Provo, UT 84602; denebstarlight@yahoo.com

Jeannette Lawler, Eric G. Hintz, Brigham Young University

This project investigates the effectiveness of several commonly used methods for teaching the phases of the moon to fifth- and sixth-grade students. Common teaching methods to be investigated are the use of diagrams, animations, modeling/kinesthetics, and direct observations of the Moon (in a planetarium). Students will be taught about the phases of the Moon using one or more of these methods. Data will then be measured by pre- and post- assessment of the students' understanding. The data will be used to evaluate the effectiveness of each teaching method individually and comparatively, as well as the method's capacity to discourage common misconceptions about Moon phases. Results from this research will be useful to teachers and provide foundational data for future research in the development of educational planetarium shows.

PST1A05: 7:30–8:15 p.m. Student Projects at the UWG Observatory

Bob Powell, University of West Georgia, Dept. of Physics, Carrollton, GA 30118; bpowell@westga.edu

Robert Moore, University of West Georgia

The University of West Georgia Observatory has had recent resurgence in use for student research. These projects are now possible because of the acquisition of guided telescopes, professional software, and digital cameras. These items have increased the capabilities of the Observatory for meaningful observing projects using state-of-the-art equipment. Current and ongoing projects include a search for unknown asteroids using a wide field telescope, a large format camera, and the Astrometrica software package. Another uses the same telescope and camera with narrowband color filters to find candidate variable stars. Those stars will then be observed with a higher precision telescope and camera for differential photometric observations of variability. A third project uses the observatory's 16-inch telescope and an SBIG ST-7 camera to make measurements of position angle and separations for binary stars from the Washington Double Star "Dead Star" Catalog.

LABS/APPARATUS

PST1B01: 7:30–8:15 p.m. Economical Magnetic Field Sensors for Introductory Physics

Timothy Lim, Colorado School Of Mines, Dept. of Physics,1523 Illinois St., Golden, CO 80401; tlim.mines@gmail.com

Magnetic fields and interactions are important concepts for students in introductory physics, yet they are often extremely difficult to grasp. We believe that making physical measurements of magnetic fields produced by rare-earth magnets and various configurations of current will help make the abstract concepts more tangible. This poster presents the design of a magnetic field sensor with variable measurement ranges and electronics that are compatible with existing laboratory equipment. The sensor is robust, modular, portable, programmable, and expandable. The low cost of this sensor makes it feasible to outfit any large-enrollment introductory physics course. This senior design project is in satisfaction of Engineering Physics graduation requirement at Colorado School of Mines.

PST1B02: 8:15–9 p.m. Quantitative Study of Faraday's and Lenz's Law

Joel C. Berlinghieri, The Citadel, Grimsley Hall, 171 Moultrie St., Charleston, SC 29409; Berlinghieri@Citadel.edu

Magnetic pellets, individually and strung together to form chains, are released so that they drop through and along the axis of a coil. The drop-height of each pellet depends on its start position. The induced potential and current are measured using a PASCO current/voltage sensor attached to a matched impedance connected across the coil. Power and total induced energy are computed for each induced pulse. Both entry and exit pulses are recorded. The speed of the pellets are measured after exiting the coil with and without the impedance connected. A simple model is used to analyze the potential, power, and energy data as a function of drop height.[1]

1. Joel C. Berlinghieri, P*hysics Laboratory Manual for Scientists and Engineers,* Tavenner, 2009, ISBN971-1-930208-35-3.

PST1B03: 7:30–8:15 p.m. Dielectric Constants and the Parallel Plate Capacitor: Doing It Right!

Mark F. Masters, IPFW, 2101 Coliseum Blvd., E, Fort Wayne, IN 46805; masters@ipfw.edu

Timothy T. Grove, IPFW

One common and seemingly simple laboratory investigation of capacitance consists of inserting multiple sheets of paper (or other thin sheet dielectric materials) between two conductive plates and measuring the capacitance of this system. The separation between the two plates is nominally determined by the number and the thickness of the individual dielectric sheets. The end result of this investigation is to determine the dielectric constant of the sheet dielectric. Unfortunately, this is seriously flawed because of air trapped between the dielectric sheets. The calculated dielectric constant is too low because it is of a composite material of air and the dielectric sheet. We present a simple method of performing these measurements that does not have these shortcomings and provides more accurate values for the dielectric constant. Better yet, the described investigation is even simpler for the students to perform.

PST1B04: 8:15–9 p.m. The Effective Mass of a Ball in the Air

James T. Pantaleone, University of Alaska Anchorage, 3211 Providence Drive, Anchorage, AK 99508; afjtp@uaa.alaska.edu

John Messer, University of Alaska Anchorage

The air surrounding a projectile affects the projectile's motion in several different ways. Besides the buoyant force and the drag force there is the added mass. The added mass is the increase in the projectile's inertia from the motion of the air around it. The added mass can be calculated for a sphere in an ideal fluid, where it is found to be one-half the mass of the fluid displaced by the sphere. Using this value, introductory physics lab students can easily and accurately measure the acceleration of gravity with a beach ball projectile.

PST1B05: 7:30–8:15 p.m. What Do Students Get Out of Advanced Laboratory Experiences?

David Schuster, Colorado School of Mines, 2640 S. Moore Dr., #304, Lakewood, CO 80227; dschuste@mines.edu

Vince Kuo, Pat Kohl, Colorado School of Mines

A two-semester hands-on advanced laboratory sequence is required for graduation for all physics majors at the Colorado School of Mines. Typical course enrollments are 50-60 students, primarily juniors. In order to assess the educational effectiveness of this course, a study has been designed to measure student comprehension and retention of essential course concepts. Students complete a global concept assessment implemented using a pre-post design to determine their improvement in the course. Additionally, topical-quizzes relating to the material of each specific lab are administered in two ways: in one section, these quizzes are given at the beginning of each class, and in the other section at the end. This design investigates whether previewing lab material has different effects on student understanding than reviewing it after the fact. Results are discussed.

PST1B06: 8:15–9 p.m. Using Campus Fiber Networks in a Speed-of-light Lab

James D. White, Juniata College, 1700 Moore St., BAC, Huntingdon, PA 16652; white@juniata.edu

Measurements of the speed of light in optical fiber are often conducted in undergraduate physics labs by correlating the length of fiber to the time a pulse of light takes to travel through them. With the ubiquitous use of fiber for campus Internet connections between buildings, access to various lengths of fiber patch cables has become increasingly easy and inexpensive. In addition, since most colleges have installed far more strands of fiber between buildings than needed, students can measure the distance to college dorms and academic buildings via fiber cable routes by tapping into the campus fiber network. The added relevance of using the same fiber, same connectors, and similar signal sources and detectors significantly adds to student interest in this lab experience. This presentation outlines this surprisingly accurate and inexpensive lab as well as the instructive error analysis that is conducted as a part of the work.

PST1B07: 7:30–8:15 p.m. Experiments in Solar & Wind Power

Stephen Luzader, Frostburg State University, 59 Centennial St., Frostburg, MD 21532; sluzader@frostburg.edu

Hang Deng-Luzader, Frostburg State University

While developing lab activities on solar and wind power for gifted and talented middle school students, we found we needed to perform some experiments that would be suitable for physics majors. These include determining the current-voltage characteristic for a solar cell, finding the Thevenin resistance of a solar cell and a wind turbine in order to find the optimum load resistance, determining the maximum electrical efficiency of solar cells and wind turbines, and demonstrating that the maximum power output from a wind turbine depends on the cube of the wind speed. These experiments would be suitable as a basis for a variety of courses and individual or group research projects. Supported in part by Maryland State Department of Education Grant 901838.

PHYSICS EDUCATION RESEARCH I

PST1C01: 7:30–8:15 p.m. Development of a Faculty Perceptions Survey

Wendy K. Adams, University of Colorado, UCB 390, Boulder, CO 80309; wendy.adams@colorado.edu

Brett Gilley, University of British Columbia

Carl E. Wieman, University of British Columbia & University of Colorado

The Science Education Initiatives at the University of Colorado and the University of British Columbia pair Science Teaching and Learning fellows with faculty to transform their courses. One of the goals of the program is to identify any changes to the faculty's perceptions of teaching and student learning due to this collaboration. We have developed a Faculty Perceptions Survey which addresses a wide range of perceptions about teaching and students that both education researchers and teaching faculty value. We have conducted faculty interviews in a range of science departments in both the United States and Canada as part of this development. The Initial results suggest that experienced teaching faculty and education researchers agree on most of the areas addressed by the survey. With this research, we are hoping to provide a tool to facilitate these sorts of partnerships, offer one measure of change and learn more about faculty's perceptions of teaching. This work is supported by the Science Education Initiatives at the University of British Columbia and the University of Colorado.

PST1C02: 8:15–9 p.m. Epistemological Effect of Assessment Style in Introductory Physics

Mark Bowen, U.C. Davis PER Group, 1546 Squaw Valley Dr., Woodland, CA 95776; physicswarrior@yahoo.com

Epistemologies were measured across two separate lecture sections of introductory algebra-based physics at UC Davis. Remarkable differences in epistemologies, as measured by the MPEX II survey were noted with one section's students (section A) showing significantly better gains in almost all epistemological categories than the other (section B). One difference between the sections was the style of the assessment (quizzes) employed by each lecturer. Section A's assessment required complex reasoning using basic physics concepts while section B's assessment consisted of standard physics problems that could be solved algorithmically. Although there may have been other important differences between the sections such as lecture style, we hypothesize the assessment in section A sent a strong, positive epistemological message to the students. We will report results from a new investigation, varying assessment style in two separate lecture sections, each with the same instructor.

PST1C03: 7:30–8:15 p.m. Effects of Temporal Order of Physical and Virtual Activities*

Adrian Carmichael, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506-2601; adrianc@phys.ksu.edu

Jacquelyn J. Chini, Elizabeth Gire, N. Sanjay Rebello, Kansas State University

Sadhana Puntambekar, University of Wisconsin-Madison

Understanding how students use and learn from physical and virtual experiments has become an important area of research in science education. It has been shown that using both physical and virtual experiments can increase student learning better than using just a physical experiment. In this study, we aim to gain deeper insight into how both physical and virtual experiments can be used to maximize student learning. We investigated how the temporal order of performing both physical and virtual experiments influenced students' conceptual understanding of inclined planes. Students in a conceptual-based physics laboratory learned about inclined planes in the context of an inquiry-based curriculum. We report on analysis of data from pre-, mid- and post-tests that were designed to assess student understanding of the physics concepts related to inclined planes.

*This work is funded in part by the U.S. Department of Education, Institute of Education Sciences, Award #R305A080507.

PST1C04: 8:15–9 p.m. When Would Students Use Physical or Virtual Data?

Jacquelyn J. Chini, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506-2601; haynicz@phys.ksu.edu

Adrian Carmichael, Elizabeth Gire, N. Sanjay Rebello, Kansas State University

Sadhana Puntambekar, University of Wisconsin-Madison

We extend our previous study of students' views of the usefulness of data collected from experiments with physical and virtual manipulatives. Our previous research on the effects of physical and virtual experimentation on student learning suggests a mode-dependent difference by concept. We investigate whether students recognize the same effect. Students enrolled in a conceptual-based physics laboratory performed four two-hour experiments with physical and virtual pulleys and inclined planes over four weeks. Students then completed an open-ended survey designed to explore their views about data collected from physical and virtual experiments with pulleys. Students were asked to choose which type of data, physical or virtual, would be most useful in several situations with varying context, concepts and pulley setups. We will present the results of this survey and compare these results with those from our previous study, where students had only one week's exposure to the pulley experiments.

PST1C05: 7:30–8:15 p.m. Motivations to Use or Not Use Research-based Strategies

Melissa Dancy, Johnson C. Smith University, 100 Beatties Ford Rd., Charlotte, NC 28216; melissa.dancy@gmail.com

Charles Henderson, Western Michigan University

Chandra Turpen, University of Colorado

We conducted interviews with 72 physics faculty who reported being current users, former users, or knowledgeable non-users of either Peer Instruction or Workshop Physics. Interviewees who reported using a strategy were asked why they initially tried using the strategy. Additionally, former users where asked why they discontinued use. Knowledgeable non-users (faculty familiar with the strategy who had never tried it) were asked why they had decided not to use the strategy. We report an analysis of their responses.

PST1C06: 8:15–9 p.m. Assessing Students' Attitudes in a College Physics Modeling Course

Jorge de la Garza, Tecnologico de Monterrey, Av. E. Garza Sada 2501, Monterrey, NL Mexico 64849; jdelagarza@itesm.mx

Hugo Alarcon

Recently Brewe, Kramer and O'Brien[1] have reported positive attitudinal shifts using the strategy of modeling instruction, which are contrary to previous observations on other methodologies based in active learning.[2] Taking into account the benefits of modeling instruction, it was implemented in an introductory mechanics course to improve conceptual learning. Inspired in the published results,[1] the Colorado Learning Attitudes about Science Survey (CLASS)[2] was applied as a pre-test at the beginning of the semester, and as a post-test at the end. Comparing the different categories of the CLASS, we have determined significantly positive shifts in Overall, Sophistication in Problem Solving, and Applied Conceptual Understanding.

1. E. Brewe, L. Kramer, and G. O'Brien, "Modeling instruction: Positive attitudinal shifts in introductory physics measured with CLASS," *Phys. Rev. ST Physics Ed. Research* **5**, 013102 (2009).

2. W.K. Adams, K.K Perkins, N.S. Podolefsky, M. Dubson, N.D. Finkelstein, and C.E. Wieman, "New instrument for measuring student beliefs about physics and learning physics: The Colorado learning attitudes about science survey," *Physical review special topics*, 101010, (2006).

PST1C07: 7:30–8:15 p.m. Understanding Confusion: Is it as Bad as it Seems?

Jason E. Dowd, Harvard University, 17 Oxford St., Cambridge, MA 02138; jedowd@gmail.com

Ives S. Araujo, Julie A. Schell, Jessica Watkins, Eric Mazur, Harvard University

Physics instructors, by and large, try to avoid confusing their students. However, the truism underlying this approach, "confusion is bad," has been challenged by instructors dating as far back as Socrates, who asked students to question their assumptions and wrestle with ideas. This begs the question: Are confused students simply lost, or does their confusion indicate deeper, more critical thinking than less-confused learners? We evaluated student performance on assignments (i.e. correct and incorrect responses) in an introductory physics course that involved innovative methodologies (peer instruction, just-in-time teaching, and research-based materials) while simultaneously asking them to self-assess their confusion over the material. We probed whether students who said they were confused were correct more or less frequently than students who did not claim to be confused. In this poster, we highlight our results and draw some conclusions about confusion. Is it really as bad as it seems?

PST1C08: 8:15–9 p.m. Is Explanation Enough to Assess Student Understanding?*

James Finley, Rutgers University, 10 Seminary Place, New Brunswick, NJ 08901; tbartiro@gmail.com

Tara Bartiromo, Eugenia Etkina, Rutgers University

There is a strong emphasis in physics education research on the use of multiple representations to help students solve physics problems. Students who learned kinematics from the Physics Union Mathematics curriculum* answered a qualitative test question that required them to use multiple representations to explain their answer. Depending on the representation used for grading, different students showed understanding. When we looked at pairs of representations (motion diagram and graph), we found that students were often consistent but not necessarily correct. Based on the patterns in the data we argue that to fully assess student understanding we need to provide students with problems that require them to use at least three different representations to explain their answer.

*Work supported by NSF grant DRL-0733140.

PST1C09: 7:30–8:15 p.m. Describing Collaborative Activity in Terms of Substantive and Interactional Constraints*

Brian W. Frank, University of Maine, 5709 Bennett Hall, Orono, ME 04468; bwfrank@umit.maine.edu

Adam Kaczynski, Benedikt Harrer, Michael C. Wittmann, University of Maine

How should we define "tutorial instruction"? On the one hand, tutorial instruction might be defined as a curricular genre, one that comprises specific forms and styles for conveying instruction through material artifacts. On the other hand, tutorial instruction might be defined as a social genre, one that comprises specific forms and styles for participating in a classroom setting. We believe that these two aspects of tutorial instruction are intimately related, but how do we describe that relationship? To address both of these questions, we propose a framework for conceptualizing tutorial activities as overlapping (and possibly conflicting) sets of intended and realized constraints. We see various ways that classroom configurations, instructors, and even worksheets act to constrain the substantive and interactional aspects of students' classroom activity. To illustrate this framework, we explain how several unanticipated facets of student activity during a modified tutorial about light and shadow arise within different constraints.

*The research has been funded in part by the National Science Foundation under Grant No REC-0633951.

PST1C10: 8:15–9 p.m. Thinking about Representational Fluency in Terms of Epistemic Games*

Elizabeth Gire, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506-2601; egire@phys.ksu.edu

Dong-Hai Nguyen, N. Sanjay Rebello, Kansas State University

Competence in physics requires the ability to use various representations (words, equations, pictures, diagrams, and graphs) to analyze physical situations and to solve problems. We use the framework of epistemic games to describe and study students' use of representations while solving physics problems. Epistemic games are activities and strategies that guide inquiry and are used to create knowledge or solve problems. Examples of some epistemic games include Making a List and Pictorial Analysis. We focus on students' use of graphs and equations for problems in Newtonian mechanics and electrostatics. Our data come from individual and focus group interviews with students in a college-level, calculus-based introductory physics course.

*This research is supported in part by NSF grant 0816207.

PST1C11: 7:30–8:15 p.m. The Relationship Between Instructor and Situational Characteristics and the Use of Research-based Instructional Strategies in Introductory Physics*

Charles R. Henderson, Western Michigan University, WMU Physics, Kalamazoo, MI 49008-5252; Charles.Henderson@wmich.edu

Melissa H. Dancy, Johnson C. Smith University

Magdalena Niewiadomska-Bugaj, Western Michigan University

Chandra Turpen, Western Michigan University and University of Colorado at Boulder

During fall 2008 a web survey, designed to collect information about pedagogical knowledge and practices, was completed by a representative sample of 722 physics faculty across the United States. We have previously presented summary statistics from this survey to indicate, for example, that nearly half of the college physics faculty in the United States report that they currently use one or more of the Research-Based Instructional Strategies (RBIS) we asked about. Here we describe how seven situational characteristics and 13 personal characteristics correlate with faculty use of RBIS. Logistic regression analysis was used to develop a model that predicts faculty membership in one of four groups related to their knowledge and use of RBIS. Five characteristics were identified as significant predictors in the model: class size, departmental encouragement, gender, attendance of the physics and astronomy new faculty workshop, and percentage of job responsibilities related to teaching.

*Supported by NSF #0715698.

PST1C12: 8:15–9 p.m. What Does Epistemological Priming Look Like?

Paul S. Hutchison, Grinnell College, Dept. of Education, Grinnell, IA 50112; hutchiso@grinnell.edu

Mary McDonald, Grinnell College

Renee Michelle Goertzen, University of Maryland, College Park

We previously reported the results of a large-n survey study showing statistical differences in student responses to a dynamics question when different lead=in questions were used to prime different stances toward knowledge. Subsequently several "think-aloud" interviews using the same questions as the large-n study were conducted to investigate student reasoning under the different priming conditions. Analysis of the think-aloud interviews shows when students encounter the dynamics question most initially employ reasoning strategies similar to those they used on the priming questions. Different types of priming questions result in different initial reasoning strategies. In most interviews students became dissatisfied with their initial reasoning strategy and switched to a different one, but the priming effect on the initial reasoning strategy may explain the statistical difference we observe in the large-n survey study.

PST1C13: 7:30–8:15 p.m. The Impact of Self-Efficacy in the Introductory Physics Year

Lauren E. Kost, University of Colorado at Boulder, 390 UCB, Boulder, CO 80309; Lauren.Kost@colorado.edu

Steven J. Pollock, Noah D. Finkelstein, University of Colorado at Boulder

Our previous work on gender differences in introductory physics[1] has focused on student performance in the first-semester, calculus-based mechanics course. We found that males outperformed females on the FMCE by about 10% on average over seven semesters. Regression analyses suggest that by accounting for differences in the backgrounds of males and females, the gender gap is reduced to 3%. We continue these analyses in the second-semester electricity and magnetism course. We examine issues of retention, conceptual performance, identity and self-efficacy. In this poster we focus on differences in males' and females' sense of physics self-efficacy (students' beliefs about their ability to complete the tasks necessary to be successful in physics) and how self-efficacy impacts students' performance in the course. We find significant differences on key questions about identity and self-efficacy by gender, and find correlations between these differences and course performance.

1. L. E. Kost, S. J. Pollock, & N. D. Finkelstein, PRST-PER, **5**, 010101.

PST1C14: 8:15–9 p.m. Lexical Availability for Measuring Growth in Conceptual Knowledge of Electromagnetism

Jesús Madrigal-Melchor, Unidad Académica de Física, Universidad Autónoma de Zacatecas, Calzada Solidaridad esq. Paeo a la Bufa s/n, Zacatecas, Mexico 98060; jmadrigal.melchor@fisica.uaz.edu.mx

Juan M. Rivera-Juárez, Juan López-Chávez, Agustín Enciso-Muñoz, Armando D. Contreras-Solorio, Unidad Académica de Física, Universidad Autónoma de Zacatecas

The Index of Lexical Availability (IDL), which arises from lexicometry, reflects a mental ordering of the vocabulary of a specific theme–interest center. We generate a database on the terminological dominion in electromagnetism that has the experts using the IDL and similarly we do it for the novices. We realized the comparisons of individual orderings in which it's observed that they have a low correlation among them. The previous results give foundation to the conical model of education to the physics. Lexical Availability (IDL) exhibits the existing correlation between the words of an interest field, which allows a grouping of terms that form conceptual constellations, which has allowed us to design a lesson that instead of leaving the separated or loose terms, improves the integral learning of the concepts. We have done similar research in the mechanics area and have an educational proposal.

PST1C15: 7:30–8:15 p.m. A Protocol for Evaluating Meaningful Understanding*

Mojgan Matloob Haghanikar, Kansas State University, 403 Cardwell Hall, Manhattan, KS 66506; mojgan@phys.ksu.edu

Sytil Murphy, Dean Zollman, Kansas State University

As a part of a study of the science preparation of elementary school teachers, students' reasoning skills in courses with interactive engagement teaching-learning strategies are being compared with those in traditional courses. We have devised a rubric based on the hierarchies of knowledge and cognitive processes cited in a two-dimensional revision of Bloom's taxonomy. [1] We developed two questions about phases of the Moon and light colors with the same levels of cognitive processing and types of knowledge on the base of taxonomy. In this poster we use our rubric to analyze students' responses. We assess and compare the levels of students' reasoning skills between these two disciplines.

*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 Objective,* Longman New York, (2001).

PST1C16: 8:15–9 p.m. How Students Promote and Discourage Each Other's Answer

Mary McDonald, Grinnell College, 1115 8th Ave., Box 4034, Grinnell, IA 50112; mcdonald@grinnell.edu*

Paul Hutchison, Grinnell College

"Framing" describes an individual's ongoing interpretations of the kind of activity they are engaged in. This interpretation is based in part on social cues from people around them. Therefore, framing implies that interactions with peers can inform students' framing during groupwork. To investigate this relationship, we studied video of group activity in an inquiry-based introductory physics class for elementary education majors. We created case studies of episodes with at least one change in a student's framing. In particular, we focus on transitions into or out of a framing we call "answermaking." We typically consider answermaking detrimental to student learning in its overemphasis of school tasks. Our analysis identifies student activities that may discourage (or support) answermaking. These cases present researchers a starting place for continued scholarship as well as data available for analysis. To teachers we offer ideas of what to look for and support during groupwork.

*Sponsor: Paul Hutchison

PST1C17: 7:30–8:15 p.m. Using the PER User's Guide and Adopting/Adapting Course Materials

Sarah B. McKagan, 2436 S. Irving St., Seattle, WA 98144; sam.mckagan@gmail.com

The PER User's Guide will be a web resource for helping physics educators learn about the results of physics education research (PER) and apply those results in their classrooms. As part of the development of this resource, we are conducting research on how educators adopt and adapt published PER-based curricula in new environments. We will present preliminary findings from this research and discuss how the PER User's Guide will incorporate these findings and help educators use PER-based curricula effectively.

PST1C18: 8:15–9 p.m. Longitudinal Development of Students' Representational Skills in Introductory Physics*

Dong-Hai Nguyen, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506-2601; donghai@phys.ksu.edu

Elizabeth Gire, N. Sanjay Rebello, Kansas State University

Solving physics problems posed in different representations is one of the most important skills that future physicists and engineers should have. Therefore, much effort has been focused on understanding and facilitating students' problem solving in multiple representations. In an ongoing research project, we investigate the difficulties students encounter when solving physics problems posed in multiple representations and the hints that might help students overcome those difficulties. We conducted individual teaching/learning interviews with 15 engineering students in eight sessions over two semesters of their Engineering Physics course sequence at Kansas State University. In these interviews, students were asked to solve several problems posed in verbal, graphical, and equation representations. Verbal hints were provided by the interviewer when students had difficulties solving the problem. We discuss some longitudinal trends that we observed in students' performance throughout our interviews over the two semesters.

*This research is supported in part by NSF grant 0816207.

PST1C19: 7:30–8:15 p.m. Important Types of Instructor-Student Interactions for Student Achievement in Reformed Courses

Cassandra Paul, University of California Davis, 1 Shields Ave., Davis, CA 95616; capaul@ucdavis.edu

Wendell H. Potter, University of California Davis

It has been solidly established by physics education research that interactive engagement curricula are the most successful at fostering student learning. However, curriculum is not the only element of a learning environment. Instructors can and do implement the same curriculum in strikingly different ways. I statistically analyze the amount of time 30 different instructors (all teaching the same interactive engagement course) spend in the classroom explaining, observing, and dialoguing with their students. I then correlate the frequencies of these interactions (and subcategories of these interactions) to student achievement in the classroom.

PST1C20: 8:15–9 p.m. A Study of Knowledge-based Inferences in Comprehension of Physics Problems

María E. Pereyra, FaMAF, Universidad Nacional de Córdoba, Medina Allende s/n - Ciudad Universitaria, Córdoba, Argentina 5000; epereyra@famaf.unc.edu.ar*

Zulma E. Gangoso, María E. Truyol, FaMAF, Universidad Nacional de Córdoba

To understand the statement of a physics problem, students activate their knowledge of the world and of the specific discipline and construct a situation model of what the text is about. To that end they generate knowledge-based inferences to complement the explicit information given in the text and construct a meaningful representation that is coherent and explains actions, events, and states mentioned in the text. Without this construction, the text cannot be comprehended and the problem cannot be correctly solved. Meanwhile, problem solving is the main activity used to teach and evaluate in physics courses. A strategy to improve comprehension in physics problem solving is to identify and justify those inferences. We briefly review the main perspectives concerning the generation of knowledge-based inferences and attempt the implementation of an instrument to study the construction of inferences in the context of solving a physics problem. Preliminary results are presented and discussed.

*Sponsor: David Sokoloff

PST1C21: 7:30–8:15 p.m. Becoming a Physics Expert: A Qualitative Interview Study*

Idaykis Rodriguez, Florida International University, 11200 SW 8th St., VH 173, Miami, FL 33199; irodr020@fiu.edu

Eric Brewe, Laird Kramer, Florida International University

We examine the process of becoming a physics expert, taking a socio-cultural view of learning. We present results from a qualitative interview study of faculty views on expertise. Three university physics professors were interviewed in one-hour long sessions to address the research question of how they perceive the process of becoming a physics expert. The transcripts were analyzed for emergent themes. The data indicates that faculty view building expertise as moving through stages, developing knowledge and skills, and adopting the norms of the community. These findings are consistent with the theoretical learning model, Legitimate Peripheral Participation.[1] These themes further suggest that understanding the process of becoming a physics expert can be explored by examining graduate students going through the process.

*Supported by NSF Award # PHY-0802184

1. J. Lave, & E. Wegner, *Situated learning: Legitimate peripheral participation,* Cambridge University Press, New York City (1991).

PST1C22: 8:15–9 p.m. Predicting Success from Sources of Self-Efficacy: A Gender Study*

Vashti Sawtelle, Florida International University, 11200 SW 8th St., CP 204, Miami, FL 33199; davisvas@gmail.com

Eric Brewe, Laird Kramer, Florida International University

The quantitative results of Sources of Self-Efficacy in Science Courses (SOSESC) in physics survey will be presented as a predictor of students who pass Introductory Physics 1, and disaggregated by gender. Self-efficacy as a theory to explain human behavioral change has recently become a focus of education researchers as a mechanistic way of understanding students who persist in science fields. Zeldin et al. [1,2] present evidence that indicates men and women draw on different sources for evaluation of their self-efficacy beliefs in science. At Florida International University we have examined the predictive ability of SOSESC scores on students passing the Introductory Physics 1 courses from the perspective of gender theory. Logistic regression analyses support self-efficacy literature for both men and women. Predicting passing of men requires only information on Mastery Experiences. Predicting passing for women requires information on Vicarious Learning Experiences, though not on Verbal Persuasion Experiences.

*Work supported by NSF Award # PHY-0802184

1. A.L Zeldin, & F. Pajares, *Am. Educ. Res. J.* **37**(1), (2000).
2. A.L. Zeldin, S,L. Britner, & F.J. Pajares, *Res. Sci. Teach.* **45**(9), (2008).

PST1C23: 7:30–8:15 p.m. Positive Impacts of Modeling Instruction on Self-Efficacy*

Vashti Sawtelle, Florida International University, 11200 SW 8th St., CP 204, Miami, FL 33199; davisvas@gmail.com

Eric Brewe, Laird Kramer, Florida International University

Analysis of the impact of Modeling Instruction on the sources of self-efficacy for students in Introductory Physics 1 will be presented. We measured self-efficacy through a quantitative diagnostic (SOSESC) developed by Fencl and Scheel[1] to investigate the impact of instruction on the sources of self-efficacy in all Physics 1 with Calculus classes. We collected both pre- semester data and post-semester data, and evaluated the effect of the classroom by analyzing the shift (Post-Pre). At Florida International University, a Hispanic-serving institution, we find that traditional lecture classrooms negatively impact the self-efficacy of all students, while the Modeling Instruction courses had no impact for all students. Further, when disaggregating the data by gender and sources of self-efficacy, we find that Modeling Instruction positively impacted the Verbal Persuasion source of self-efficacy for women.

*Work supported by NSF Award # PHY-0802184

1. H. Fencl & K. Scheel, *J. Coll. Sci. Teach.* **35**(1), (2005).

PST1C24: 8:15–9 p.m. Analyzing Reflective Interviews: Naturally Classroom Contextualized Epistemological Resources

Christopher W. Shubert, University of New Hampshire, DeMeritt Hall 9 Library Way, Durham, NH 03824; cwf3@unh.edu

Dawn C. Meredith, University of New Hampshire

Reflective interviews review short clips of videotaped lab work and focus questioning on student approaches to the lab activity as it took place in the natural classroom setting. Clips are intentionally selected as likely anchors for productive epistemological reflection. The analysis of the video, both the lab and the interview, are then carried out using a methodology based on constructivist grounded theory, where layers of labels are created and reviewed throughout the analytical process. Preliminary labels are considered open coding and are created to maintain valid description of student thinking. As these labels are reviewed and more videos are analyzed, the labels are refined and generalized into a focused coding. This focused coding is applied to a larger data set to test reliability. The goal of this process is to develop valid and reliable epistemological resources that are explicitly tied to the natural classroom setting.

PST1C25: 7:30–8:15 p.m. Faculty Interpretations of Instructional Strategies: A National Study*

Chandra A. Turpen, Western Michigan University and University of Colorado, Boulder, 4490 Ludlow St., Boulder, CO 80305; Chandra.Turpen@colorado.edu

Melissa H. Dancy, Johnson C. Smith University

Charles R. Henderson, Western Michigan University

A survey, designed to collect information about pedagogical knowledge and practices, was completed by a representative sample of 722 physics faculty nationally from multiple types of institutions (two-year, four-year, and graduate universities). A sub-sample of these respondents (N=72) participated in an associated interview study to better understand how faculty interact with research-based instructional strategies (RBIS), use RBIS, and perceive their institutional contexts. This talk will describe some of the preliminary findings from the interview study targeting two particular RBIS: Peer Instruction and Workshop Physics. Specifically, we describe what faculty meant when they identified themselves as users of these curricula. Meanings ranged from professors adopting the general philosophy of the curriculum (or what they believed to be the general philosophy) while inventing how it concretely applies to their classrooms to professors who use the curriculum as is, without significant modifications. We describe common adaptations of these curricula and their associated prevalence.

*Supported by NSF #0715698

PST1C26: 8:15–9 p.m. Gender Differences in Students' Reported Homework Habits*

CANCELED

*Caryn A. Burnett,** University of Colorado at Boulder, 390 UCB, Boulder, CO 80309; Caryn.Burnett@colorado.edu*

Lauren E. Kost, Michael A. Dubson, University of Colorado at Boulder

The large, introductory physics courses at the University of Colorado use an online, personalized homework system called CAPA. Weekly assignments consist of 10-18 questions; students have up to six tries to get each question correct. The CAPA system records when and what students submit each time they submit an answer. In prior studies, we found gender differences in how long students wait before starting their homework, the amount of time between their first and last submissions, and the amount of time between their last submission and the due date. While females tend to do worse on exams, they perform better on the CAPA homework and appear to have better homework habits than males. In this poster we focus on data collected from an online survey that asked students about their homework habits beyond what is recorded by the CAPA system.

*This research is funded by a Noyce Fellowship.

**Sponsored by Lauren Kost.

PST1C27: 7:30–8:15 p.m. Exploring Gender Differences in Force Concept Inventory Results through Factor Analysis

Richard D. Dietz, University of Northern Colorado, Physics Dept., Greeley, CO 80639; rdietz@unco.edu

Robert H. Pearson, Matthew R. Semak, Courtney W. Willis, University of Northern Colorado

It has been widely reported that males perform better than females on the Force Concept Inventory (FCI). The reasons for this situation remain obscure. We have determined that applying the technique of factor analysis to FCI responses by all students in introductory physics leads to the identification of several factors associated with distinct physical concepts. Here we apply the same technique to the analysis of FCI results but with the responses separated by gender in the hope of gaining some insight into the performance difference between males and females.

TEACHER TRAINING/ENHANCEMENT

PST1D01: 7:30–8:15 p.m. The Coupled-Inquiry Cycle: Effective Inquiry for Physics Students

Eric N. Rowley, Wright State University, 205 Carter's Grove Rd., Centerville, OH 45459; fizx_teacher@mac.com

The Coupled-Inquiry Cycle (CIC) (2003) is a student-centered, inquiry-based learning cycle. This model encourages deeper content understanding, higher-level thinking, and science process skills through guided and open-inquiry. Come learn how the CIC model can provide scaffolding for students to deepen their understanding of science content and process skills. This session will involve discussions of use of this learning cycle in the K-12 classroom as well as the future plans to utilize the CIC in college physics courses for K-12 pre-service teachers.

PST1D02: 8:15–9 p.m. Developing and Assessing University Students' Communication Skills Through Teaching Physics

Jessica E. Bartley, University of Colorado, Physics Dept., 2136 19th St., Boulder, CO 80304; Jessica.Bartley@Colorado.edu*

Laurel M. Mayhew, Noah D. Finkelstein, University of Colorado

The University of Colorado Partnerships for Informal Science Education in the Community (PISEC)[1] provides opportunities for undergraduates, graduate students, and post docs to participate in after school informal science activities with children. While we have previously documented the positive impact of this program on these university educators' conceptual mastery, and interest in teaching, [2,3] we examine the potential for these environments to positively impact university participants' teaching skills and their abilities to communicate about science to nonscientists. The Communication in Everyday Language Assessment, one component of the PISEC Assessment Suite, [1] has been used since the fall of 2007 to measure participants' ability to communicate in these informal settings. We present this instrument, its development and validation, and data that document the shifts that students undergo as a result of participating in PISEC. This work is supported, in part, by NSF # 0551010, the JILA AMO PFC.

1. http://spot.colorado.edu/~mayhew/PISEC/.
2. N.D. Finkelstein and L. Mayhew, "Acting in Our Own Self-Interest: Blending University and Community" P*roceedings of the 2008 Physics Education Research Conf,* AIP Press, Melville NY, 1064, (2008).
3. L. Mayhew and N. Finkelstein, "Learning to Teach Science through Informal Science Education Experiences," *Proceeding of the 2009 Physics Education Research Conf.,* AIP Press, 1179, 205-208, (2009). Finkelstein PERC 2009

*Sponsored by Noah D. Finkelstein.

PST1D03: 7:30–8:15 p.m. Physics by Inquiry Programs for In-service K-5 and 5-12 Teachers*

Robert J. Endorf, University of Cincinnati, Dept. of Physics, PO Box 210011, Cincinnati, OH 45255-0011; Robert.Endorf@uc.edu

Don Axe, Amy Girkin, Jeffrey Radloff, Kathleen M. Koenig, Wright State University

We describe the Physical Science by Inquiry professional development programs that we have been conducting at the University of Cincinnati for teachers in grades K-5 and grades 5-12. Each summer a four-week 12 quarter-credit-hour graduate course in Physics by Inquiry is given for teachers in grades 5-12 and a separate two-week 6 quarter-credit-hour course is given for teachers in grades K-5. These graduate courses use modules from *Physics by Inquiry*[1] developed by Lillian McDermott and the Physics Education Group at the University of Washington. The programs provide additional support for the teachers through three follow-up academic-year seminars and an optional web-based support course. Data will be presented from pre-tests and post-tests taken by the participants that illustrate large gains in the teachers' science content knowledge, science process skills, and confidence in being able to prepare and teach inquiry-based science lessons.

* Supported by The Improving Teacher Quality Program administered by the Ohio Board of Regents.

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

PST1D04: 8:15–9 p.m. Profiling Iowa's High School Physics Teachers

Trevor Kittleson, University of Northern Iowa, 215 Begeman Hall, Cedar Falls, IA 50614-0150; trevor.kittleson@gmail.com

Jeffrey T. Morgan, University of Northern Iowa

The University of Northern Iowa is heavily involved in offering professional development opportunities to science teachers throughout the state. In order to ascertain the current state of physics teaching in Iowa, and allow us to tailor our programs to the needs of practicing teachers, we invited all known high school physics teachers in the state to complete a survey that probed their background, current teaching practices, and future plans. We found, among other things, that while most schools employ teachers who meet the state's minimum requirements for certification in physics teaching, only one in five physics teachers has a degree in physics. Although the results we share regarding teachers' education, practices, and plans for remaining in physics teaching are specific to the state of Iowa, the trends we observed are likely mirrored in other states with significant numbers of small, rural schools.

PST1D05: 7:30–8:15 p.m. What Constitutes Effective Instruction? Views of High School Physics Teachers

Jeffrey T. Morgan, University of Northern Iowa, 315 Begeman Hall, Cedar Falls, IA 50614-0150; jeff.morgan@uni.edu

Trevor Kittleson, University of Northern Iowa

Our 2009 survey of Iowa's high school physics teachers asked participants whether or not they currently employed or had previously attempted various non-traditional approaches to physics teaching, including modeling, PRISMS, and Physics by Inquiry. Teachers who answered in the affirmative were labeled non-traditional, while the rest were considered traditional. A subsequent question asked them about their level of agreement with ten statements regarding effective physics teaching, while another asked them to rank skills or knowledge they deemed most important for their students' success in future physics courses. Examining the responses to those questions by the two groups revealed differing views on such things as the importance of numerical problem solving, when physics should be taught in the secondary science sequence, and the role of textbooks in a physics course, while the groups exhibited strong agreement on the role of group work and the importance of conceptual questions.

PST1D06: 8:15–9 p.m. Kennesaw State University's MAT in Physics

Taha Mzoughi, Kennesaw State University, Dept. of Biology and Physics, 1000 Chastain Rd., #1202, Kennesaw, GA 30144; tmzoughi@kennesaw.edu

For two years now, Kennesaw State University has been awarding Masters of Arts Degrees for Teaching Physics (MATs). Our students include physics majors and career changers from closely related fields. Most benefit of a Noyce Scholarship. The poster will describe our program, our student population and our recruitment program.

PST1D07: 7:30–8:15 p.m. ATE Project for Physics Faculty

Thomas L. O'Kuma, Lee College, Physics Dept., Baytown, TX 77522-0818; tokuma@lee.edu

Dwain M. Desbien, Estrella Mountain Community College

The ATE Program for Physics Faculty has finished its fourth year and its 15th workshop/conference. In this poster, we will display some of the materials from these various workshops/conference and illustrate some of the activities, sessions, and individuals involved—particularly from the DVTS-MBL Workshop at Lee College. We will also display what's next.

PST1D08: 8:15–9 p.m. Recognition Investigation of Physics and Chemistry Teachers on Electrodes in Galvanic Cell

Hyun-Jung Park, Sookmyung Girls' Middle School, Dokok, Kangnam, Seoul, 135-270 Korea; jbkim@knue.ac.kr

Jung Bog Kim, Korea National University of Education

This research investigated recognitions on outside and inside electrodes in an electric circuit supplied by a galvanic cell, through survey and interview to teachers who are studying in departments of Physics Education and Chemistry Education at H University Graduate School. Physics majors' designations on outside or inside parts of electrodes in a galvanic cell were different from chemistry majors'. Teachers who had majored in physics had misconceptions on the inside electrode of a galvanic cell (20%), while teachers who had majored in chemistry had misconceptions on the outside electrode (64%). Reasonings for designations of electrodes were attributed to direction of electric current in case of physics teachers and redox in case of chemistry teachers, respectively, which are strongly dependent on backgrounds performed in their undergraduate course.

PST1D09: 7:30–8:15 p.m. The Online Doctorate in Physics Education: An Experience of Teachers Training

Mario Humberto Ramírez Díaz, CICATA-IPN, Av. Legaria #694 Col. Irrigación, México, D.F. 11500; mramirezd@ipn.mx

Eduardo Chávez Lima, ESCOM-IPN

As a result of the International Year of Physics in 2005, The National Polytechnic Institute of Mexico created the web environment post-graduate studies in physics education. In 2008 the program had its first graduate student in the speciality, and in 2009 the author of this work was the first doctorate graduate student. This work presents the experience in this kind of postgraduate programs in physics education, furthermore it shows the results obtained in research through the program.

PST1D10: 8:15–9 p.m. Connecting Pivotal Concepts in K-12 Science Standards to Research in Physics Education

Chandralekha Singh, University of Pittsburgh, Dept. of Physics, 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 U.S. 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.

PST1D11: 7:30–8:15 p.m. Physics and Literacy Learning in a Course for Prospective Teachers*

Emily H. van Zee, Oregon State University, 267 Weniger Hall, Corvallis, OR 97331; Emily.vanZee@science.oregonstate.edu

Henri Jansen, Michele Crowl, Adam Devitt, Oregon State University

Learning to teach science effectively includes learning to listen closely, speak clearly, write coherently, read with comprehension, and critique multimedia resources. We have explored ways to enhance such literacy learning in a physics course for prospective elementary and middle school teachers. Data sources include students' electronic bulletin board postings, responses to homework assignments and examinations, and video recordings of class activities. We present examples of a) diagnostic questions to document initial and developing knowledge, b) reading and writing strategies to enhance learning during inquiries into physical phenomena, c) assignments in which the prospective teachers engage friends and family members in learning science, d) readings written by elementary and middle school teachers who provide examples of inquiry-based science instruction that enhances literacy learning, and e) websites documenting prospective teachers' physics and literacy learning.

*This project is supported by the National Science Foundation under Grant No. DUE-0633752. See: http://contentbuilder.merlot.org/toolkit/html/snapshot.php?id=289047664300583

PST1D12: 8:15–9 p.m. Pre-service Teacher Training: Reasons Behind the Problems in Practicum

Gozde M. Didis, Middle East Technical University, Faculty of Education, Dept. of Secondary Science and Mathematics Education, Ankara, Turkey 06531; mgozde@metu.edu.tr

Nilufer Didis, Middle East Technical University

Teacher training is one of the important majors of education. During teacher training period, pre-service teachers are aimed to have both theoretical and experiential knowledge about teaching. The theoretical part of this training is conducted by the faculty of education at the universities. However, the experiential part is conducted by both universities and cooperating high schools, since practicum is a key element of teacher training (Beck & Kosnik, 2002; McIntyre, Byrd, & Foxx, 1996). In the previous research, the problems of teacher candidates during their experience in the high schools were examined. In this study, pre-service teachers' reasons behind the problems in practicum were investigated. For this aim, semi-structured interviews were conducted by pre-service teachers at the Department of Secondary Science and Mathematics at different universities. The participants were selected purposively from four different majors (biology, chemistry, mathematics and physics education). The phenomenographic analysis was used to examine the structure of pre-service teachers' reasons, and the variation was investigated. The results of the study may be helpful for teacher trainers to reexamine their programs.

PRE-COLLEGE

PST1E01: 7:30–8:15 p.m. GEONS: Geomagnetic Events Observation Network by Students

James Bean, Carson High School, 1111 Saliman Rd., Carson City, NV 89701; jbean@carson.k12.nv.us

Terry Parent, Carson Middle School

Geomagnetic Events Observation Networks by Students (GEONS)...studying how solar weather affects the Earth's magnetic field. Using real-time magnetometer and solar data, students can calculate the Earth's magnetic field locally and predict geomagnetic storms (aurora).

PST1E02: 8:15–9 p.m. Interactive Tutorial for Developing Scientific Reasoning*

Nathaniel Caldwell, Metro Early College High School, 1929 Kenny Road, Columbus, OH 43210; caldwell.1@themetroschool.org

Jing Han, Lei Bao, The Ohio State University

Improving students' scientific reasoning abilities is an important goal in STEM education. We have developed a web-based integrative tutorial to help high school students develop reasoning skills in control of variable and proportional reasoning. In this presentation, we will report the pilot study results with a group of high school students and discuss the effectiveness of the tutorial module.

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

PST1E03: 7:30–8:15 p.m. The Physics Bowl: A Contest for High Schools

Michael C. Faleski, Delta College, 1961 Delta Road, University Center, MI 48642; michaelfaleski@delta.edu

The PhysicsBowl is an annual contest for high school students for which prizes are awarded to high scoring students and schools. The contest is given during the month of April and can serve as a good review for any physics class, including those taking AP or IB curricula. This informational poster will include copies of last year's exam, the equation sheet, the solutions, and the list of winners in an attempt to increase the awareness of this contest for both students and schools.

PST1E04: 8:15–9 p.m. Improving Students' Understanding on Optical Density

Jung Bog Kim, Korea National University of Education, Dept. of Physics Education, Cheongwon, Chungbuk Korea, 363-791; jbkim@knue.ac.kr

We investigated how to teach the concept of the optical density effectively. Students or teachers understood easily the fact that light passes through in transparent solids or liquids, however, they found difficulties in describing the optical density depending on light frequency when they observe with colored cellophanes. Teaching materials using not only colored cellophanes but also sieve and different size of beads have been designed to help students improve their ability to explain their understanding of the optical density. After being taught about whether the solids and liquids are transparent or not, students who participated in the science gifted education program and elementary school teachers were asked to explain the reason of phenomena observed with the red cellophane. We discussed how they are developing their concept of the optical density through this procedure.

PST1E05: 7:30–8:15 p.m. GK-12 at Brown University: An Inquiry-based Approach to Physics Education

John Macaluso, Brown University, 182 Hope St., Barus & Holley Building, Box 1843, Providence, RI 02906; John_Macaluso@brown.edu

The NSF GK-12 Program at Brown University places graduate student fellows in K-12 classrooms in the Providence Public School District. There, the fellows engage K-12 students in current physics by developing hands-on, inquiry-based lessons. A strong focus is placed on encouraging graduate fellows to bring research into the classroom. Outside the classroom, the program works closely with teachers (through workshops and training sessions) to enhance their knowledge of cutting-edge physics topics, their approach to physics education, and their science literacy in general. This presentation will focus on programmatic successes and challenges over the first three years of the Brown GK-12 initiative.

PST1E06: 8:15–9 p.m. Integration of THEMIS-GEONS Users Guide into Middle School GEMS Sun-Earth Curriculum

Terry Parent, Carson Middle School, 1140 West King St., Carson City, NV 89703; tparent@carson.k12.nv.us*

Classroom-ready activities developed and tested by GEONS teachers can be used by teachers presenting Earth and physical science courses in grades 6-9. GEONS activities integrated with middle school GEMS curriculum will connect basic magnetism from mapping field lines around bar magnets to electromagnetic induction as a prerequisite to understanding magnetism on Earth and in space.

*Sponsored by James Bean, Carson High School, Carson City, NV

PST1E07: 7:30–8:15 p.m. Now Even Middle School Teachers Can Teach Spectroscopy!

Pamella W. Ferris, Riverside Middle School, 1095 Fury's Ferry Rd., Evans, GA 30809; pam.ferris@ccboe.net

With low-cost spectrometers now available, even middle school teachers can use cutting-edge technology in their classrooms. Pique students' interest in multiple areas of physical science using technology that shows students how actual scientists conduct research. Using Inquiry-based strategies, students will observe the emission spectra of various light sources, first by using only the naked eye and diffraction gratings. Then using inexpensive spectroscopes, students gather data and compare those measurements to measurements of the same wavelengths made with a low-cost, but fully functional spectrometer. Never before have middle schools been able to afford such leading-edge technology. Students can now become "real" scientists and collect "real" data. This will undoubtedly spark many middle school students' interest in science and may even encourage them to become scientists in the future.

PST1E08: 8:15–9 p.m. Investigating the Electromagnetic Spectrum: ROYGBIV and Beyond

Pamella Ferris, 4521 Deer Run, Evans, GA 30809; PamellaFerris@comcast.net

Students have traditionally investigated the visible light spectrum from 380nm to 750nm (ROYGBIV) But what lies beyond those frequencies? It has been difficult to conduct scientific investigations beyond the visible light spectrum in the middle school due to our limited sensors. The human eye can detect Electromagnetic Radiation in the "visible range," but does not have the ability to detect Radio, Microwave, Infrared, Ultraviolet, X-ray, or Gamma Rays. Computer probe ware is necessary to detect and measure frequencies beyond which our eyes can see. Computer probe ware is necessary to conduct these investigations. The equipment presented will give students the ability to investigate the "invisible" part of the Electromagnetic Spectrum in order to determine emitters, detectors and shields for each of these different frequencies.

PST1E09: 7:30–8:15 p.m. Hybrid Optics and Photonics Program for High School Students and Teachers

Pamela O. Gilchrist, North Carolina State University, 909 Capability Drive, Research Building IV, Suite 1200, Raleigh, NC 27695; pamela_gilchrist@ncsu.edu

Joyce H. Clark, Geraldine Cochran, Stacey Kaufman, Joe Price, North Carolina State University - The Science House

Photonics Leaders II is a year-round National Science Foundation (NSF) Innovative Technology Experiences for Students and Teachers (ITEST) program located at The Science House on the North Carolina State University campus. The program goals are to prepare underrepresented minority students for science, technology, engineering, and mathematics disciplines and equip parents and teachers with resources to engage students during their educational transition via face-to-face and online science learning environments. The poster session will present the program model, methods used to introduce learners (both students and teachers) to optics and photonics, evaluation methods employed, curriculum development efforts and initial program findings and challenges. Come and learn about the impact of the hybrid science-learning program that prepares students, teachers and parents for the 21st century.

PST1E10: 8:15–9 p.m. The Physics Van Program: Supporting the Needs of Chicago Area Physics Teachers*

Joel N. Hofslund, Chicago State University, Dept. of Chemistry and Physics, 9501 S. King Drive - SCI-309, Chicago, IL 60628; jhofslund@aol.com

Mel S. Sabella, Chicago State University

During the past seven years, Chicago State University, through its Physics Van Program, has worked with many Chicago area high school physics students and their teachers. The Physics Van Program provides both intellectual support and access to laboratory equipment. Intellectual support is provided through a two-week summer in-service course that emphasizes research-based teaching methodology as well as instruction in the use of both basic and technology-based equipment. During the academic year, the Van Program allows teachers who have been participants to engage their students in the program activities by lending them the necessary equipment. Teachers who have been involved in the program have formed a network through which they can share common goals, discuss the conceptual difficulties of their students, and pass on valuable teaching tips. In this poster, we present a description of the program and discuss how the collaborative nature of the project has informed the program's evolution.

*Funded by the Illinois Board of Higher Education.

PST1E11: 7:30–8:15 p.m. Active Learning Studio Physics Classroom Design for Secondary Education

Simon Huss, Winward School, 11350 Palms Blvd., Los Angeles, CA 90066; shuss@windwardschool.org

Thomas Haglund, James Bologna, Windward School

This poster details the Active Learning Studio Physics Classroom designed by Windward School's Science and Technology Department. This learning space is an adaptation of the MIT Technology Enhanced Active Learning model for use at with a secondary curriculum. Windward highlights the available technologies, methodologies for student assessment and teacher training, and design of learning spaces for secondary education. Active learning shifts the focus of responsibility for learning to students allowing them to develop enhanced comprehension while providing the teacher with more accurate and timely feedback of the students' understanding. This model is increasingly used at the university and college level, however it has not yet been widely adopted in secondary education.

PST1E12: 8:15–9 p.m. The Beginnings of Energy in Third Graders' Reasoning*

*Jennifer A. Radoff, ** University of Maryland, 4224 Guilford Drive, Apt. C, College Park, MD 20740; jradoff@umd.edu*

David Hammer, University of Maryland, College Park

Fred Goldberg, San Diego State University

Both the National Science Education Standards and the Benchmarks for Scientific Literacy, supported by most existing research on student learning about energy, suggest that ideas about energy forms, transfer, and transformation are appropriate for teaching in the middle school grades. In this poster, we present evidence of younger children's resources for thinking about these specific ideas about energy. At the same time, we argue, eliciting these productive ideas requires a learning environment focused on the children's inquiries rather than on their arrival at those conceptual objectives. That is, their teacher guided them to express themselves clearly, to draw on their own tangible experience, and to make sense. She did not guide them to particular ideas about energy, but discovered the beginnings of the concept in what the children invented for themselves. In this way, we suggest, the extended focus on children's inquiry was a significant factor in allowing their productive ideas to emerge.

*This work is supported by a grant from the National Science Foundation, grant number: DRL-0732233

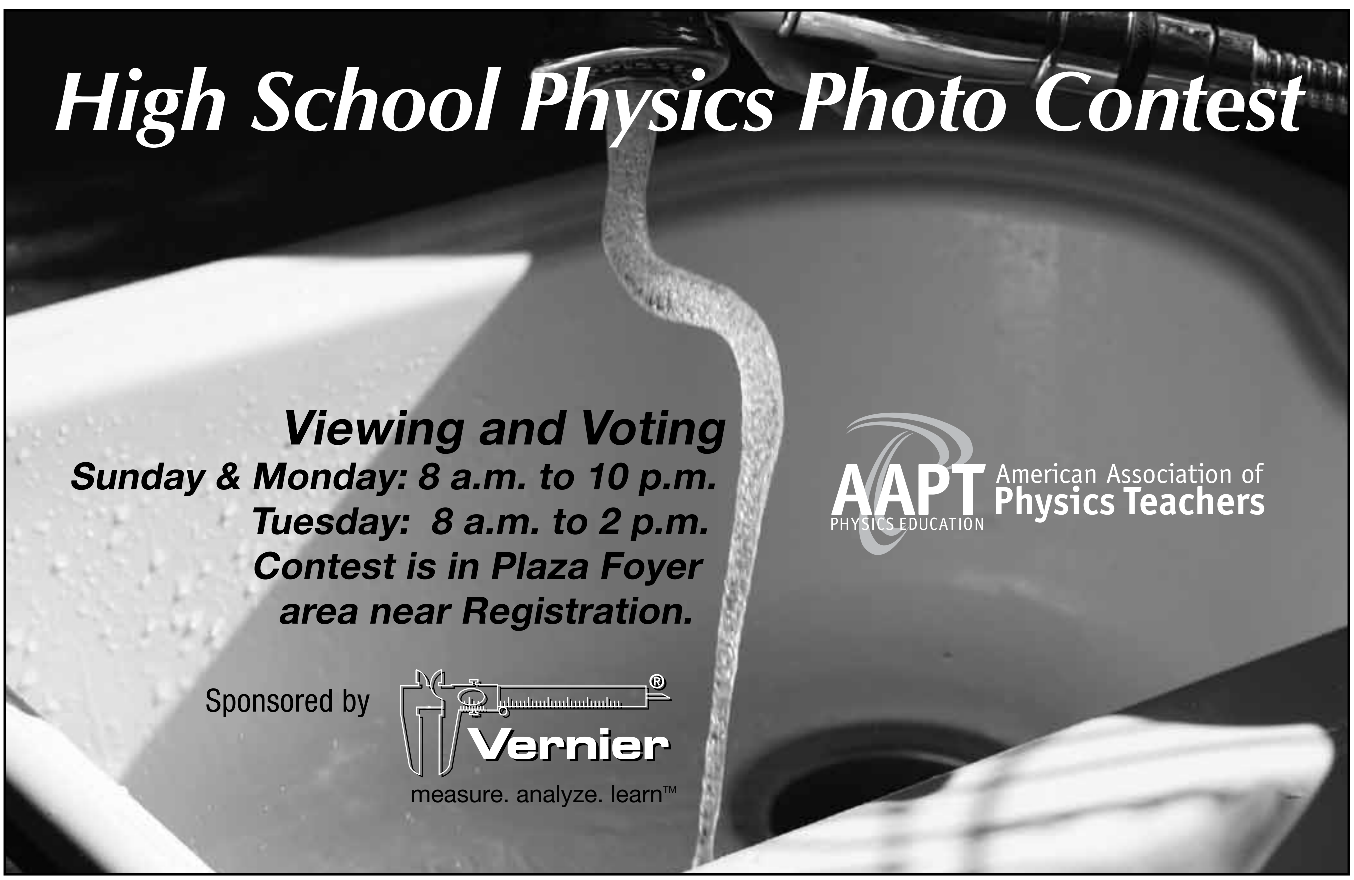
**Sponsored by David Hammer.

PST1E13: 7:30–8:15 p.m. Partners in Science Program: Enriching Science Teaching Through Research

Leonard C. Smith, M.J. Murdock Charitable Trust & Portland State University, P0 Box 751, Portland, OR 97207-0751; chuckjoy@oregonsbest.com*

Many high school science teachers' professional preparation has focused on textbook knowledge and has not provided the teacher with an opportunity to participate in the excitement of the scientific discovery process. This program enables teachers and academic scientists to collaborate in the advancement of science, with the goal that both will grow professionally in the process. Grants are made to the research institution to support two successive summers of a research partnership. An annual national conference is held each year in January, bringing teachers from all parts of the country together to discuss their research, orally and by posters, and also giving them opportunity to hear and interact with speakers of national and international reputation. This poster presentation will provide additional details about the program.

*Sponsored by Dr. Erik Bodegom, Dept. of Physics, Portland State University



Tuesday, July 20

Millikan Medal, Teaching Awards	10:30 a.m.	Grand Ballroom I
Great Book Giveaway	5–6 p.m.	Registration area
Summer Picnic	6:30–8 p.m.	Performing Arts Center
Gala Demo Show	8–9:10 p.m.	Performing Arts Center
Exhibit Hall	10 a.m.–4 p.m.	Exhibit Hall
Celebrating 50 Years of Laser film	9:20–10:50 p.m.	Galleria I

Session EA: Teaching with Technology II

Location: Galleria II
Sponsor: Educational Technologies Committee
Date: Tuesday, July 20
Time: 8:20–10 a.m.

Presider: Taha Mzoughi, Kennesaw State, tmzoughi@kennesaw.edu

EA01: 8:20–8:30 a.m. Using Camtasia and PC Tablets in Creating Lecture Notes

Farhang Amiri, Weber State University, Physics Dept., 4010 University Circle, Ogden, UT 84408-2508; famiri@weber.edu

Two years ago, during the AAPT Summer Meeting in Edmonton, Canada, I learned about the use of pc tablets in teaching. Since then, with the aide of the computer program "Camtasia," I have created short lecture notes that supplement some of the courses that I teach. In this talk, I present examples of the work that I have done, and I will explain how we can make these audio/video lectures more effective teaching tools.

EA02: 8:30–8:40 a.m. Implementing VPython Tutorial Videos in Matter and Interactions Labs*

Jeffrey M. Polak, North Carolina State University, Campus Box 8202, Raleigh, NC 27695-8202; jeff_polak@ncsu.edu

Shawn A. Weatherford, Ruth Chabay, North Carolina State University

Computational modeling is an important part of the Matter and Interactions (M&I) curriculum. Students in this introductory calculus-based course write simple programs in VPython to model physical systems. We created a series of short tutorial videos that introduce students to key programming concepts. Each video combines voice-over narration with a demonstration of the concept within the VPython environment. Over the last year we have piloted and implemented the tutorial videos in the M&I Mechanics lab sections at North Carolina State University to replace the introduction of the programming concepts in written lab instructions. These videos are available through the video sharing website YouTube.[1] We will present our motivation behind the creation of the videos, report how the students used the videos during the laboratory sessions, and outline the future directions of this tutorial video project.

*Support for this project comes from NSF Award DUE-0618504

1. http://www.youtube.com/VPythonVideos.

EA03: 8:40–8:50 a.m. Developing and Deploying Computational Exercises in Introductory Physics

Marcos Caballero, Georgia Institute of Technology, 837 State St., Atlanta, GA 30332; caballero@gatech.edu

Michael Schatz, Georgia Institute of Technology

Matthew Kohlmyer, North Carolina State University

Students taking introductory physics are rarely exposed to numerical computation, that is, using a computer to solve science and engineering problems. An introductory physics course at Georgia Tech utilizes numerical computation as a tool for describing physical phenomenon not easily described using analytic methods. Students are taught to develop visual 3D models of a variety of physical phenomenon (e.g., the motion of a spring-mass system exposed to viscous drag in 3D). We present an overview of the computational component of this curriculum, the development of exercises to enhance students' understanding of numerical computation, and visualization introduced in the mechanics curriculum, and preliminary measurements of performance and attitudes.

EA04: 8:50–9 a.m. An Inside Look: Practical Strategies for Personal Response Systems (Clickers)*

Stephanie V. Chasteen, University of Colorado at Boulder, UCB 390, Boulder, CO 80301-5375; stephanie.chasteen@colorado.edu

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. So I will give you a glimpse inside our classes at the University of Colorado with a brief but informative video, and point you to similar research-based resources on clicker use (including our own banks of clicker questions). I'll discuss a framework for classifying cognitive levels (Bloom's Taxonomy), and show you how questions can be written at these different levels. In this way, clickers help us support student achievement of higher order thinking which is the hallmark of deep understanding. 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.

EA05: 9–9:10 a.m. Animations for Physics and Astronomy Project at Penn State Schuylkill

Michael R. Gallis, Penn State Schuylkill, 200 University Dr., Schuylkill Haven, PA 17961; mrg3@psu.edu

This presentation provides an update to the Animations for Physics and Astronomy Project at Penn State Schuylkill. The animations have been used to portray a variety of dynamical systems and processes for physics and astronomy topics typically presented in the advanced high school through introductory college level. New additions to the collection of approximately 250 animations in the collection will be presented, as well as information on dissemination efforts through the project website and YouTube Channel. The role of a focus group composed of high school faculty to revise and enhance the animations as well as develop some curricular materials for the animations will be discussed. Finally, some of the results of project assessments will also be presented. Project homepage: http://phys23p.sl.psu.edu/phys_anim/Phys_anim.htm

EA06: 9:10–9:20 a.m. Implementing Active-engagement Strategies in a Large Introductory Optics Course

Stephen C. Hall, Pacific University, 2043 College Way, Forest Grove, OR 97116; hall@pacificu.edu

James J. Butler, Pacific University

We recently implemented Peer Instruction and Just in Time Teaching (JiTT) in a year-long introductory optics sequence (class size ~ 90) in the Pacific University College of Optometry. Student conceptual understanding as measured by gains on a multiple-choice conceptual diagnostic exam given pre- and post-instruction is well above that expected from standard instruction and is consistent with that shown by active-engagement teaching strategies. These strategies were implemented via an audience response system ("clickers") and pre-class reading questions delivered via the web ("web warm-ups"). We will briefly describe the Peer Instruction question cycle, show examples of question cycles and student responses, and discuss how the web warm-ups can be used to generate questions for use during Peer Instruction.

EA07: 9:20–9:30 a.m. Interactive Online Optics Module for the College Physics Course

Barbara M. Hoeling, California State Polytechnic University, Pomona, 3801 W. Temple Ave., Pomona, CA 91768; bmhoeling@csupomona.edu

We present the interactive online learning module that we have developed for the optics content of our algebra-based freshman physics course for life science majors. Using the commercially available software "SoftChalk," this module contains images, videos of problem solutions, and interactive animations that allow the students to actively explore the physics content beyond the still pictures in a book. All of these elements are accompanied by narration with transcript, to guide the students along in their lesson while at the same time allowing them to navigate freely between the different "pages" of the module. A survey of student attitudes toward this new instruction method will be presented along with the results of student learning.

EA08: 9:30–9:40 a.m. Effectiveness of an Active Web-based Tutorial in Introductory Physics

Brian Holton, Passaic County Community College, One College Blvd., Paterson, NJ 07505; holton2@comcast.net

Angelica Abdool, Passaic County Community College

The Internet is no doubt a wonderful learning tool; however, while the physics educational community jumped early into the microcomputer-based learning game, its effective use of the net for instruction has not advanced as far as one would expect. This talk will include a brief synopsis of research on Internet-based learning and detail our experience with successes and failures in developing, using, and analyzing the effectiveness of an active web-based physics tutorial.

EA09: 9:40–9:50 a.m. Sharing Large-Project Science Data with Students via the Web

Dale Ingram, LIGO Hanford Observatory, PO Box 159, Richland, WA 99352; ingram_d@ligo-wa.caltech.edu

Investigations in Understanding the Universe (I2U2) is an NSF-funded effort to involve students and the public in research by providing access to data sets from large research projects using Grid technology. Current I2U2 partners are QuarkNet, the Laser Interferometer Gravitational-wave Observatory (LIGO) the Compact Muon Solenoid (CMS) and the Adler Planetarium. For schools, I2U2 offers the Electronic Laboratory—a browser-based data interface wrapped in a web environment that provides guidance as students build investigations with data from the project of their choice. E-Labs include resources, a milestone-based roadmap for completing a project, poster capability, and teacher tools such as pre- and post-tests and a teacher-viewable logbook. The entire e-Lab is online and paperless. We will feature the LIGO e-Lab, which provides data from LIGO's arrays of seismometers. Students have used LIGO's data sets to investigate research questions about earthquakes and other processes related to the propagation of seismic waves.

EA10: 9:50–10 a.m. Advanced Physics Classroom Applications of Music Production Software

David Keeports, Mills College, 5000 MacArthur Blvd., Oakland, CA 94613; dave@mills.edu

Software intended for the production of music can serve many useful purposes in the physics classroom. Among the more basic possible classroom applications of such software are the generation, graphical display, and spectral analysis of a wide variety of waves corresponding to musical sounds. In this presentation, I will focus upon some of the more advanced applications of music production software with an emphasis upon Apple's Logic. First I will briefly outline some of the capabilities commonly found in current music production software above the entry level. I will then illustrate one of those capabilities by demonstrating how Logic can capture the reverberance of a space so that that reverberance can later be added to sounds recorded outside of the space.

Session EB: Once a TIR Always a TIR

Location: Galleria III
Sponsors: Teacher Preparation Committee, Physics in High Schools Committee
Date: Tuesday, July 20
Time: 8:20–10 a.m.

Presider: Jack Hehn, AIP, jhehn@aip.org

EB01: 8:20–8:50 a.m. From the Physics Classroom to the College of Engineering

Invited – Ellen Momsen, Oregon State University, 147 Batcheller Hall, Corvallis, OR 97331-2409; ellen.momsen@oregonstate.edu

Participation in the PhysTec program introduces a classroom teacher to a wide variety of opportunities to make an impact in STEM education in ways quite different than previously imagined. My experiences as a PhysTec Physics Teacher in Residence in 2002-03 led me to subsequently develop and lead the Women and Minorities in Engineering Program at Oregon State University, a program designed to recruit and retain a more diverse student population in the College of Engineering. The extensive outreach program managed by this office has introduced many engineering students to the excitement of K-12 teaching and interestingly, several of the top engineering graduates have pursued careers as high school science teachers.

EB02: 8:50–9:20 a.m. Once a TIR Always a TIR

Invited – Nancy Stauch, 1295 Noyes Rd., Arroyo Grande, CA 93420; nstauch@calpoly.edu

The session titled "Once a TIR, Always a TIR," has a definitive and literal meaning for me. In 2004 I was sponsored by PhysTEC to serve as a TIR for one year. With the support (both financially and philosophically), of our Science and Mathematics Dean, and our physics department, I continue serving as a TIR at Cal Poly to this day. My move from the classroom to the university has been life changing! With the opportunity to view teacher preparation through the lens of the university, my eyes were opened to the fact that the real-world science classroom and the education classes have not always been on the same page. Working as a team, we are moving toward a powerful and sustainable educational program. In this talk, I will explain my journey, and how the TIR role is both an opportunity to contribute to teacher preparation and to grow as a professional.

EB03: 9:20–9:30 a.m. The TIR as the Pump for the Pipeline

Jon P. Anderson, University of Minnesota, 116 Church St., SE, Minneapolis, MN 55455; anderson@physics.umn.edu

Of the many roles that comprise a TIR position, one of the most important is the recruitment and encouragement of future physics and physical science teachers. It can also be argued that this role also has the largest and longest lasting impact on physics and physical science education. This talk will discuss how having the TIR as a "point person" helps provide continuity for the recruitment of future physics teachers and how this continuity works to keep the pipeline of future physics teachers flowing.

EB04: 9:30–9:40 a.m. How a TIR Survived Planning a Physics Conference

Sharon Cooke, University of North Carolina, Phillips Hall, CB #3255, Chapel Hill, NC 27599; cookely@att.net

In 2009 The Phys-TEC program at the University of North Carolina at Chapel Hill received a grant to revive a physics conference for physics educators, formerly called the "Christmas Conference" that had been held from the '60s to the '80s before losing funding and momentum. This revival was a funded idea, without form with but possessing much promise as I began my tenure as TIR. Over the next five months as the conference came into being, I developed a great many new schools, some not wholly desired, and gained a new appreciation for what it takes produce a fine conference.

EB05: 9:40–9:50 a.m. A Reform Model for LA and TA Weekly Lab Preparation*

*Diane E. Crenshaw,** Florida International University, 11200 SW 8th St., CP204, Miami, FL 33199; diane.crenshaw@fiu.edu*

Vashti Sawtelle, Laird Kramer, Florida International University

We will present a new model for weekly undergraduate Learning Assistant (LA) and graduate Teaching Assistant (TA) lab preparation. Florida International University has reformed its introductory physics laboratory sequence by implementing research-validated, PER-based materials, and incorporating LAs into instructional team. LAs are undergraduate students evaluating and/or preparing for future teaching careers; their experience and effectiveness is enhanced through structured weekly lab training sessions. We have reformulated the weekly LA and TA training sessions to include components that target pedagogy for TAs, content knowledge for LAs, and combined group planning during the two-hour sessions. Survey data was collected during training sessions, and observational data was collected during labs and analyzed for fidelity of instructional practice. We will present the training session design and outcomes from the pilot program.

*Work supported by PhysTEC and NSF PHY-0802184.

**Sponsored by Laird Kramer.

EB06: 9:50–10 a.m. Increasing the Responsibilities of Experienced Learning Assistants

Steven R. Olsen, University of Minnesota, 2469 Westview Terr., Mendota Heights, MN 55120; olsen@physics.umn.edu

In our Learning Assistant (LA) program at the University of Minnesota, a few undergraduates who have shown promise as possible future teachers are asked to return for a second semester. We have worked to develop a number of new activities and increased responsibilities for these returning LAs. These new requirements have led to leadership and instructional opportunities for these students. The increase in our number of students going into the field of education may be partly attributed to these new requirements. I will introduce the activities/responsibilities we use and give possible suggestions for using our Returning Learning Assistants to continue to improve our programs.

Session EC: Action Research in the High School Classroom

Location: Broadway I/II
Sponsors: Research in Physics Education Committee, Teacher Preparation Committee
Date: Tuesday, July 20
Time: 8:20–10:20 a.m.

Presider: Mel Sabella, Chicago State University, msabella@csu.edu

In this session high school physics teachers discuss action research projects they have been involved with in their classrooms. The session will serve as a showcase of different types of studies and illustrate how these studies have informed instructional practice. Presentations in this session have clear ties to Physics Education Research and will provide examples of what both high school and college teachers can do to strengthen their role as diagnostician in the classroom.

EC01: 8:20–8:50 a.m. Implementing Physics First District-wide in 8th Grade

Invited – Angie D. DiLoreto, Bellevue School District, 4002 Burke Ave., N., Seattle, WA 98103; diloretoa@bsd405.org*

Bellevue School District in collaboration with FACET Innovations and Seattle Pacific University implemented a district-wide Physics First course in the fall of 2006. Teachers participated in extensive professional development before adoption as well as during the following three years. In this talk the research on student learning before, during, and after initial implementation will be presented. The indispensable administrative support for systemic implementation of research-based science curriculum and instruction will be discussed. A discussion of successes as well as challenges will be offered. This effort can serve as a model for an authentic, multi-year partnership between a school district, educational researchers, and higher education.

*Sponsored by Mel Sabella

EC02: 8:50–9:20 a.m. Reflections on Seven Years of Experimenting with Lesson Study

Invited – Bradford K. Hill, Southridge High School, 9625 SW 125th Ave., Beaverton, OR 97008; bradford_hill@beaverton.k12.or.us

For the last seven years I have participated in a modified Japanese lesson study as a pre-service teacher, in the Knowles Science Teaching Foundation (KSTF), as a beginning teacher, and now as a veteran teacher. In traditional Japanese lesson study, teachers within the same school jointly plan "research lessons" that bring to life both specific subject matter and long- term goals for students, and carefully study evidence of students' learning and engagement. Lesson study presents a challenge for U.S. secondary science teachers, where there is often only one teacher per subject in a school. As a KSTF teaching fellow, I had support to meet three times a year with teachers across the United States to collaboratively plan lessons, share evidence of student learning and study our teaching. For the last two years, without this support, I have transitioned to using low-cost technology to continue the lesson study with teachers outside my school.

EC03: 9:20–9:50 a.m. Choose Your Own Grade: Practices and Results in College-Prep Physics

Invited – Chris D'Amato, Rutgers University and Pequannock Township High School, 85 Sunset Rd., Pompton Plains, NJ 07444-1699; cd@chrisdamato.com*

As a student in the Rutgers Physics Teacher program, I experienced an approach to assessment in which students can revise their work (homework, quizzes, etc.) multiple times with the final purpose of mastery. In my current position, as a high school physics teacher, I implement the same approach in my classroom. It is a system of hybrid formative/summative assessments used to assign grades and improve concept development. Students complete several graded activities per week, but any student may improve any grade afterward without penalty. Using action classroom research, I attempt to assess whether this system addresses its goals of: (1) increased student learning; (2) increased student attention and motivation; (3) decrease in dissatisfaction of students and parents. I will discuss some practical aspects of implementing such a system and present the pros and cons of several different "points recovery" systems that I have tried.

*Sponsored by Mel Sabella

EC04: 9:50–10:20 a.m. Using Research to Improve Student Learning In High School Physics

Invited – Chuck M. Kralovich, Bellevue High School, 10460 Wolverine Way, Bellevue, WA 98004; kralovichm@bsd405.org*

By administering short, free-response tests at the beginning and end of a unit, teachers can gain insight into student understanding both before and after instruction. The use of such tests enables teachers to collect quantitative data on student conceptual and reasoning difficulties and to assess the effectiveness of their instruction in helping students learn physics. In addition, the results help teachers identify persistent difficulties and modify the curriculum and instructional sequence in order to better meet the students' learning needs. The effectiveness of these modifications can be measured by systematic, year-to-year comparisons of student performance. Specific examples in the contexts of kinematics, momentum, and forces will be discussed.

*Sponsored by Mel Sabella.

Session ED: *Panel:* An Interactive Guide to the Paradigms in Physics Programs

Location: Broadway III/IV
Sponsors: Physics in Undergraduate Education Committee, Graduate Education Committee
Date: Tuesday, July 20
Time: 8:20–10:20 a.m.

Presider: Juan Burciaga, Denison University, burciagaj@denison.edu

For more than 12 years the Physics Department at Oregon State University has employed a fundamentally different approach to the upper-level curriculum. Paradigms in Physics abandons the traditional structure of the core courses and addresses the problems, mathematics, and theories of physics through the lens of underlying, fundamental concepts. But how does this approach actually work? When, and how, do students see key concepts? How do the faculty introduce these ideas in the paradigms approach? Are there benefits to this approach? Are there other teaching strategies that have developed in this unique learning environment? The session will consist of a panel of experienced faculty speaking on the implementation of the Paradigms program followed by an opportunity to work through a series of teaching/learning exercises and syllabi with the panel members.

ED01: 8:20–10:20 a.m. Introduction to the Paradigms Program at Oregon State University*

Panel – Corinne A. Manogue, Oregon State University, Dept. of Physics, Corvallis, OR 97331-6507; corinne@physics.oregonstate.edu

In 1996, the entire Department of Physics at Oregon State University set out to completely revamp the upper-division courses for majors. The resulting Paradigms in Physics Project rearranges the content to better reflect the way professional physicists think about the field and also uses a number of reform pedagogies which place responsibility for learning more firmly in the hands of the students. The choice of topics, their presentation, the many different pedagogies that appear, and the strength of the student cohort are all features of our program. After a brief introduction by the presider, this interactive session will not only allow you to hear from several of the original implementers and from others who are newer to the project, but also to get a first-hand look at some of the curricular materials and strategies.

*This work was funded in part by NSF Grants: DUE 9653250, 0088901, 0231032, 0231194, 0618877, 0837829.

ED02: 8:20–10:20 a.m. Electricity & Magnetism in the Paradigms*

Panel – Elizabeth Gire, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506; egire@phys.ksu.edu

Topics in electricity and magnetism are covered in two Paradigms courses: Idealization & Symmetries and Static Vector Fields. These courses emphasize calculating fields from sources, developing a geometric understanding of the differential form of Maxwell's equations, and making symmetry arguments for applications of Gauss's and Ampere's laws. Activities highlight conceptual and computational connections between the four fundamental static fields in vacuum: electric potential, electric field, magnetic vector potential, and magnetic field. Students also explore techniques for visualizing scalar and vector fields with Maple, using power series expansions to describe the behavior of fields in particular regions of space, and a geometric approach to vector calculus. Activities emphasize idealization and modeling processes, using multiple representations in solving problems, and developing habits of mind for making sense of physics problems. I will talk about my experiences teaching in these Paradigms during my post-doc at Oregon State.

*This material is based upon work supported by the National Science Foundation under DUE Grant No. 0837829.

ED03: 8:20–10:20 a.m. Quantum Mechanics in the Paradigms in Physics Curriculum

Panel – David H. McIntyre, Oregon State University, Dept. of Physics, Corvallis, OR 97331; mcintyre@ucs.orst.edu

Quantum mechanics is integrated into four Paradigms courses: Spin and Quantum Measurement, Waves, Central Forces, and Periodic Systems, and is covered by one Capstone course. The first course teaches students about the fundamental postulates and concepts of quantum physics through their manifestation in Stern-Gerlach spin-1/2 experiments. Cross-platform JAVA software has been developed to perform Stern-Gerlach experiments and study measurements, interferometers, spin precession in a magnetic field, and "which-path" detection. In the later courses, students are exposed to several quantum systems' particle in a box, on a ring, on a sphere, hydrogen atom and harmonic oscillator so that they have the opportunity to explore common features and reflect on the postulates. We build upon the spins-first approach by freely going between bra-ket and wave function notation whenever possible, and by using the spin-1/2 example to introduce perturbation theory, addition of angular momentum, and identical particles.

ED04: 8:20–10:20 a.m. Waves and Oscillations in the Paradigms Curriculum

Panel – Janet Tate, Oregon State University, Dept. of Physics, Corvallis, OR 97331; tate@physics.oregonstate.edu

The waves and oscillations subject content in the paradigms curriculum is presented so that students learn the concepts of this fundamental subject matter in the context of both classical and quantum mechanical systems. The examples of the (an)harmonic pendulum, the series LRC circuit, waves in ropes and coaxial cables serve as concrete visualizations of oscillations, waves and pulses, and integrated labs and writing assignments are used to develop the skills to investigative and test models. The experimental examples are useful backdrops for learning about the more abstract quantum wave function approach. The presentation of wave equations from both classical and quantum mechanics helps students to understand the connection between the abstract bra-ket formulation and the more "visual" wave function approaches to quantum mechanics, and to learn about the idea of basis functions in several contexts. The ideas of superposition and projection are emphasized, and Fourier decomposition, which is first learned in the context of classical systems, is presented in the language of projections. This makes the ideas of superposition, measurement and probability in quantum mechanics much more sensible to the students.

ED05: 8:20–10:20 a.m. Energy and Entropy and More*

Panel – David Roundy, Oregon State University, Dept. of Physics, 301 Weniger Hall, Corvallis, OR 97331-6507; roundyd@physics.oregonstate.edu

In three years as an assistant professor at Oregon State, I have taught three classes in the paradigms sequence. In the spring of 2009, I co-taught the "Energy and Entropy" paradigm with Prof. Rogers of Ithaca College as part of a curriculum development grant to develop new curricular materials using an information-theoretic approach to statistical physics. Then in the following fall, I taught the very first paradigm, "Symmetries and Idealizations." This involved the challenge of introducing the students to an active-engagement learning approach. This year I taught "Energy and Entropy" on my own, having rewritten and reorganized much of the course material to emphasize basic concepts that our students are not learning in their lower-division courses. I will describe the intimidating experience of teaching in an active-engagement classroom for the first time, and will share some of my experiences in teaching and reworking the Energy and Entropy paradigm.

*This project was partially supported by NSF grant DUE-0837829.

ED06: 8:20–10:20 a.m. Bridging the Gap Between Lower-Division Mathematics and Middle-Division Physics*

*Panel – Tevian Dray,** Oregon State University, Dept. of Mathematics, Corvallis, OR 97331; tevian@math.oregonstate.edu*

How do physics students learn to be excellent problem solvers? Middle-division physics material, such as electrostatics, requires students to solve complicated problems involving many steps, yet lower-division mathematics courses typically emphasize the algorithmic solution of single-step problems. This presentation provides an overview of the methods used at OSU to bridge this gap, not only within the early paradigms courses, but also in prerequisite mathematics courses. These methods include an emphasis on geometric reasoning and the use of multiple representations.

*This work was supported in part by NSF grants DUE-9653250, DUE-0088901, DUE-0231032, DUE-0231194, and DUE-0618877.

**Sponsored by Juan Burciaga.

ED07: 8:20–10:20 a.m. An Outsider's Perspectives on Paradigms

Panel – Steven J. Pollock, University of Colorado, Boulder, Physics, Boulder, CO 80309; steven.pollock@colorado.edu

In the process of transforming an upper division E&M course at the University of Colorado, Boulder, we have made extensive use of materials and activities developed for the Paradigms program at Oregon State University. Following this, in Fall 2009, I visited OSU while on sabbatical and taught the "Vector Fields" paradigm, in order to get first hand experience with the methods, environment, and practices associated with this pedagogy. In this panel presentation, I will present perceived and measured advantages and value of the materials, along with some difficulties and challenges.

ED08: 8:20–10:20 a.m. Narrative Interpretations of Ways of Speaking During Physics Paradigm Discussions

Panel – Emily H. van Zee, Oregon State University, Dept. of Science and Mathematics Education, Corvallis, OR 97311; Emily.vanZee@science.oregonstate.edu

As a science education researcher, I have developed narrative interpretations of physics paradigm discussions. These are based upon transcripts of video recordings of class discussions and comments by the instructor and others as they watch and analyze the videos. The purpose of such narrative interpretations is to provide interested faculty with examples of physics paradigm discussions that convey not only what was said but also how the instructor thinks about structuring such discussions, interpreting what students say, and forming questions and comments in response.

Session EE: *Panel:* Importance of Mentoring and Professional Development to Increase Diversity in Graduate Education

Location: Grand Ballroom II
Sponsors: Graduate Education Committee, Minorities in Physics Committee
Date: Tuesday, July 20
Time: 8:20–10:20 a.m.

Presider: Marianne Breinig, University of Tennessee, mbreinig@utk.edu

The session will showcase specific efforts in improving guidance, mentoring and professional development to help all graduate students and to promote diversity in graduate programs in physics.

EE01: 8:20–10:20 a.m. The Fisk/Vanderbilt Masters-to-PhD Bridge Program*

Panel – Arnold Burger, Fisk University, 1000 Seventeenth Ave. N, Nashville, TN 37208-3051; aburger@fisk.edu

Keivan G. Stassun, David J. Ernst, Kelly Holley-Bockelmann, Fisk University

Donna J. Webb, Vanderbilt University

The Fisk-Vanderbilt Masters-to-PhD Bridge Program allows students to seamlessly move from the Masters degree program at Fisk University into the PhD program at Vanderbilt University. The program started in 2004, focusing on mentoring graduate students in space science and astronomy. As of spring 2010, the program has 34 students in physics, materials, and biology, 31 of them under-represented minority, 60% female, and the retention is 92%. Research components of the program at Fisk, Vanderbilt and collaborating institutions, initially facilitated by joint federal funding, were essential in the development, growth and sustainability of the program. The talk will review the expansion of the program and describe the network of collaborations used to leverage student research opportunities through summer internships, coop opportunities. Essential ingredients for the success of the program, such as proactive recruiting, a holistic approach to evaluating student applications, and personal and intensive mentoring and advising, will be described.

*Acknowledgement: The authors acknowledge the financial support from the National Science Foundation, DHR-CREST and I3 programs and AAPT's Committee on Graduate Education in Physics and Committee on Minorities.

EE02: 8:20–10:20 a.m. APS/IBM Research Program for Undergraduate Women: CSWP, IBM, and Diversity

Panel – Barbara A. Jones, IBM Almaden Research Center, Dept. GFBA, 650 Harry Road, San Jose, CA 95030; bajones@almaden.ibm.com

I will first overview the goals and activities of the Committee on the Status of Women in Physics of the American Physical Society. As a past chair, I will discuss the ways in which I believe this rather undersung committee has considerable importance in promoting women in physics. Notable is the APS/IBM Research Program for Undergraduate Women, a joint program of IBM and the APS, chaired from the IBM Almaden Research Center. Awardees receive a salaried summer internship at IBM, a mentor, and opportunity to present their research at summer's end. The internship has been running for nine years with considerable success, and I will provide a history and analysis of this program. I will also describe IBM's experiences running a similar internship program for under-represented minorities. Finally, I will discuss IBM's historically positive views on diversity as an imperative both for the research environment and for overall business success.

EE03: 8:20–10:20 a.m. The Importance of Diversity and Inclusiveness in Physics

Panel – Willie S. Rockward, Morehouse College, 830 Westview Dr., SW, Atlanta, GA 30314; wrockwar@morehouse.edu

Over the past 50 years, the community of science has failed to attract, recruit, and/or retain women and underrepresented minorities with the physics community leading the way. Although major national efforts are ongoing, current trends and statistics show declining results. Many agree that science departments are experiencing issues in diversity and inclusiveness. To address these challenges, we present modern tips, tools, and techniques for mentoring women and underrepresented minorities in both undergraduate and graduate departments. Also, my methodology and pedagogical approach for mentoring African-American males at Morehouse College will be presented.

Session EF: *Panel:* What Is the Next Big Thing? Social Networking and Beyond

Location: Pavilion East
Sponsor: Educational Technologies Committee
Date: Tuesday, July 20
Time: 8:20–10:20 a.m.

Presider: Gary White, AIP, College Park, MD, gwhite@aip.org

Speakers will discuss a variety of social/science e-networking venues, concluding with a panel discussion.

EF01: 8:20–10:20 a.m. Brave New World: Blogging and Beyond

Panel – Jennifer Ouellette; lucrezia@mindspring.com

The Internet has tangibly changed how science information is disseminated, particularly to the general public, and is increasingly being used as a classroom tool. Unlike traditional media, blogging is a two-way channel, in which writers and readers (or teachers and students) participate in a conversation. This kind of invested interaction can enhance rather than detract from learning if used correctly. As tools on the web continue to evolve, users are finding new ways to connect with a broad audience. I will give an overview of the current state of science blogging and how blogs and other tools like Facebook and Twitter can enhance science communication, both in and out of the classroom. The rise of YouTube, Hulu, and other online media is creating even more new opportunities for creative communication. What will Blogging 3.0 look like?

EF02: 8:20–10:20 a.m. Social Networking Among Teachers to Enhance Curriculum

Panel – Meredith Ashbran, 3662 Karen Ave., Long Beach, CA 90808; mashbran@lbschools.net

I will discuss how to use social networking among teachers to create and share lessons and digital resources. Also, I will examine the community aspects and sharing of resources through MERLOT and the MERLOT content builder and personal collections. Included will be ways to use these sorts of tools with students to enhance the curriculum.

EF03: 8:20–10:20 a.m. Facing Facebook: Social Media in and out of the Classroom*

Panel – Stephanie V. Chasteen, University of Colorado at Boulder, UCB 390, Boulder, CO 80301-5375; stephanie.chasteen@colorado.edu

Your students are already using tools like Facebook and Twitter. In fact, they're often using them when you'd rather they'd be doing something else (like paying attention in class). How can we turn the potential obstacles of Web 2.0 and social media into an opportunity for effective teaching and learning? I'll share some techniques instructors are using for communicating with their students and each other, including class blogs, real-time aggregated conversations in class, tweeted answers to student questions, dedicated YouTube channels, wiki-based class contracts, and more. Through using these tools, rather than ignoring them, we can help students gain social media literacy skills. Even more importantly, we may choose to leverage social media to promote conversation about things that we care about, using platforms that students find familiar and fun.

*Funded by CU's Science Education Initiative (http://colorado.edu/sei) and the National Science Foundation Grant No. 0737118.

EF04: 8:20–10:20 a.m. Society of Physics Students and Web 2.0: Strategies and Successes

Panel – Tracy M. Schwab, American Institute of Physics/Society of Physics Students, One Physics Ellipse, College Park, MD 20740; tschwab@aip.org

The Society of Physics Students (SPS) has a solid history of engaging members and volunteers through its programs, meetings, publications and web presence. In the past several years, SPS has furthered its reach in the undergraduate community by utilizing social media, with notable success on Facebook, Twitter, YouTube, Flickr, Adopt-A-Physicist and The Nucleus. Established social media channels are proven platforms for allowing more people to engage with us, and they allow SPS to reach a wider audience. They provide immediate impact, plus long-term support of our programs and goals. Three of our target audiences are students who may belong to an SPS chapter but have not joined the national organization, students who attend institutions with no SPS chapter, and international students. As a panelist, I will share our strategies and success stories, and touch on our efforts to present a consistent identity or "brand" across these sites.

Session EG: *Panel:* Problem Solving: A Lever for Conceptual Change

Location: Galleria I
Sponsor: Research in Physics Education Committee
Date: Tuesday, July 20
Time: 8:20–10:20 a.m.

Presider: Chandralekah Singh, University of Pittsburgh, clsingh@pitt.edu

Helping students become good problem solvers is a major goal of most physics courses. This session will examine strategies for helping students develop effective problem solving approaches and explore problem solving as a lever for conceptual change.

EG01: 8:20–10:20 a.m. Problem Solving Heuristics and Conceptual Understanding

Panel – David P. Maloney, IPFW, 7421 Alleghany Court, Fort Wayne, IN 46835; maloney@ipfw.edu

How are conceptual understanding and problem solving related? Research has provided some answers to this question. We know that physics experts make extensive use of their well-organized conceptual knowledge to solve problems in a "forward" manner with understanding. Research has also shown that novices, who lack such conceptual knowledge and understanding, are forced to use so-called weak methods, or heuristics, to deal with the problems they encounter. And normally novices apply these weak methods in a rote manner, with little thought devoted to the physics concepts, principles, and relations involved. So a reasonable question to ask is: Can we make novices' use of heuristics productive in terms of helping the novices develop conceptual understanding? This presentation will consider some related research and describe musing on this issue.

EG02: 8:20–10:20 a.m. Diagnosing Problem Solutions – What Can Students Do and How Does It Help Them?

Panel – Edit M.Yerushalmi, Weizmann Institute of Science, Rehovot, Israel 76100; edit.yerushalmi@weizmann.ac.il

Students need to diagnose possibly deficient problem solutions in various circumstances: while evaluating former steps in their own solution in order to arrive at an answer; while processing instructor's feedback on their quiz in order to learn from it; or, while comprehending peers' solutions in group and classroom problem-solving sessions. Meaningful diagnosis, where students realize conflicts between their own, possibly flawed mental model and the scientific one, can prompt self repair and advance students' conceptual understanding. This presentation will describe studies of diagnostic performance and its effect on transfer tasks in the context of a) diagnosing students' own quiz solutions; b) diagnosing instructor made mistaken solutions. These studies were carried out in algebra- based introductory physics in the United States and in Israeli high school physics classrooms. In particular, the presentation will discuss the conditions that allow students to perform meaningful diagnosis.

EG03: 8:20–10:20 a.m. Novices and Experts: The Twain do Meet in Classrooms

Panel – Kathleen A. Harper, Dept. of Physics & Astronomy, Denison University, 103 Olin Science Hall, Granville, OH 43023; harperk@denison.edu

When introductory physics students engage in problem solving, they often exhibit behaviors that can frustrate their teachers. Some well-known examples of these habits include refusing to draw free-body diagrams, hunting through the book to find an example problem to use as a (perhaps inappropriate) template, and the classic "plug-n-chug" mentality. Studies in science education and cognitive science have yielded rational explanations for many of these novice behaviors and lay a groundwork for instructors to aid their students in beginning to develop more expert-like skills and behaviors. A few examples of these studies, as well as curricular tools that have developed as a result, will be shared. These tools not only encourage students to try more expert-like strategies, but also prime them for developing conceptual understanding.

EG04: 8:20–10:20 a.m. Can Problem Solving in Physics Facilitate Conceptual Change in Mathematics?*

Panel – N. Sanjay Rebello, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506-2601; srebello@phys.ksu.edu

Elizabeth Gire, Dong-Hai Nguyen, Kansas State University

The ability to solve problems has long been valued as one of the measures of deep conceptual understanding in physics. However, a less frequently asked question is: Can solving physics problems change students' understanding of mathematical concepts? Some mathematics educators describe understanding of mathematical concepts as the ability to recognize and use these concepts in multiple representations. Extending this idea, we investigate whether students' understanding of the mathematical concept of integration changes as students apply this concept in physics problems in multiple representations across topical areas of physics. We conducted eight teaching/learning interviews with 15 students in one year of calculus-based physics. During these interviews, students solved physics problems that required them to integrate physical quantities in different representations and contexts. We examine our longitudinal data from these interviews and ask whether the process of solving these problems changes these students' understanding of the concept of integration.

*This research is supported in part by NSF grant 0816207.

Session GB: Biomedical Labs for Introductory Physics

Location: Pavilion West
Sponsors: Laboratories Committee, Apparatus Committee
Date: Tuesday, July 20
Time: 8:20–10:10 a.m.

Presider: Nancy Beverly, Mercy College, Dobbs Ferry, NY, nbeverly@mercy.edu

Introductory physics courses can better serve life science students by including life-oriented physics laboratory activities, providing motivational relevance and appropriate transfer experience. The session showcases talks about labs with a life-oriented or biomedical context. They can range from single activities to whole courses, and from modifications of typical labs to entire new activities.

GB01: 8:20–8:50 a.m. Ground-Up Development of Biomedical Labs: Wavefront Aberrometry and PET*

Invited – Dyan L. McBride, Mercyhurst College, 501 E. 38th St., Erie, PA 16546; dmcbride@mercyhurst.edu

Dean A. Zollman, Sytil Murphy, Kansas State University

This talk will use two biomedical labs (wavefront aberrometry and positron emission tomography) to underscore the necessity of solid pedagogy as the foundation of a good lab activity. Specifically, this talk will focus on how these two labs were designed from the ground up, directly from research results. Along with incorporating the medical context, this process emphasizes the need to consider students' existing knowledge, the foundational physics principles, and how they are able to apply that existing and foundational knowledge to the new (bio-medical) context. Along with the activities and materials themselves, research on student interaction with the materials/activities will be presented as evidence of the strength of the research-designed materials.

*Supported in part by NSF grant DUE 04-26754

GB02: 8:50–9:20 a.m. Use Biomedical Laboratories in Physics to Develop Student Reasoning

Invited – Robert G. Fuller, University of Nebraska - Lincoln, 3901 S. 27th St., Unit 33, Lincoln, NE 68502; rfuller@neb.rr.com

The results of the "intrinsic motivation for learning" work by Thomas Malone[1] can be combined with the "development of reasoning" work by Robert Karplus[2] to create introductory physics laboratories that feature biomedical applications of physics. This presentation will discuss the attributes of the work of Malone and Karplus and illustrate how they can work together to construct physics laboratories that encourage the development of reasoning by students as well as intrigue them with biomedical applications. A concrete example will be given in a six-week module "How Do We See Color?"

1. T.W. Malone, "Toward a Theory of Intrinsically Motivating Instruction," *Cognitive Science* **4**, 333-369 (1981).

(2) R. Karplus, "Science Teaching and the Development of Reasoning," *Journal of Research in Science Teaching* **14**(2), 169-175 (1977)

GB03: 9:20–9:50 a.m. Development and Refinement of Biomedical Labs: MRI and CT*

Invited – Sytil K. Murphy, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506; smurphy@phys.ksu.edu

Dean A. Zollman, Kansas State University

Dyan L. McBride, Mercyhurst College

Research-based curriculum development usually begins with collecting information about how students learn the topics under consideration. Then a set of lessons are built from that information. Because a significant amount of information about student learning of physics is available, we should be able to build on that research rather than always start with new research. Using knowledge of the research-base and experience working with students, a hands-on activity was developed that forms the basis of a curricular activity on Magnetic Resonance Imaging (MRI). Similar work is currently being done for CT scans. Without further contact with students, the initial draft of the curricular activity was written and testing began, first with coworkers and then with students. Even with the knowledge base available, a significant amount of refinement of the activities was needed in order to produce clear and concise activities.

* Supported in part by NSF grant DUE 04-26754.

GB04: 9:50–10 a.m. Doppler Velocimetry in the Introductory Physics Laboratory

Al J. Adams, University of Arkansas at Little Rock, 2801 South University Ave., Little Rock, AR 72204-1099; ajadams@ualr.edu

James D. Wilson, University of Arkansas at Little Rock

Physics teachers are expanding the number of laboratory experiences closely aligned with the content areas for the life sciences. Examples, as evidenced by a workshop presented at the 2010 APS/AAPT Joint Meeting in February, include laser tweezers, diffusion, biomechanics, magnetic resonance, and optical diffraction of biological tissue. Another application-rich topic in physics and the life sciences is the Doppler phenomenon. The Doppler shift can be used to measure the velocity profile for a moving fluid akin to blood flow and it can be done with ultrasound and with optics. We are devising two experimental systems for characterizing flow, the first using ultrasound and the second laser radiation. The experimental systems are designed to monitor flow rates on the order of meters/second with a resolution of centimeters/second and utilize relatively inexpensive, or at least commonplace, equipment and supplies. The prototype systems will be described in this presentation as will the results of the first implementation of these laboratories during the 2010 spring and summer I terms.

GB05: 10–10:10 a.m. Electrocardiogram Physics Lab Exercise

Justin Dunlap, Portland State University, 1719 SW 10th Ave., Portland, OR 97201; jdunlap@pdx.edu

Ralf Widenhorn, Portland State University

We present an experimental exercise using a three lead electrocardiogram (EKG) sensor as a voltage probe to analyze different electric circuits. The lab exercise is designed such that the physics of the EKG instrumentation, as well as the physics of the heart as an electric dipole, are explored. Measurements are taken by the student to highlight aspects of the EKG design including signal amplification and band-pass filtering. Further, the experiment introduces aspects of the human body as an example of electrostatics including the heart as a three-dimensional electric dipole and the body as a conductor. While appropriate as an application of circuit design and voltage measurements for any physics student, the lab is aimed at pre-medical students who have already completed an introductory physics course. The lab is part of a series of activities that should improve the understanding of medical instrumentation as well as the human body.

Thank you to Vernier for sponsoring the AAPT Demo Show and Picnic!

Summer Picnic

Tuesday, 6:30–8 p.m.
(ticket required)

Demo Show

Tuesday, 8–9:10 p.m.

Portland Center for the Performing Arts

(across Broadway from the Hilton)

AAPT Awards Ceremony

Location: Grand Ballroom I
Date: Tuesday, July 20
Time: 10:30 a.m.–12:15 p.m.

Presider: Alex Dickison

Pat Heller

Millikan Medal – Awarded to Patricia Heller, *Associate Professor of Curriculum and Instruction at the University of Minnesota and a founding member of the Physics Education Research (PER) Group*

Guiding the Future: Developing Research-based Physics Standards 10:30–11:15 a.m.

Every physics instructor knows that her class would be much more effective if her students were better prepared. Specifying that preparation, whether for continued education or productive citizenship, is the goal of those who develop science standards. Almost two decades after the American Association for the Advancement of Science's "Benchmarks for Science Literacy" and the National Academies' "National Science Education Standards" set in motion attempts to systematize science standards in K-12 education, there is a growing realization at both the state and national level that those standards need to be revised to be based more firmly on learning research. Physics educators need to be heard on what physics concepts and related skills are truly essential for student success in higher education and in the workplace. These concepts and skills then would be linked to the necessary supporting knowledge that can appropriately be learned at earlier points in a student's K-12 education.

This talk frames the task by addressing the following questions about developing K-12 physics standards for college success: What physics is it necessary for students to understand in elementary school (grades K-4), middle school (grades 5-8) and high school (grades 9-12) to be college ready? What do we want students to be able to do with this knowledge? How can research about learning physics be built into physics standards? How can we determine that students' knowledge has progressed to an appropriate level of sophistication for their age? How can the standards build in the practical constraints that limit what can realistically be achieved?

William P. Hogan

Excellence in Undergraduate Physics Teaching Award –

Awarded to William P. Hogan, *Professor of Physics at Joliet Junior College, Joliet, IL*

Stumbling on a Tightrope 11:15–11:45 a.m.

Early in my teaching career, I became frustrated with the many somewhat contradictory goals I faced with my classes, e.g. being tough to challenge students or being easy to build my retention percentage. For a time, I dabbled with each extreme in turn and I found it comforting that some students applauded despite the frustration of some of their classmates. Eventually, I came to believe that my obligation was to not choose a comforting extreme but to instead make the most vocal students at both extremes unhappy. I was pleasantly surprised at the end of a long semester of making no one happy when I found that my students performed well on assessments and my student evaluations were positive. My talk will be a discussion of the issues I've struggled with and the spectacular mistakes I've made along the way as I've tried to find an unhappy medium that works.

Diane Riendeau

Excellence in Pre-college Physics Teaching Award –

Awarded to Diane Riendeau, *physics teacher, Deerfield High School, Deerfield, IL*

Who's In?? 11:45–12:15 a.m.

If I have found any success in teaching, it is not by my own hands. Mentoring has shaped me at all phases of my career. Being a mentor is a vital role we should all play during our time as physics teachers. I argue that being a mentee is equally important. I'd like to challenge your beliefs on the importance and benefits of mentoring relationship at ALL times in your career. At the end, I hope you can answer the question posed in the title with a resounding, "I am!"

CKB03: ALPhA Session: Crackerbarrel for Advanced Laboratory Personnel

Location: Galleria I
Sponsors: Laboratories Committee, Apparatus Committee
Date: Tuesday, July 20
Time: 12:15–1:15 p.m.

Presider: Gabe Spalding, Illinois Wesleyan University; gspaldin@iwu.edu

A moderated, open discussion about instructional laboratories beyond the introductory level (but including Modern Physics, Optics, Electronics, and other "Advanced Labs")

CKB04: Crackerbarrel on Professional Concerns for High School Teachers

Location: Galleria II
Sponsors: Physics in High Schools Committee, Professional Concerns Committee
Date: Tuesday, July 20
Time: 12:15–1:15 p.m.

Presider: Robert Beck Clark, rbc@aip.org

This crackerbarrel session is meant to provide high school physics teachers with the opportunity to discuss their special professional concerns and to investigate possible solutions.

CKB05: Crackerbarrel for PER Graduate Students

Location: Galleria III
Sponsors: Research in Physics Education Committee, Professional Concerns Committee
Date: Tuesday, July 20
Time: 12:15–1:15 p.m.

Presider: Sissi Li, lisi@onid.orst.edu

FA: Keeping It Real: How Do We Engage in Authentic Assessment in the Physics Classroom?

Location: Galleria I
Sponsor: Physics in Two-Year Colleges Committee
Date: Tuesday, July 20
Time: 1:20–1:40 p.m.

Presider: Paul Williams, Austin Community College, pwill@austin.cc.tx.us

Many of us are products of "traditional" undergraduate physics education where lecture and lab (when there was one) were seemingly only coincidentally related. Furthermore, we submitted homework, took tests, wrote lab reports, and received our grades. Are there better ways? Online homework/tutoring systems, lab practicals/practicums, 1-on-1 interviews are alternative modes of assessment. How do we keep it real?

FA01: 1:20–1:30 p.m. Assessing Compare and Contrast Activities Integrated In College Algebra-based Physics

Frances A. Mateycik, Penn State Altoona, 1640 E Pleasant Valley Blvd., #3, Altoona, PA 16602; fam13@psu.edu

Nobel S. Rebello, Kansas State University

David H. Jonassen, University of Missouri - Columbia

Recognizing the deep structure differences and similarities between problems is essential for conceptual schema adaptation. Students in an algebra-based physics course were asked to explicitly compare and contrast physical cases in both homework and laboratory settings. Students were required to communicate similarities and differences between selected problems on each weekly homework assignment and also collaboratively communicate similarities and differences between specific laboratory observations and specific homework problems. Data were collected to assess students' emphasis on deep-structure at the beginning and end of the spring 2010 semester using similarity ratings surveys. Each survey asked students to rate the similarities between eight pairs of problems of varying similarity, and then defend each of their ratings with a two or three-sentence statement. For this talk, I will report on the results from the similarity ratings and discuss possible extensions of this study for future semesters.

FA02: 1:30–1:40 p.m. Calibrated Peer Review in Modern Physics and Honors Classes

R. Steven Turley, Brigham Young University, N345 ESC, Provo, UT 84602; turley@byu.edu

Calibrated peer review is a process where students can provide assessments on each other's writing based on a rubric supplied by the instructor. Students "calibrate" their assessments by comparing their assessments of sample writing samples with the instructor's assessments of the same writing. I will discuss the implementation and evaluation of calibrated peer review in a sophomore-level modern physics class and an Honors general education seminar. This will include how the process was implemented using Moodle and Blackboard, student reaction to the process, and the effectiveness of the process in improving student writing and conceptual understanding. I will also share what I learned about effective rubrics, what kind of assignments work best, and helping students get the most out of the process.

FC: Labs/Apparatus

Location: Galleria III
Date: Tuesday, July 20
Time: 1:20–2:30 p.m.

Presider: Bill Reay, Ohio State University, reay@mps.ohio-state.edu

FC01: 1:20–1:30 p.m. Transfer of Learning in the Context of an Inquiry-based General Physics Laboratory

Edgar D. Corpuz, University of Texas-Pan American, 1201 W. University Dr., Edinburg, TX 78539; ecorpuz@utpa.edu

Rolando Rosalez, University of Texas-Pan American

This research investigates how several inquiry-based introductory physics laboratory activities facilitate the knowledge construction of students. In this paper, we will document the associations that students make as they go through hands-on activities designed to guide them to discover for themselves physics principles or relationship of physical quantities. Our results show that most students do not readily transfer the target content knowledge to a transfer context (e.g. real-life situations).

FC02: 1:30–1:40 p.m. Atmospheric Pressure in a Partially Filled Inverted Glass of Water

John Ron Galli, Weber State University, Physics Dept., 2508 University Cir., Ogden, UT 84408-2508; jrgalli@weber.edu

A well-known demonstration of the force due to atmospheric pressure is to fill a container (drinking glass, for example) with water then place a flat lightweight plate (thin cardboard, for example) on top so as to trap the water when inverted. Atmospheric pressure can support the entire weight of the water so long as the plate is kept horizontal and no water leaks out or no air leaks in. Surprising experiments and calculations will be done to show that this can also work even when the glass is not completely filled and contains a significant quantity of trapped air at atmospheric pressure on top of the water.

FC03: 1:40–1:50 p.m. Promoting Metacognition in Introductory Calculus-based Physics Labs

Drew R. Grennell, Western Washington University, 516 High St., Bellingham, WA 98225; grenned@students.wwu.edu*

Andrew Boudreaux, Western Washington University

In the Western Washington University physics department a project is under way to design and improve introductory calculus-based labs. The project seeks to adapt and develop research-based curriculum to promote conceptual understanding and reasoning ability through guided questioning, engage students through open-ended challenge tasks, and guide students to explicitly engage in metacognition. Examples of instructional strategies specifically designed for metacognition include analysis of alternate reasoning provided by fictitious students and guided review of student's initial ideas through prelabs and group discussion questions. Assessment of student's use of metacognition include pre- and post- data from the MPEX survey, analysis of written lab worksheets, and student evaluations of the lab course that include specific evaluation of metacognition tasks. Future plans include video studies that may provide insight into the metacognitive processes of student groups, as well as use of additional assessments such as C-LASS and EBAPS.

*Sponsored by Andrew Boudreaux

FC04: 1:50–2 p.m. Cheap Physics

Bruce R. Judson, , 13310 Dwyer Blvd., New Orleans, LA 70129; bjudson2003@yahoo.com

I believe you can use cheap, ordinary items from the buliding supply/lumber yard to build 90% of the items needed in an ordinary high school physical science or physics lab-based classroom. Examples: Aluminum lab bars are approximately $40 each. Adding the connecting clamps and lab bars for a small classroom can easily approach $1000. Local building supply stores (Lowes, Home Depot, Ace, TrueValue, etc.) can sell (often donate) 3/4 black iron pipe, floor flanges and attaching parts cut and threaded to fit for $40. You can buy one aluminum bar for $40 or you can buy enough pipe and fittings to equip your lab with black iron pipe lab bars that are stronger and more versatile. String and rope can be used to support ramps (boards) for various push-pull experiments with coefficients of friction, weight, motion, motion in two dimensions, etc. Lab carts can be made from simple wheels and 2x4 lumber cut so that the cart is exactly 1 kg or any convenient mass. Furthermore, these carts are much more rugged than most commercial models made from brittle or easily damaged plastic.

FC05: 2–2:10 p.m. The Laser Level in Introductory Optics Labs

S. Clark Rowland, Andrews University, Dept. of Physics, Berrien Springs, MI 49104-0380; rowland@andrews.edu

Mickey D. Kutzner, Andrews University

Laser levels are inexpensive household tools that can be used in the elementary laboratory for a number of ray-trace experiments. When used with a plane mirror, students may use the laser level to explore image formation and the law of reflection. The laser level and a flat slab of glass can be used to illustrate apparent depth in the lab. Snell's law, the lens equation, and critical angle measurements are all possible using the laser level. The magnet on the laser level also makes it an ideal light source for use with blackboard optics demonstrations.

FC06: 2:10–2:20 p.m. Simple Demonstrations with Inexpensive Violet Laser Pointers

Tandy Worland, University of Puget Sound, 1500 N. Warner, Tacoma, WA 98416-1031; worland@pugetsound.edu

Violet laser pointers are now inexpensive (about $10, including shipping) and readily available due to the recent development of "Blu-ray" DVD technology. As a result, it is now possible to span nearly the entire visible spectrum with inexpensive laser pointers powered by AAA batteries. In addition to extending the common demonstrations and experiments performed using red and green lasers, the violet wavelength (405 nm) is sufficiently short to produce fluorescent, phosphorescent, and photochromic effects that are usually obtained with ultraviolet sources. An overview of the currently available laser pointers will be provided along with examples of demonstrations featuring the violet color.

FC07: 2:20–2:30 p.m. Assessing the Effectiveness of Undergraduate Physics Laboratory

Lewetegn Damena Kassahun, Addis Ababa University, Addis Ababa, 96/1948 Ethiopia; kassa_l98@yahoo.com

The main purpose of the study was assessing the effectiveness of physics laboratory of KCTE in consideration of undergraduate students. It also identifies the strengths and weakness in achieving the higher level of taxonomy of education looking through the factor that facilitates success in the science laboratory. The study was conducted mostly on the first and the second year students which means students of the new curriculum and performing experiments in the current year. The respondents of the study were 80 in attitude question and 50 in cognitive and psycho motor level question. The result of the study indicates that the students' achievement in the higher level of cognitive, psycho motor domain was very low as compared to the achievement in the lower level. Moreover, student attitudes shifted toward negative due to the overall structure of the laboratory. The attitude result of the instructor and the laboratory assistance indicates that they have good attitude towards the laboratory of physics. However, it was found out that KCTE physics lab lacks fulfilling the factor like resources, learning environment, curricula, teaching effectiveness and assessment strategies. During observation students spent most of their time on manipulation of the apparatus that was great boundary in order to bring them to the naturalization level of the psycho motor domain. Based on, this major findings recommendation are made to include all level performance of students based on the different factors and the goal of the undergraduate program.

FD: PER: Topical Understanding and Attitudes

Location: Broadway I/II
Date: Tuesday, July 20
Time: 1:20–2:30 p.m.

Presider: Karen Cummings, SCSU, mingsk2@southernct.edu

FD01: 1:20–1:30 p.m. Embracing Confusion: Students' Attitudes toward Confusion for Model-based Inquiry

Lauren Swanson, University of California, Santa Barbara, Dept. of Education, Santa Barbara, CA 93106-9490; aemerson@education.ucsb.edu

Danielle B. Harlow, University of California, Santa Barbara

While the word confusion often has negative connotations, it is also an indispensable aspect of developing new scientific knowledge. Students engaging in model-based inquiry are expected to construct evidence-based explanations (models) of phenomena. When new observations do not match their expectations, students can become confused. This can either lead to frustration or motivate them to revise their current model so that it accounts for new evidence. We report on how an undergraduate course based on the Physics and Everyday Thinking (PET) curriculum led students to accept confusion as a useful and productive stage in their learning process. We show survey and video-based evidence of observable changes in students' attitudes regarding confusion.

FD02: 1:30–1:40 p.m. Bridging the Gap Between Science Education and PER: Formative Assessment

Kara E. Gray, School of Education, University of Colorado - Boulder, 249 UCB, Boulder, CO 80309; kara.gray@colorado.edu

Valerie K. Otero, School of Education, University of Colorado - Boulder

Research by the Science Education community has shown that Formative Assessment has substantial impacts on students' academic performance. Despite this, the term Formative Assessment does not typically appear in the recommendations of the Physics Education Research (PER) community. Yet much of the research done in, and the best practices encouraged by, the PER community would be considered formative assessment. This presentation explores the convergence of science education research on formative assessment and relevant work in PER by presenting a conceptual framework that highlights perspectives in both communities. We will present data to demonstrate how the notion of formative assessment allows us to investigate the pedagogical development of undergraduate Learning Assistants (LAs). The Colorado LA program provides an experiential learning environment for students to plan instruction with the lead instructor of the course, investigate science education literature, and reflect on their teaching while actually engaging in teaching introductory physics.

FD03: 1:40–1:50 p.m. Students' Responses to Different Representations of a Vector Addition Question*

Jeffrey M. Hawkins, The University of Maine, 120 Bennett Hall, Orono, ME 04469-5709; Jeffrey.hawkins@maine.edu

John R. Thompson, Michael C. Wittmann, The University of Maine

Eleanor C. Sayre, Wabash College

Jessica W. Clark, Rochester Institute of Technology

Students use multiple methods to add vectors graphically,[1] some of them leading to correct solutions, some of them not. We discuss students' responses to four different representations of a single graphical vector addition question, designed to elicit different solution methods. These four questions have vectors arranged in either a head-to-tail or a tail-to-tail orientation and either with and without a grid. These questions were administered to several hundred students at two different universities. We present results describing the types of language they used as well as inconsistencies between students' explanations and drawings.

1. J. M. Hawkins, J. R. Thompson, and M. C. Wittmann, *AIP Conf. Proc.* 1179, 161 (2009).

*Supported in part by NSF Grant REC-0633951

FD04: 1:50–2 p.m. Helping Students Use Reflective Writing More Effectively

Xiang Huang, Concordia University, 734-7400 Sherbrooke, Montreal, QC H4B1R8; x.xianghuang@gmail.com*

Kalman[1] has produced a toolbox that is helpful for students in gateway courses to develop a scientific mindset. Reflective writing is one of these tools. We use the case study tradition to explore the relationship between students' writing products and students' attitude to physics and science courses. Also we try to find students' perspective of the difference between reflective writing and summary writing to help students use this tool more effectively.

1. C. S. Kalman, *Successful Science and Engineering Teaching: Theoretical and Learning Perspectives,* Springer (2008).

*Sponsored by Calvin S. Kalman.

FD05: 2–2:10 p.m. Measuring Conceptual Change: Data-driven model of Gains and Losses

Nathaniel Lary, John Abbott College, 68 Finchley, Montreal, QC H3X 2Z9; lasry@johnabbott.qc.ca

Orad Reshef, Kelly Miller, Ahmed Ibrahim, McGill University

The normalized gain is among the most common metrics used to measure conceptual change in PER. The normalized gain has proved to be a very useful metric to measure changes before and after instruction and between different types of instruction. As such, it has been of paramount importance in making the case in favor of active engagement approaches. At the AAPT winter meeting in Washington, D.C., some issues were raised concerning the lack of a measure of "conceptual loss" in the standard normalized gain metric. We present Force Concept Inventory data collected before and after instruction and determine the extent of these losses. We describe the impact this may have on the normalized gain measure in comparison to other metrics that have been proposed.

FD06: 2:10–2:20 p.m. What do Seniors Remember from Freshman Physics?

David E. Pritchard, MIT, 77 Massachusetts Ave., Cambridge, MA 02139; dpritch@mit.edu

Analia Barrantes, Andrew Pawl, MIT

We have given 56 MIT seniors who took mechanics as freshmen a written test similar to the final exam they took in their freshman course, plus the MBT and C-LASS standard instruments. Students in majors unrelated to physics scored 60% lower on the final exam than they did as freshmen. The students' performance on nine of the 26 MBT items (with six of the nine involving graphical kinematics) represents a normalized gain of 70% over their freshman pre-test score, while their performance on the remaining 17 questions is best characterized as a loss of approximately 50% of the material learned in the freshman course. Attitudinal survey results indicate that half the seniors feel the specific mechanics course content is unlikely to be useful to them, a significant majority (75-85%) feel that physics does teach valuable skills, and an overwhelming majority believe that mechanics should remain a required course at MIT.

FD07: 2:20–2:30 p.m. Achieving Epistemological Closeness: Integrated Classroom Context through Reflective Interviews

Christopher W. Shubert, University of New Hampshire, DeMeritt Hall 9 Library Way, Durham, NH 03824; cwf3@unh.edu

Dawn C. Meredith, University of New Hampshire

Two epistemological approaches to PER are frame analysis of in-class

learning activities, and resource analysis of out-of-class interviews. These methods are limited by the broadness of frames and the distance of interviews from the classroom context. A key benefit of fine-grained interview analysis is closeness to the actuality of student behavior; however, this benefit comes with the cost of removing closeness to the classroom context. Reflective interviews may break down this tradeoff by bringing the context of classroom activities into the purview of focused interviews. These interviews review short clips of videotaped lab work and focus questions on the learning activity as it took place in the natural classroom setting. The analysis of these videos, both the lab and the interview, are then carried out using a methodology based on constructivist grounded theory, where layers of labels are created and reviewed throughout the analytical process.

FE: Interactive Lecture Demonstrations: Physics Suite Materials that Enhance Learning in Lecture

Location: Broadway III/IV
Sponsors: Research in Physics Education Committee, Educational Technologies Committee
Date: Tuesday, July 20
Time: 1:20–2:20 p.m.

Presider: Priscilla Laws, Dickinson College, lawsp@dickinson.edu

FE01: 1:20–1:50 p.m. Active Learning in Lecture, Lab and Workshop/Studio Environments Using ILDs

Invited – Priscilla W. Laws, Dickinson College, Dept. of Physics and Astronomy, Carlisle, PA 17013; lawsp@dickinson.edu

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 Suite materials such as Workshop Physics and RealTime Physics require students to take an active part in their learning through hands-on activities in laboratory settings. Sokoloff and Thornton developed Interactive Lecture Demonstration (ILD) sequences to engage students in active learning in lecture sessions. Audience participation will be used to demonstrate how ILDs are used in lecture settings.(2) In addition, I will discuss an example of how judicious use of ILDs can be used to improve conceptual learning in laboratory and workshop/studio environments without diminishing the level of hands-on experience gained by students.

1. E.F. Redish, *Teaching Physics with the Physics Suite* (Wiley and Sons, Hoboken, NJ, 2004).

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

FE02: 1:50–2 p.m. Interactive Lecture Demonstrations Using Personal Response Systems (Clickers)

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

Ronald K. Thornton, Tufts University

Personal response systems (clickers) have become ubiquitous on college and university campuses. This paper reports on efforts to adapt Interactive Lecture Demonstrations (ILDs) for use with clickers. Research results show that the clicker versions of ILDs are nearly as effective as the original paper and pencil ones.[1]

1. This work was sponsored by National Science Foundation grant DUE-0633740.

FE03: 2–2:10 p.m. LivePhoto Projectile Motion ILD*

Robert Teese, Rochester Institute of Technology, 54 Lomb Dr., Rochester, NY 14623; rbtsps@rit.edu

Priscilla Laws, Dickinson College

Patrick Cooney, Millersville University

Maxine Willis, Dickinson College

The LivePhoto Physics project has developed a research-based collection of video analysis materials for introductory physics courses. In digital video analysis, students use computers as laboratory instruments to make measurements on video images of real events. The curricular materials we have produced include LivePhoto videos, guided inquiry activities for classroom use or homework assignments, and interactive lecture demonstration sequences. We have written and are currently classroom-testing an ILD on projectile motion that will be described in this talk.

*This Project has been supported by National Science Foundation grants 0424063, 0717699 and 0717720 (http://livephoto.rit.edu/).

FE04: 2:10–2:20 p.m. The Art of Teaching Physics with Juggling and Balance

Duane L. Deardorff, The University of North Carolina at Chapel Hill, Campus Box 3255, Chapel Hill, NC 27599; duane.deardorff@unc.edu

One particular set of Interactive lecture demonstrations that I enjoy using in my introductory physics classes involve juggling and balance. As a professional juggler for more than 20 years, I have shared this art form with many groups, and incorporating it into the physics classroom seems natural since juggling and physics both involve matter in motion. Juggling can be used to teach certain aspects of mechanics: projectile motion, time of flight, reaction time, torque and rotational motion. I will present several demonstrations that can be used by nearly anyone, even those who do not already know how to juggle.

FF: Interdisciplinary Success Stories: Team Teaching

Location: Grand Ballroom II
Sponsor: Physics in High Schools Committee
Date: Tuesday, July 20
Time: 1:20–2:30 p.m.

Presider: Karen Jo Matsler, kjmatsler@gmail.com

FF01: 1:20–1:50 p.m. War Fair: Integrating English, Mathematics, Science and History

Invited – Jan L. Mader, Great Falls High School, 1900 2nd Ave., S., Great Falls , MT 59405; jan_mader@gfps.k12.mt.us

In an effort to combat the "Why do I have to learn this or when am I ever going to use this" mantra from our freshmen, freshman small learning communities have implemented "War fair." Students are teamed and choose a topic of interest. They then must investigate the historical, scientific, mathematical, and English connections of that topic. Throughout the development of the project, the core teachers meet and analyze the student's progress, grade benchmarks and re-direct misguided approaches. The culminating event is a community-wide presentation where students are evaluated on their experimental design and presentation of results. War Fair presentations are made from 8 a.m. until 7 p.m., with scholarships and prize money awarded based on the judge's evaluations and community selections. The design and implementation of this project-based learning technique will be presented.

FF02: 1:50–2:20 p.m. Team Teaching AP Physics and Calculus in the Workshop Mode

Invited – Maxine C. Willis, Dickinson College, Dept. of Physics and Astronomy, Carlisle, PA 17013; willism@dickinson.edu

Sue Fehringer, Gettysburg College

Shawn Godack, Gettysburg Area High School

AP Workshop combines AP Physics Mechanics C and AP Calculus AB as first-year courses in both physics and calculus for the majority of students. The physics course uses the Workshop Physics curriculum, and the calculus course uses Workshop Calculus, both developed at Dickinson College. Students are duel enrolled in both AP Physics Mechanics C and AP Calculus AB. Gettysburg Area High School is on block scheduling. During the first semester, the courses are combined and are team-taught with both the calculus and the physics instructors in the classroom for the entire block. The instructors are given common planning time to coordinate the topics and to plan how to share the instructional time. During the second semester, the courses are separated and each subject moves forward independently in its individual block. Results of AP Tests and Conceptual Evaluations will be shared.

FF03: 2:20–2:30 p.m. Fizzcalc: An Integrated AP Physics C and AP Calculus BC Course

Robert H. Shurtz, Hawken School, Box 8002, Gates Mills, OH 44040; rshur@hawken.edu

During the 2009-10 academic year, I taught an integrated double-period AP Physics C / AP Calculus BC course, "Fizzcalc." I organized the syllabi of the two courses and developed curricular materials to follow my general plan of (1) introduce a physics concept that reveals a problem we want to solve; (2) recognize that we need a calculus tool that we don't currently have in order to solve that problem; (3) develop and prove the tool; (4) apply the tool to solve the physics problem and also apply the tool to solve related problems. Although the course was a lot of work for me and a lot of work for my students, my students and I have thoroughly enjoyed the course and have found it to be a great learning experience. We find that the 100-minute daily periods go by very quickly. I will present the outline of the course, give details of a sample unit, and discuss successes and challenges of the course based on student evaluations, exams, and my own observations.

FG: Lecture/Classroom II

Location: Pavilion East
Date: Tuesday, July 20
Time: 1:20–2:30 p.m.

Presider: Steve Luzader, Frostburg State University, sluzader@frostburg.edu

FG01: 1:20–1:30 p.m. Visible PCK: An Observational Approach to the Concept of Image

David Schuster, Western Michigan University, Physics Dept., Kalamazoo, MI 49008; david.schuster@wmich.edu

Rex Taibu, Chaiphat Plybour, William Mamudi, Betty Adams, Western Michigan University

What is the essence of the concept of image in optics, and its relation to underlying principles? Consequently, how might we design instruction to promote learners' conceptual understanding of the image concept? The pedagogical content knowledge (PCK) a teacher needs in order to develop an effective instructional approach is considerable and multi-faceted. It involves a deep grasp of the concept while also knowing about "ways to go" in teaching and "ways to think" in learning. Despite what some textbooks imply, the concept of image is more than an intersection point on a standardized ray diagram, and likewise more than just "what you see in a mirror." In two successive presentations we demonstrate both observational and theoretical approaches to teaching the concept of image, while simultaneously making PCK visible by discussing why we do things that way. In this first talk we demonstrate and discuss the observational approach.

FG02: 1:30–1:40 p.m. Visible PCK: A Theoretical Approach to the Concept of Image

Rex Taibu, Western Michigan University, Mallinson Institute for Science Education, Kalamazoo, MI 49008; rex.taibu@wmich.edu

David Schuster, Chaiphat Plybour, William Mamudi, Western Michigan University

Adriana Undreiu, University of Virginia's College at Wise

This is the second of two successive presentations about the Pedagogical Content Knowledge (PCK) involved in designing instruction to promote learners' conceptual understanding of the concept of image. In this presentation we demonstrate a "theoretical" approach to teaching and learning the concept, simulating light behavior via ray construction, while simultaneously discussing why we do it this way, to complement the observational approach.

FG03: 1:40–1:50 p.m. Integrating EFFECTs into a Physics Course

David J. Smith, University of the Virgin Islands, College of Science and Mathematics, St. Thomas, VI 00802; dsmith@uvi.edu

The Environments for Fostering Effective Critical Thinking program (EFFECTs) is an NSF grant (DUE 0633635) awarded to the Civil Engineering Department at the University of South Carolina. As the name suggests, EFFECTs provides critical thinking opportunities to first-year engineering students by posing a "driving" question, followed by a sequence of modules that address the various aspects of that question. The University of the Virgin Islands on St. Thomas has a strong 3/2 engineering transfer program with several mainland institutions, including USC. Through collaboration between USC engineering faculty and UVI physics faculty, an EFFECT was designed for a first-year physics course. In this EFFECT the driving question is, "How does one design a water catchment system to supply potable water for the population of an island?" We will discuss methodology for EFFECTs, in general, as well as some specific details of the physics EFFECT.

FG04: 1:50–2 p.m. How We Teach Students Who Don't Have Math Background

Hiro Shimoyama, The University of Southern Mississippi, 118 College Dr., #5046, Hattiesburg, MS 39406; hironori.shimoyama@usm.edu

How well the students learn in class for algebra-based introductory physics often depends on their (mathematical) ability. On the other hand, the curriculum also has to be matched with students' level to improve their overall capability. Therefore, grasping their background of related skills is necessary to make the curriculum effective. However, a large deviation between their level of skills and the teacher's expectation tends to conceal the truth even with an educational measurement. It also hinders the educator from facilitating an effective curriculum for the students. I present the way I sought the students' background and how I implemented the curriculum in Southern Mississippi.

FG05: 2–2:10 p.m. Medical Physics: An Interdisciplinary Algebra-based Physics Elective Course Emphasizing Contemporary Medical Technologies

Grace Van Ness, Portland State University, 1719 SW 10th Ave., Portland, OR 97201; vanness@pdx.edu*

Ralf Widenhorn, Portland State University

A solid scientific foundation is crucial for physicians to keep up with new advancements in an ever evolving field. American premedical course requirements include one year of biology, general chemistry, organic chemistry, and physics. The algebra-based physics course is often dominated by premedicine students; however, since other majors also take this class it does not exclusively focus on material relevant to health professionals, such as MRI, X-rays, PET scans, ultrasound imaging, radiation treatment, and lasers. In addition, students perceive premedical education to be neither coherent nor well structured. We describe the development of Portland State University's Physics in Medicine course, which addresses a gap in the limited number of intermediate-level algebra-based physics courses for prehealth majors across the United States. Course activities provide a clear connection between pre-medical algebra-based general physics and applied physics principles of clinical medicine.

*Sponsored by Erik Bodegom

FG06: 2:10–2:20 p.m. Illustrations of Sound Standing Waves in Air Columns in Introductory Physics Textbooks

Liang Zeng, The University of Texas-Pan American, 1201 W. University Dr., Edinburg, TX 78539; zengl@utpa.edu

Edgar Corpuz, Rolando Rosalez, Ivette Abundiz, The University of Texas-Pan American

The comparative effectiveness of illustrations of sound standing waves in a column of air inside a pipe in various introductory physics textbooks was investigated in terms of helping students learn the underlying concepts. It was found that the pictorial representations for sound standing waves inside a pipe can be categorized into several typical representative models. An experiment was conducted to analyze those models that vary from one another on student learning of the concepts, such as air molecule motion inside a pipe, relation between the amplitude of the waves and the diameter of the pipe, and phase difference between pressure variations and displacement variations. The results of this study can provide an empirical basis in proposing a more adequate and effective pictorial representation as well as related texts of sound standing waves inside a pipe.

FG07: 2:20–2:30 p.m. Formula Recollection Made Easy Through a WORLDLY Recognized Mnemonic Technique

Shannon A. Schunicht, Texas A&M University, 6773 Bendwood, College Station, TX 77845.3005; mnemonicmind@alpha1.net

While in the Army, Mr. Schunicht was involved in a mid-air collision rendering him unconscious for three weeks. Everything had to be re-learned, as nursing actions were reported as having been displayed upon awakening from the extended unconsciousness (19 days). Studies in recovery brought about some pragmatic discoveries to compensate for the residual memory deficits. The most valuable was having each vowel represent a mathematical operation, i.e. "a" multiplication implying "@","o" for division implying "over", "i" for subtraction implying "minus", "u" for addition implying "plus", and "e" implying"equals". Most constants and variables are indeed consonants, e.g. "c" = "speed oflight & "z" = "altitude". ****Note how using this mnemonic technique, [vowels:mathematical operations], any formula may be algebraically manipulated in to a memorable word combination for ease of recollection. Additional letters may be inserted to enhance the intelligibility of the initial letter compilation but these additional letters need be CONSONANTS ONLY.

FH: Research on Teaching Assistants and Learning Assistants

Location: Pavilion West
Sponsor: Teacher Preparation Committee
Date: Tuesday, July 20
Time: 1:20–2:50 p.m.

Presider: Stamatis Vokos, Seattle Pacific University, vokos@spu.edu

Many universities use graduate teaching assistants (TAs) and/or undergraduate learning assistants (LAs) to make large-enrollment courses more collaborative, student-centered, and interactive. In this session, researchers report on projects that have begun to identify specific challenges to effective university-level professional development and explore solutions that respond to those specific challenges.

FH01: 1:20–1:50 p.m. Cultivating Concern with Others: Thinking as the Root of Teacher Identity*

Invited – Hunter G. Close, Seattle Pacific University Dept. of Physics, 3307 3rd Avenue, West, Seattle, WA 98119; hclose@spu.edu

Rachel E. Scherr, Seattle Pacific University

In the Physics Learning Assistant (LA) Program at SPU, talented undergraduate students help teach introductory physics in a tutorial-style environment. One of the goals of the program is to recruit these STEM majors into the teaching profession by providing them with successful and intellectually challenging teaching experiences. The central guiding principle of our program is this: A teacher is someone who is concerned with the thinking of others. We strive to develop this sense of teacher identity by engaging LAs in activities in which they study thought processes outside themselves. We then observe LAs' behavior as they interact with the people, things, and ideas of physics in various settings. Our effort is to determine to what degree and in what fashions concern with others' thought is taken up, and to gain leverage for the development of LAs' skills for teaching and interest in the profession.

*Supported in part by NSF DRL 0822342 and the Seattle Pacific University Science Initiative.

FH02: 1:50–2:20 p.m. A New Perspective on TAs: Respecting TAs' Beliefs and

Invited – Renee Michelle Goertzen, University of Maryland, Physics Dept., College Park, MD 20742; goertzen@gmail.com

Rachel E. Scherr, Seattle Pacific University

Andrew Elby, University of Maryland, College Park

Effective physics instruction benefits from respecting the physics ideas that introductory students bring into the classroom. We argue that it is similarly beneficial to respect the teaching ideas that novice physics instructors bring to their classrooms. We present a case study of a tutorial teaching assistant (TA), Alan. When we first examined Alan's teaching, we focused our attention on the mismatch between his actions and those advocated by the TA instructors. Further study showed us that Alan's teaching was well integrated with his beliefs about how students learn physics and how teachers can best assist students. Learning about Alan's resources for teaching changed our thinking about what might constitute effective professional development for Alan and other TAs. We advocate a new perspective on TA professional development: one in which TAs are seen as partners in the endeavor of educating students and one which seeks productive seeds in their beliefs.

FH03: 2:20–2:50 p.m. The Colorado LA Model: Impacts and Outcomes

Invited – Steven J. Pollock, University of Colorado, Physics, Boulder, CO 80309; steven.pollock@colorado.edu

Valerie Otero, University of Colorado, Boulder

The Colorado Learning Assistant Model, at its core, is a model of institutional change. Through the mechanism of course transformation it enhances the education of STEM students, recruits and prepares future STEM teachers, and leads to faculty development. We present data to support these claims, including impacts on students in the transformed classes, and on the LAs themselves. Measures include assessment of students' content learning and attitudes and beliefs, with a focus on physics. In addition, our data show increasing number and quality of K-12 STEM teachers. We discuss the potential for faculty development by demonstrating strong course learning gains, faculty participation, and spread of innovations over time. Finally, we will discuss ways in which the LA program is an experiential learning model and a low-cost path to productive educational change.

FI: Simulated Learning: Using Simulations to Teach Physics

Location: Salon Ballroom II
Sponsor: Physics in Two-Year Colleges Committee
Date: Tuesday, July 20
Time: 2–2:50 p.m.

Presider: David Weaver, Chandler-Gilbert CC, david.weaver@cgcmail.maricopa.edu

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?

FI01: 2–2:10 p.m. How Physical and Virtual Experiments Influence Students' Understanding of Pulleys

Jacquelyn J. Chini, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506-2601; haynicz@phys.ksu.edu

Elizabeth Gire, Adrian Carmichael, N. Sanjay Rebello, Kansas State University

Sadhana Puntambekar, University of Wisconsin, Madison

The usefulness of experimentation with physical manipulatives, virtual manipulatives, or some combination of both is of interest to a wide audience, including education researchers, curriculum developers, and science teachers. To add to existing literature on this topic, we extend our previous studies of the effects of experimentation with physical and computer simulated pulley systems. Students enrolled in a conceptual-based introductory physics course for future elementary school teachers experimented with physical and virtual pulleys in an open format Activity Center. The Activity Center format allowed students to choose the order and timing of how they completed the experiments. Students completed a pre-test before beginning the experiments, a mid-test after completing one type of experiment, and a post-test after all instruction. Analyzing students' performance on these tests allows us to compare the effectiveness of four conditions, including isolated modes and sequencing effects: physical only, virtual only, physical-virtual, and virtual-physical.

FI02: 2:10–2:20 p.m. Dynamo: A Simulation Editor and Delivery Program for Classical Mechanics

Michael G. Duffy, Emory & Henry, PO Box FF, Emory, VA 24327; mgduffy@ehc.edu

Real-life demonstrations and video analysis are powerful ways to bring life and meaning to the often abstract, algebraic manipulations of classical mechanics. But they're inflexible, limited by the physical constraints of the apparatus used. Computer simulations can be less rigid but you still need to find (or write), vet, and learn how to use a wide range of different programs if you plan to cover much material with them. Here, I will demonstrate DynaMo, a simulation editor and delivery program with a rich, flexible, but consistent user-interface allowing you to easily create and embed a wide range of mechanics simulations in text documents that can be used by instructors or students to explore a variety of different physical systems. One important feature is the ease with which you can create multiple, nearly identical systems, run simultaneously, to highlight the effects of a particular parameter.

FI03: 2:20–2:30 p.m. Student Thinking on Atomic Structure with the Atom Builder Sim

Andy P. Johnson, Center for Math and Science Education, Black Hills State, 910 8th St., Spearfish, SD 57783; andy.johnson@bhsu.edu

Anna Hafele, Black Hills State University

Understanding ionizing radiation requires a basic mental model of atomic structure. Students need to be able to locate the parts, and also understand the energy scale and roles of electrons vs. nucleons. They must have a sense of how changing the number of electrons, protons, or neutrons have very different effects. Many non-STEM students appear to lack these understandings, in fact, some seem to have little or no useful knowledge about atoms at all. As part of our development of an entry-level inquiry-based unit on ionizing radiation, we are developing a visualization tool/simulator that allows students to investigate what happens when Z, N, or the electron number change in a lone atom. In this presentation we will report on what sense students make of atoms before and after working with the Atom Builder simulator as part of guided activities in radiation.

FI04: 2:30–2:40 p.m. Complexity of Computer Simulations: Implications for Sim Design and Learning

Noah S. Podolefsky, University of Colorado, Dept. of Physics, 390 UCB, Boulder, CO 80309-0390; noah.podolefsky@colorado.edu

Katherine K. Perkins, Wendy K. Adams, Kelly Lancaster, University of Colorado

PhET Interactive Simulations (sims) are highly interactive and engaging educational tools. Some sims use just one or two simple controls, while others provide nearly endless possibilities for interaction. To engage students, learning from sims must be challenging enough to maintain interest, but not so challenging as to be overwhelming. One element contributing to this challenge is sim complexity. Our research aims to define and quantify the degrees of sim complexity: (1) computed solely from properties of the sim (number of controls and visual displays) and (2) dependent on the user's knowledge structure. The net complexity depends on the dynamic interaction between these two dimensions as a user engages with a sim. We apply this complexity model, coupled with student interviews, in order to guide sim design, inform levels of guidance that students might need, and provide insight into student learning and the importance of sim users' prior experiences.

FI05: 2:40–2:50 p.m. Physics Educators as Designers of Simulation Using Easy Java Simulation

Loo Kang WEE, Ministry of Education Singapore, MOE Building, 1 North Buona Vista Dr. (S)138675, Singapore, 519935; weelookang@gmail.com

To deepen the professional practice of physics educators, we seek to highlight the Open Source Physics (OSP) and Easy Java Simulation (Ejs) community of educators that engage, enable and empower teachers as learners so that we can be leaders in our teaching practice. We learned through Web 2 online collaborative means to develop simulations together with reputable physicists through the open source digital library. By examining the open source codes of the simulation through the Ejs toolkit, we are able to examine and make sense of the physics from the computational models created by practicing physicists. We will share some of the simulations that we have remixed from existing library of simulations models into suitable learning environments for inquiry of physics.
http://www.phy.ntnu.edu.tw/ntnujava/index.php?board=28.0

GA: Teacher Training/Enhancement

Location: Galleria I
Sponsor: Teacher Preparation Committee
Date: Tuesday, July 20
Time: 3–4:40 p.m.

Presider: Monica Plisch, APS, plisch@aps.org

GA01: 3–3:10 p.m. Student-Generated Scientific Inquiry*

Leslie J. Atkins, California State University, Chico, 400 W. 1st St., Chico, CA 95929-0202; ljatkins@csuchico.edu

Irene Y. Salter, California State University, Chico

This talk reports on student activities and student learning in a novel course for undergraduate pre-service teachers, Student-Generated Scientific Inquiry. The course is part of a larger effort to reform teacher preparation in science at California State University, Chico. The course activities scaffold students' inquiry to move beyond simple "science fair" experiments that seek to find correlations, toward a deeper understanding of investigation and experimentation as methodologies for evaluating scientific models and arbiters of scientific arguments. The topics addressed in the course (light, color, and sound) are ones that span physical and biological modes of inquiry; this talk will focus on the physics investigations that students constructed, the arguments and models that those investigations sought to resolve, and the impact of those investigations on student understanding of the nature of science.

*This work is funded through the NSF CCLI program, grant 0837058. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

GA02: 3:10–3:20 p.m. SHAPE-ing the Future: A Conference for High School Physics Teachers

Alice D. Churukian, The University of North Carolina at Chapel Hill, Dept. of Physics and Astronomy, Chapel Hill, NC 27599; adchuruk@physics.unc.edu

Laurie E. McNeil, The University of North Carolina at Chapel Hill

For many years, the Physics and Astronomy Department at the University of North Carolina at Chapel Hill held an annual conference for high school physics (and other science) teachers from across North Carolina to provide them with an opportunity to learn about current advances in physics and applications to the classroom. While the conference died out in the '80s, it was fondly remembered by those who attended as a chance to "recharge their batteries" and network with their counterparts from across the state. At the urging of local teachers, we decided to reinstate the conference, and the Symposium on the Horizons in Astronomy and Physics Education (SHAPE) was born. The outcome of our efforts and how we hope to improve them for future events will be presented.

*Partially supported by a grant from the North Carolina Space Grant K-12 Professional Development program.

GA03: 3:20–3:30 p.m. Learning About Teaching & Learning in PET

Danielle B. Harlow, University of California, Santa Barbara, Dept. of Education, Santa Barbara, CA 93106-9490; dharlow@education.ucsb.edu

Lauren H. Swanson, Hilary Dwyer, Anne E. Emerson, Sungmin Moon, University of California, Santa Barbara

We report on an adapted version of the Physics and Everyday Thinking (PET) curriculum. A unique aspect of PET is the inclusion of special activities that focus on Learning about Learning (LAL). In many of these activities, undergraduates analyze video clips of children talking about science. We adapted PET by increasing the time spent on the LAL activities, augmenting the existing activities with discussions about teaching and the design of the PET curriculum, and adding additional activities focused on LAL. To compensate for the additional time on LAL, we reduced the content activities to only those that directly supported LAL activities. We found that students made significant gains on the C-LASS and were able to apply aspects of the PET pedagogy to lesson design.

GA04: 3:30–3:40 p.m. Profiling Iowa's High School Physics Teachers

Trevor Kittleson, University of Northern Iowa, 215 Begeman Hall, Cedar Falls, IA 50614-0150; trevor.kittleson@gmail.com

Jeffrey T. Morgan, University of Northern Iowa

The University of Northern Iowa is heavily involved in offering professional development opportunities to science teachers throughout the state. In order to ascertain the current state of physics teaching in Iowa, and allow us to tailor our programs to the needs of practicing teachers, we invited all known high school physics teachers in the state to complete a survey that probed their background, current teaching practices, and future plans. We found, among other things, that while most schools employ teachers who meet the state's minimum requirements for certification in physics teaching, only one in five physics teachers has a degree in physics. Although the results we share regarding teachers' education, practices, and plans for remaining in physics teaching are specific to the state of Iowa, the trends we observed are likely mirrored in other states with significant numbers of small, rural schools.

GA05: 3:40–3:50 p.m. Formative TA Evaluations by Online Survey

Michael R. Meyer, Michigan Technological University, Fisher Hall 118, 1400 Townsend Drive, Houghton, MI 49931; mrmeyer@mtu.edu

Teaching Assistants (TAs), as new teachers, often need (and want) feedback about how they are doing in the classroom. End of term feedback comes too late for them to make changes, but, when a large number of sections and TAs are involved, it's challenging to get good formative feedback during the term without loss of significant class time. In this presentation, I'll discuss an online system implemented in the Michigan Tech introductory physics labs that has successfully provided constructive midterm student feedback and improved TA performance.

GA06: 3:50–4 p.m. What Constitutes Effective Instruction? Views of High School Physics Teachers

Jeffrey T. Morgan, University of Northern Iowa, 315 Begeman Hall, Cedar Falls, IA 50614-0150; jeff.morgan@uni.edu

Trevor Kittleson, University of Northern Iowa

Our 2009 survey of Iowa's high school physics teachers asked participants whether or not they currently employed or had previously attempted various non-traditional approaches to physics teaching, including modeling, PRISMS, and Physics by Inquiry. Teachers who answered in the affirmative were labeled "non-traditional," while the rest were considered "traditional." A subsequent question asked them about their level of agreement with 10 statements regarding effective physics teaching, while another asked them to rank skills or knowledge they deemed most important for their students' success in future physics courses. Examining the responses to those questions by the two groups revealed differing views on such things as the importance of numerical problem solving, when physics should be taught in the secondary science sequence, and the role of textbooks in a physics course, while the groups exhibited strong agreement on the role of group work and the importance of conceptual questions.

GA07: 4–4:10 p.m. Tracking the Development of Scientific Reasoning Abilities in Pre-service Teachers

Eric N. Rowley, Wright State University, 205 Carter's Grove Rd., 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. A new curriculum for our "Foundations in Scientific Literacy and Problem Solving" course was implemented beginning fall 2008 to address this issue. This course, taken by all middle childhood science and math licensure students, was revised to employ explicit instruction on NOS and SR in the context of applied scientific investigations. Evaluation of the curriculum indicated that students made significant shifts in understanding and abilities as a result of this one quarter course. In spring 2010, approximately 75 of these students were post-tested again 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.

GA08: 4:10–4:20 p.m. The Development of a Pedagogical Content Knowledge (PCK)Course for Chicago Area Teachers[1]

Mel S. Sabella, Chicago State University, Dept. of Chemistry and Physics, 9501 S. King Dr., Chicago, IL 60628; msabella@csu.edu

Michelle Dillon, Virginia Hayes*, Joel Hofslund, Chicago State University*

Chicago State University has been involved in developing PER-based learning environments for the introductory physics classes for over five years. In the summer of 2009, we adapted elements of these instructional materials to aid inservice science teachers in integrating content knowledge and knowledge of pedagogy. The course, consisting of biology, chemistry, and physics teachers, engaged participants in diverse instructional techniques and formative assessment practices. The explicit link between these two types of knowledge allowed participants to revisit challenging physics concepts through multiple lenses, creating a rich set of PCK knowledge that often seemed greater than the sum of its parts. We present a description of our course, discuss successes and challenges, and describe our efforts at assessing PCK.

*Sponsored by Mel Sabella.

1. Supported by the Illinois Board of Higher Education and the National Science Foundation CCLI Program (DUE 0632563.)

GA09: 4:20–4:30 p.m. Eliciting Beliefs of Recitation Instructors Through Video Commentary

Benjamin T. Spike, University of Colorado, Boulder, Dept. of Physics, 390 UCB, Boulder, CO 80309; spike@colorado.edu

Noah D. Finkelstein, University of Colorado, Boulder

Our recent pre- and post-semester interviews with graduate Teaching Assistants (TAs) and undergraduate Learning Assistants (LAs) incorporated video clips of recitation instructors serving in a similar role at another university. As part of the interview, the TAs and LAs were prompted to provide general commentary on the clip they observed, and identify specific observations they found interesting or significant. We present a framework for analysis of these commentaries, along with results on how the TAs and LAs interpret observed practices through their own experience in the classroom. We are particularly interested in how these "stimulated commentaries" may complement both traditional interview data and in-class observations to provide a more complete picture of instructor beliefs.

GA10: 4:30–4:40 p.m. Information Fluency: Where to Start?

Pat T. Viele, Cornell University, 4 Dorchester Dr., Geneseo, NY 14454; ptv1@cornell.edu

Are you confused about how to start helping your students gain skills in information fluency? Never fear, Pat the Librarian is here to help with tips on: effective searching for information, evaluation of information, and using informtion effectively and ethically.

GC: PER: Problem Solving, Topical Understanding and Attitudes

Location: Galleria III
Date: Tuesday, July 20
Time: 3–4:50 p.m.

Presider: Rosemary Russ

GC01: 3–3:10 p.m. Adapting Effective Small Group Activities

Warren M. Christensen, North Dakota State University, 2106 7th St., N, Fargo, ND 58102; warren.christensen@ndsu.edu

As a means of facilitating deep conceptual learning in an environment with substantial classroom constraints, the Physics Education Research Group at North Dakota State University has been actively involved in adapting research-validated instructional materials for use in a traditional lecture setting. Constrained by four 50-minute lecture sections per week and without the benefit of recitations for small-group activities, these "Tutorial-based Lectures" make use of a variety of pedagogical strategies, such as student discussion/interaction and "clickers," etc. To date, successful measured improvement of student content understanding via these adapted curricula has varied. One potentially important element is the extent to which students have access to paper copies of the tutorial during the lecture. I will report on student performance before and after instruction on entropy and the second law of thermodynamics using the Entropy "Two-blocks" Tutorial[1] in a first-semester calculus-based physics course.

1. W. M. Christensen, D. E. Meltzer, C. A. Ogilvie, "Student ideas regarding entropy and the second law of thermodynamics in an introductory physics course," *Am. J. Phys*. **77**, 907–917 (2009).

GC02: 3:10–3:20 p.m. Student Understanding of Micro and Macro in Thermal Physics

Michael E. Loverude, California State University Fullerton, Dept. of Physics, MH-611, Fullerton, CA 92834; mloverude@fullerton.edu

In the hybrid "thermal physics" course, students are expected to learn both macroscopic and particle-level descriptions of systems. Moreover, they are expected to switch back and forth between these descriptions, seemingly without effort. As part of an NSF-supported project of research and curriculum development, we have examined student understanding at both levels and considered the interplay between them. Results from written quiz and examination questions will be presented illustrating the types of problems that are challenging for many students.

*Supported in part by NSF grant DUE-0817335.

GC03: 3:20–3:30 p.m. Evolution of Students' Ideas about Entropy*

David E. Meltzer, Arizona State University, College of Teacher Education and Leadership, Mesa, AZ 85212; david.meltzer@asu.edu

Warren M. Christensen, North Dakota State University

During the past 10 years our research group has investigated student ideas and student learning about entropy and related concepts. A variety of tools and techniques have been used including individual interviews, free-response and multiple-choice diagnostic tests, archiving of responses to research-based tutorials, and classroom observations. Data have been acquired in a wide variety of different courses including introductory algebra- and calculus-based courses, upper-level courses, and courses in related fields such as chemistry. I will discuss and summarize some of the key findings generated by these investigations.

*Supported in part by NSF Grant Nos. DUE 9981140, PHY 0406724, PHY 0604703, and DUE 0817282.

GC04: 3:30–3:40 p.m. Student Ideas Relating to the Boltzmann Factor and Its Derivation

Trevor I. Smith, University of Maine, 5709 Bennett Hall, Orono, ME 04469; Trevor.I.Smith@umit.maine.edu

John R. Thompson, Donald B. Mountcastle, University of Maine

As part of a research and curriculum development project, we are developing a guided-inquiry worksheet activity (tutorial) for upper-division statistical physics designed to improve understanding of where the Boltzmann factor comes from and why it is useful. In the initial tutorial implementation, no student groups completed the worksheet. Students were subsequently interviewed to provide feedback on the rest of the tutorial instructional sequence. In-class student discussions indicate that many students did not reconstruct the physical reasoning behind the derivation of the Boltzmann factor after lecture and/or reading the course textbook—even one student who could recall the textbook derivation verbatim.

GC05: 3:40–3:50 p.m. Why do Faculty Choose to Use, or Not Use, Research-based Strategies?

Melissa Dancy, Johnson C. Smith University, 100 Beatties Ford Road, Charlotte, NC 28216; melissa.dancy@gmail.com

Charles Henderson, Western Michigan University

Chandra Turpen, University of Colorado

We conducted interviews with 72 physics faculty who reported being current users, former users, or knowledgeable non-users of either Peer Instruction or Workshop Physics. Interviewees who reported using a strategy were asked why they initially tried using the strategy. Additionally, former users where asked why they discontinued use. Knowledgeable non-users (faculty familiar with the strategy who had never tried it) were asked why they had decided not to use the strategy. We report an analysis of responses.

GC06: 3:50–4 p.m. The Relationship between Instructor and Situational Characteristics and the Use of Research-based Instructional Strategies in Introductory Physics*

Charles R. Henderson, Western Michigan University, WMU Physics, Kalamazoo, MI 49008-5252; Charles.Henderson@wmich.edu

Melissa H. Dancy, Johnson C. Smith University

Magdalena Niewiadomska-Bugaj, Western Michigan University

Chandra Turpen, Western Michigan University and University of Colorado at Boulder

During fall 2008, a web survey, designed to collect information about pedagogical knowledge and practices, was completed by a representative sample of 722 physics faculty across the United States. We have previously presented summary statistics from this survey to indicate, for example, that nearly half of the college physics faculty in the United States report that they currently use one or more of the Research-Based Instructional Strategies (RBIS) we asked about. Here we describe how seven situational characteristics and 13 personal characteristics correlate with faculty use of RBIS. Logistic regression analysis was used to develop a model that predicts faculty membership in one of four groups related to their knowledge and use of RBIS. Five characteristics were identified as significant predictors in the model: class size, departmental encouragement, gender, attendance of the physics and astronomy new faculty workshop, and percentage of job responsibilities related to teaching.

*Supported by NSF #0715698

GC07: 4–4:10 p.m. Academic Physicists: Introductory Teaching Improvement Efforts at Major Research Universities

Julie A. Schell, Harvard University, 29 Oxford St., #293, Cambridge, MA 02138; Schell@seas.harvard.edu*

There is no shortage of PER literature describing research-based, instructional strategies for improving teaching in introductory college physics courses.[1] It remains, however, that most physics faculty with visions of improved teaching based on such strategies must overcome significant barriers, including a reward system structured to faculty direct attention toward research and away from pedagogy.[2] Barriers to teaching improvement are compounded at major research universities (MRUs), where science faculty must balance extreme demands for research productivity with their teaching responsibilities. During a year-long study, I explored the teaching improvement efforts of 20 such S.T.E.M. professors at two American MRUs. This talk presents analyses of in-depth interviews with the study's five academic physicists, as well as observations of their classroom teaching and course documents. Results respond to the question: Why and how do some research-active physicists venture toward undergraduate teaching improvement in an institutional system that largely devalues faculty investments in pedagogy?

1. C. Henderson and M. Dancy, "The Impact of Physics Education Research on the Teaching of Introductory Quantitative Physics in the United States," *Physical Review Special Topics: PER*, **5** (2), 020107 (2009).

2. C. Henderson and M. Dancy, "Barriers to the Use of Research-Based Instructional Strategies: The Influence of Both Individual and Situational Characteristics," *Physical Review Special Topics: PER*, **3** (2), 020102. (2007).

*Sponsored by Eric Mazur.

GC08: 4:10–4:20 p.m. Faculty Interpretations of Instructional Strategies: A National Study*

Chandra A. Turpen, Western Michigan University and University of Colorado, Boulder, Boulder, CO 80305; Chandra.Turpen@colorado.edu

Charles R. Henderson, Western Michigan University

Melissa H. Dancy, Johnson C. Smith University

A survey, designed to collect information about pedagogical knowledge and practices, was completed by a representative sample of 722 physics faculty nationally from multiple types of institutions (two-year, four-year, and graduate universities). A sub-sample of these respondents (N=72) participated in an associated interview study to better understand how faculty interact with research-based instructional strategies (RBIS), use RBIS, and perceive their institutional contexts. This talk will describe some of the preliminary findings from the interview study targeting two particular RBIS: Peer Instruction and Workshop Physics. Specifically, we describe what faculty meant when they identified themselves as users of these curricula. Meanings ranged from professors adopting the general philosophy of the curriculum (or what they believed to be the general philosophy) while inventing how it concretely applies to their classrooms to professors who use the curriculum as is, without significant modifications. We describe common adaptations of these curricula and their associated prevalence.

*Supported by NSF #0715698.

GC09: 4:20–4:30 p.m. Computer Coaches for General Problem Solving: Research Background

Leon Hsu, University of Minnesota, Twin Cities, Dept. of Postsecondary Teaching and Learning, 206 Burton Hall, Minneapolis, MN 55455; lhsu@umn.edu

Kenneth J. Heller, Andrew J. Mason, Qing Xu, School of Physics and Astronomy, University of Minnesota, Twin Cities

Human coaching has been very successful in improving student problem solving as well as their conceptual knowledge of physics in pedagogies such as Cooperative Group Problem Solving. However, human coaches are not always available when needed. Computer tutors are being developed as a supplement to human tutors to solve the problem of access. We are developing Internet-based computer tutors to coach students in introductory mechanics as an extension of the Personal Assistant for Learning tool (PAL) by Reif and Scott (1999). These tutors are designed with a heuristic problem-solving model based upon the competent problem solving framework of Heller & Heller but can be modified to support any reasonable procedure. This coach is intended to encourage a more expert-like way of thinking of problem solving in the context of solving a specific problem. This talk discusses the research background for the design and structure of the computer tutors.

GC10: 4:30–4:40 p.m. Computer Coaches for General Problem Solving: Coaching Implementation

Qing Xu, University of Minnesota, Twin Cities, School of Physics and Astronomy, 116 Church St., SE, Minneapolis, MN 55455; qxu@physics.umn.edu

Kenneth J. Heller, Andrew J. Mason, School of Physics and Astronomy, University of Minnesota, Twin Cities

Leon Hsu, Dept. of Postsecondary Teaching and Learning, University of Minnesota, Twin Cities

We describe three different types of computer tutors for student problem solving written in Adobe Flash to be accessible to students on the Internet. The tutors comprise a system of coaching based upon the work of Reif and Scott (1999).[1] The tutor is presented in three different modes that together combine the cognitive apprenticeship model with reciprocal teaching: computer coaches student, student coaches computer, and student works independently with feedback from computer. This talk discusses the implementation of each of these forms of coaching and how they interact with a student.

1. F. Reif and L. Scott, "Teaching scientific thinking skills: Students and computers coaching each other," *AJP* **67**(9), 819-831 (1999).

GC11: 4:40–4:50 p.m. Computer Coaches for General Problem Solving: Assessment Design

Andrew J. Mason, University of Minnesota, Twin Cities, School of Physics and Astronomy, Minneapolis, MN 55455; ajmason@umn.edu

Kenneth J. Heller, Qing Xu, School of Physics and Astronomy, University of Minnesota, Twin Cities

Leon Hsu, Dept. of Postsecondary Teaching and Learning, University of Minnesota, Twin Cities

After meeting the technical challenge of producing computer coaches that interact with students via the internet, the next step is to test their effectiveness. In this talk we describe the design of an experiment to determine the use of these tutors by students and if this use affects student problem solving behavior. This talk will describe the design of a study, including a pilot phase and a larger implementation phase for an introductory calculus-based physics class for scientists and engineers.

GD: Urban/Rural Settings for High School Physics

Location: Broadway I/II
Sponsor: Physics in High Schools Committee
Date: Tuesday, July 20
Time: 3–4:40 p.m.

Presider: Jan Mader, Great Falls High School, jan_mader@gfps.k12.mt.us

GD01: 3–3:30 p.m. Developing a Physics Program by Nurturing the Middle Level

Invited – Michael Jabot, SUNY Fredonia, 291 Chestnut St., Fredonia, NY 14063; jabot@fredonia.edu

This session will present an overview of the AAPT-PTRA sponsored Rural Physics Institute at the State University of New York at Fredonia. Unique to this institute was the focus on the development of physics understandings beginning at the middle level as a basis for instruction at the high school level. This focus allowed for the establishment of baseline measures of student thinking and enhanced the coherence of the overall physics program. Data will be shared concerning the implementation of the four-year institute as well as the impact the institute had on the development of the participating schools physics programs.

GD02: 3:30–4 p.m. Urban vs. Rural: Apples to Apples or Apples to Oranges

Invited – George A. Amann, PTRA, 193 Primrose Hill Rd., Rhinebeck, NY 12572; amannga@earthlink.net

Patrick Callahan, Delaware Valley Regional HS

David McCachren, Indian Valley HS

Designing and implementing professional development that addresses best practices, curriculum alignment, content, pedagogy, assessments, research, and evaluation is always a challenge. The session will summarize the transformations that have evolved as PTRA addressed needs of both urban and rural teachers. Presenters will report on how they have been involved with the AAPT/PTRA program, the impact on teachers, students, future projects, and share successes and challenges.

GD03: 4–4:10 p.m. Urban & Rural Initiative: Who Was Transformed?

Beverly Trina T. Cannon, Highland Park H.S., 4220 Emerson, Dallas, TX 75205; cannonb@hpisd.org

The national systemic initiative programs provided opportunities for PTRAs to meet, interact and guide other physics teachers for the sole purpose of improving science education. While participating as a workshop leader in Texas and Idaho, I made note of many changes occurring during the five years. These changes will be shared in this presentation.

GD04: 4:10–4:20 p.m. Rural PTRA Workshops in Central New York

Steven L. Henning, Clarkstown H.S. North, 151 Congers Rd., New City, NY 10956; shenning@ccsd.edu

This presentation will chronicle the Rural PTRA Workshops at Colgate University in Hamilton, NY, during the summers of 2003, 2004, 2005, and 2006. Participants came from all across Central New York, Capitol Region, Lower Hudson Valley, and Vermont. The teachers ranged from beginning teachers to veterans of 25+ years. School sizes ranged from graduation classes of 25 or less to upwards of 250+ students. This talk will focus on the topics and workshops presented during this time and look at the overall success of the program.

GD05: 4:20–4:30 p.m. H.S. Physics Teaching in Oklahoma: A Status Report

Steven J. Maier, Northwestern Oklahoma State University, 709 Oklahoma Blvd., Alva, OK 73717; sjmaier@nwosu.edu

Of Oklahoma's 909 high schools, 190 offered H.S. physics during 2008-2009. While 1.5% of Oklahoma's 195 H.S. physics teachers were certified in physics only, most held multiple certifications in other disciplines. About 18% were certified alternatively. Although data are still coming in for 2009-2010, similar statistics are expected for the current academic year. The rural nature of the majority of Oklahoma's school systems and the emphasis on the end of instruction state exams in biology are hypothesized to be at the root of this low accessibility to H.S. physics. Presenting a snapshot of physics teaching in Oklahoma, the purpose of this talk is to begin a dialogue about what the next steps may be for making H.S. physics more accessible to pre-college students. From informal educational opportunities like science fairs and robotics competitions to state policy and funding, advice is being sought from others in similar environments. Data presented in this paper are organized from 1) files available on the State Department of Oklahoma website 2) specific data obtained via open records requests 3) Oklahoma state teacher certification testing results (physics OSAT) and residency year data Google Map: search "certified H.S. physics teachers in oklahoma."

GD06: 4:30–4:40 p.m. The University of the South: Rural PTRA Program

Ann M. Robinson, University of West Georgia, 293 Paces Lakes Ridge, Dallas, GA 30157; amr496@bellsouth.net

Sharon Kirby, Etowah H.S., Woodstock, GA

The University of the South, a 10,000-acre university atop Tennessee's Cumberland Plateau, was the site of a rural PTRA (Physics Teaching Resource Agent) program starting in 2005 and ending in 2008. Teacher Resource Books developed as a result of years of review by PTRA and published by AAPT were used as a guide for physics content and teaching methods. The program reached across state lines to include teachers from five states dedicated to actively studying and experimenting with physics content, learn research-based pedagogy, become familiar with various types of technology used in the laboratory, and develop techniques to lead their own workshops. Several participants would go on to present material learned at the rural program to teachers at their Tennessee Science Teachers conventions. The participants gained more than 140 hours of instruction and displayed evidence of the impact of the training through teacher assessments at the conclusion of each session.

GE: Reforming the Introductory Physics Courses for Life Science Majors III

Location: Pavilion East
Sponsor: Physics in Undergraduate Education Committee
Date: Tuesday, July 20
Time: 3–5 p.m.

Presider: Juan Burciaga, Denison University, burciagaj@denison.edu

GE01: 3–3:30 p.m. Astrobiology and Planetary Science

Invited – Don Brownlee, University of Washington, Dept. of Astronomy 351580, Seattle, WA 98195; brownlee@astro.washington.edu

Astrobiology and planetary science are highly interdisciplinary endeavors that encompass a number of wide-ranging fields including chemistry, atmospheric science, and oceanography as well as a broad range of biological and geological sciences. These two endeavors have fundamental roots in physics, and they provide numerous opportunities for students to expand their physics knowledge. Areas of focus in astrobiology and planetary science include an improved understanding of the origin of planets and the origin and evolution of life that might form on planets. With the discovery of more than 400 planets around other stars, both of these fields are areas of considerable activity and general interest. My personal view is that basic physics should concentrate on basic physics, but it is very clear that astrobiology and planetary science provide wonderful opportunities for students to apply their physics understanding to "real world" problems. My personal experience with physics undergraduates is that many have "eye opening" experiences when they can use basic physics to estimate the formation time of Earth, to understand the origin of the elements, and to try and understand the limits on the fascinating concept of the Habitable Zone—the radial distance range around a star where and an Earth-like planet can have surface water and might harbor life.

GE02: 3:30–4 p.m. Essential Optics Training for Life Science Students

Invited – Jennifer L. Ross, University of Massachusetts, Amherst, 302 Hasbrouck Lab, Amherst, MA 01003; rossj@physics.umass.edu

Optics-based instruments that have probably had the most impact on the life sciences will be discussed. One cannot open a biological journal without seeing at least five beautiful color images of cells. Life scientists are extremely good at using microscopes to discover the inner workings of biology, but only a handful of them could build, upgrade, or repair their microscope. Those who can repair or build microscope systems typically have physical science in their background or have learned through years of tinkering and studying optics on their own. In my talk, I will discuss some basic optics concepts that should be a part of the first year physics training for life science students. In addition, I will discuss a new advanced optics course wherein students design and build a fluorescence microscope.

GE03: 4:–4:30 p.m. Introducing Quantum Physics to Life Science Students

Invited – Juan Rodriguez, Centenary College of Louisiana, 2911 Centenary Blvd., Shreveport, LA 71104; jrodrigu@centenary.edu

Most students in the life sciences receive little or no training in quantum physics, except for what they are exposed to in introductory chemistry courses. Yet quantum concepts such as the wave nature of electrons and protons, quantized energy, spin, and particle tunneling, provide a necessary framework for understanding many fundamental biological phenomena and biotechnological applications. This talk focuses on Centenary's effort to address this issue in a course designed for life sciences students entitled Biophysics and Bioimaging. Topics to be discussed include how quantum principles are introduced, what experiments are performed to illustrate them, and how concepts learned are tied to photosynthesis, cellular respiration, pigmentation, and biotechnology.

GE04: 4:30–5 p.m. Medical Physics in the Introductory Physics Course

Invited – Russell K. Hobbie, University of Minnesota (Emeritus), 2151 Folwell Ave., St. Paul, MN 55108-1306; hobbie@umn.edu

In the United States the term medical physics means the physics used to diagnose and treat disease. (This definition is easily stretched to include biomedical engineering.) The American Association of Physicists in Medicine is the AIP-affiliated professional organization to which most medical physicists in the United States belong. This talk describes many of the diagnostic and treatment methods for which medical physicists are responsible, along with ways to learn more about them. These topics can be used to enrich the introductory course and also in a more advanced course. A few examples are described in greater detail. The slides for this presentation will be available at https://files.oakland.edu/users/roth/web/hobbie.htm after the talk.

GE05: 3–5 p.m. Reforming Introductory Physics Life Science Curriculum Beyond Biological Context

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

As important and vital as it is to have life science students learn physics in an appropriate biological context for their goals, providing relevance and easier transfer; that is the easy part. Once a life science context is established, a deeper, more subtle dissonance becomes apparent. For example, the problem-solving skills that physics/engineering students practice, typified by the end-of-chapter problems, are not the kinds of skills that life science students need to practice to most effectively prepare to build on foundational physics in their future endeavors. Some alternative learning objectives and practice approaches that have been tried with algebra-based classes of diverse students will be presented. This is a work in progress.

GE06: 3–5 p.m. The Humanized Physics Project Web Site: A Resource for Instructors of the IPLS Course

Poster – Robert G. Fuller, University of Nebraska, Lincoln, 3901 S. 27th St., Unit 33, Lincoln, NE 68502-5706; rfuller@neb.rr.com

Nancy Beverly, Mercy College; Christopher D. Wentworth, Doane College

Curriculum materials and ideas for better teaching and learning in the introductory physics for life science course continue to be of great interest among college physics instructors, as witnessed by the sessions devoted to this topic at recent AAPT conferences. One approach to the design of this course that offers the possibility of making learning physics more relevant to health science majors is to use the human body itself as a theme for developing physics topics. The website described here offers resources to help instructors wishing to use the human body theme in teaching introductory college physics. Included on the website are a library of activities and labs, multimedia resources including the contents of the Understanding Human Motion CD and Studies in Motion laserdisc, the textbook *Physics Including Human Applications*, by Fuller, and descriptions of courses that have used this theme. The website url is http://physics.doane.edu/hpp .

GE07: 3–5 p.m. The Effects of Multiple Reformed Courses on Freshman Cohorts

Poster – Robert B. Lynch, University of California Davis, One Shields Ave., Davis, CA 95616; rblynch@ucdavis.edu

Emily A. West, University of New Haven

Wendell H. Potter, Mark R. Bowen, University of California

Beginning with fall 2007, 48-student cohorts of entering freshmen bioscience majors have been enrolled in reformed course sections to test the proposition that students who were exposed simultaneously to both math and science courses, which explicitly stress sense-making rather than memorization, would more quickly develop habits of mind and approaches to learning that are more productive and useful than the memorization mindset that is so typical of entering freshmen. Preliminary results show positive performance gains of the cohort students in subsequent courses. Longitudinal performance data through spring-quarter 2010 for cohorts entering in 2007, 2008, and 2009 will be presented as well as qualitative interviews and survey data.

GE08: 3–5 p.m. Conceptual Physics for Life Science and Sports Medicine Majors

Poster – Dyan L. McBride, Mercyhurst College, 501 E. 38th St., Erie, PA 16546; dmcbride@mercyhurst.edu

The conceptual physics course described here serves primarily life science majors—in particular sports medicine students. As such, the course has been designed to fit the needs of those students while maintaining a focus on the core physics principles. This poster will describe some of the challenges and solutions that have presented themselves during a transitional phase of this course.

GE09: 3–5 p.m. Physics and Physiology: The Cell Membrane Potential

Poster – Richard P. McCall, St. Louis College of Pharmacy, 4588 Parkview Pl. St. Louis, MO 63110; rmccall@stlcop.edu

The study of electric potential is important for students majoring in the medical sciences. Static electricity, current flow, and the nervous system all rely on the presence of ions in the human body. At the cellular level, ions inside and outside the cell produce electric potentials that affect the movement of charge and the response of the body to stimuli. Terms such as resting potential, action potential, threshold potential, and graded potential represent certain arrangements of ions that lie on either side of the cell membrane and those that move through the cell membrane.

GE10: 3–5 p.m. Content Rich Problems for an IPLS Course

Poster – Dawn C. Meredith, University of New Hampshire, DeMeritt Hall, Durham, NH 03824; dawn.meredith@unh.edu

Jessica A. Bolker, Christopher W. Shubert, University of New Hampshire

James Vesenka, University of New England

Gertrud L. Kraut, Southern Virginia University

We present several context rich questions that address issues of interest to students in the biological sciences. The topics include locomotion of jelly fish, bat echolocation, hummingbird hovering, the human circulatory system, and phase contrast microscopy. We will also describe how students approach these types of problems.

GE11: 3–5 p.m. Authentic Assessment with Explanations and Predictions Using Model-based Reasoning

Poster – Wendell H. Potter, University of California, Davis, Physics, One Shields Ave., Davis, CA 95616; whpotter@ucdavis.edu

Scientists make sense of natural phenomena they study by developing, revising, and extending models. Our students use memorization, pattern matching, and algorithmic approaches to "get the answer" to the "problems" they are given as homework and on exams in traditionally taught introductory science courses (and often in advanced courses as well). Scientists are in the business of providing explanations and responses to questions of interest using models that are accepted within their scientific community. Is there any relationship between the "answers" to the "problems" given by our students, or more importantly, what our students do "to get the answer" and what scientists do? In our authentic student assessment we successfully ask our students to explain specific phenomena using relevant models. This has worked well for 14 years in our introductory course for life science majors at UC Davis. Examples of our approach, assessment items, and grading will be illustrated.

GE12: 3–5 p.m. Solving Content Problems in IPLS Courses Using a Models

Poster – Wendell H. Potter, University of California, Davis, Physics One Shields Ave., Davis, CA 95616; whpotter@ucdavis.edu

In addition to "What content should be included in an IPLS course?" there are a host of related issues that must be addressed when redesigning courses. These issues involve questions such as: "What level or depth of physics is required"? "How should the content topics be sequenced"? "What is the appropriate balance between traditional problem solving and conceptual understanding"? "What traditionally treated content can be omitted"? Clearly, in order to approach these questions in a rational way, we need an overarching-framework to help us see around our historically imposed blinders when thinking about introductory physics course redesign. Indeed, even the wording of these questions reflects the traps our historical blinders impose. We present clear examples of how conceptualizing both content and student-learning outcomes in terms of models and model-based reasoning provides a useful overarching framework that allows for a rational and very successful approach to IPLS course and course-content redesign.

GE13: 3–5 p.m. Understanding How Students Use Physical Ideas in Introductory Biology Courses

Poster – Jessica Watkins, University of Maryland, Dept. of Physics, College Park, MD 20742; jessica.e.watkins@gmail.com

Kristi L. Hall, Todd J. Cooke, Edward F. Redish, University of Maryland

The University of Maryland Biology and Physics Education Research Groups are investigating students' views about the role of physics in introductory biology courses. The Bio 2010 report emphasized the value of integrating physics, mathematics, and chemistry into the undergraduate biology curriculum. This poster presents data from an introductory course that addresses the fundamental principles of organismal biology. This course incorporates several topics directly related to physics, including thermodynamics, diffusion, and fluid flow. We examine pre- and post-attitude survey, interview, and class observation data to establish how students consider and employ these physical ideas in the context of their biology course. These results have broad implications as physics instructors consider reforms to meet the interdisciplinary challenges of Bio 2010.

GF: Interactive Learning with Electronic Response Systems

Location: Grand Ballroom II
Sponsors: Research in Physics Education Committee, Professional Concerns Committee
Date: Tuesday, July 20
Time: 3–5 p.m.

Presider: Neville W. Reay, OSU, reay@mps.ohio-state.edu

Speakers in this session will discuss developing and performing research on new methodologies for using electronic response systems in physics classes and beyond.

GF01: 3–3:30 p.m. Key Factors in Teachers' Success or Failure Adopting Clicker Pedagogy

Invited – Ian Beatty, University of North Carolina at Greensboro, PO Box 26170, 321 Petty Building, Greensboro, NC 27402-6170; idbeatty@uncg.edu

Why do some teachers succeed with clickers and others fail, even though those who succeed show great differences in how they use clickers, and even though many who fail seem to be doing the same things as their successful peers? Since 2006, the "Teacher Learning of Technology-Enhanced Formative Assessment" project has been giving clicker sets to middle- and high school science and math teachers; providing sustained professional development on using them effectively; and studying in longitudinal detail the difficulties the teachers encountered, the choices they made, and the successes they achieved. We find that the most crucial factors determining who succeeds, who gives up, and who merely muddles along have far more to do with teachers' deeper attitudes, models, and professional thought habits than with which "best practices" they try or what support they receive. For some teachers, a dramatic transformation from frustrated to enthusiastic can stem from a single insight.

GF02: 3:30–4 p.m. Clicker Questions as Conceptual Scaffolding in Solving Synthesis Problems

Invited – Lin Ding, The Ohio State University, Dept. of Physics, 191 W. Woodruff Ave., Columbus, OH 43210; ding.65@osu.edu

The PER Group at the Ohio State University has successfully developed and implemented a new clicker methodology to enhance student conceptual learning in physics. A large bank of research-based clicker question sequences has been created, validated, and evaluated. Studies have shown that classes that used clicker question sequences displayed a conceptual learning gain 10% higher than identical classes that did not use the materials. Notwithstanding the results, student performance on problem solving was not improved. We propose to use synthesis problems that combine concepts widely separated in the teaching timeline, together with clicker questions as conceptual scaffolding, to help students develop a more expert-like approach to problem solving. Specifically, we train students to always start with fundamental concepts. Pilot studies have been conducted to explore the effects of using clicker questions as conceptual scaffolding in student solving synthesis problems. These pilot results will be presented.

GF03: 4–4:30 p.m. Adapting Interactive Lecture Demonstrations for use with Personal Response Systems (clickers)*

Invited – Ronald K. Thornton, Tufts University, CSMT 4 Colby St., Medford, MA 02155; csmt@tufts.edu

David Sokoloff, University of Oregon

The wide use of personal response systems (clickers) at colleges and universities and less frequently in high schools has motivated us to adapt the Interactive Lecture Demonstrations (ILDs) for use with clickers. The transition is not pedagogically painless. In some cases students move from drawing multiple correlated graphs on paper to choosing graphs from only five choices with a clicker. We have developed protocols to overcome problems and maximize learning. Our initial research comparing student learning when responding on paper ILD sheets to clicker responses shows that the learning is only slightly less with clickers.

*This work was sponsored by the National Science Foundation grant DUE-0633740.

GF04: 4:30–5 p.m. Electronic Response Systems at an Urban University and a Two-year College

Invited – Tom Carter, College of DuPage, Health and Natural Science, Glen Ellyn, IL 60137; carter@fnal.gov

Mel Sabella, Chicago State University

I will present data on the effect of implementing an electronic response system and the associated peer instruction teaching method in the introductory physics classes at both an urban university and a two-year college in the Chicago area. I will show qualitative data showing both instructors and students at these two institutions value this instructional approach. I will also show some curious data that seems to indicate that additional research and revisions to the way personal response systems are used may be required in order for students to get the full educational value from this instructional mode.

GG: *Panel:* Interactive Methods for Teaching Mechanics: Tutorials, Computation, and Experimentation

Location: Broadway III/IV
Sponsor: Educational Technologies Committee
Date: Tuesday, July 20
Time: 3–5 p.m.

Presider: Vern Lindberg, Rochester Inst. of Technology, vern.lindberg@rit.edu

Recently the junior level mechanics lecture has been supplemented with (1) Mechanics tutorials (2) Computer simulations (3) Experiments. Panelists will discuss each of these approaches followed by an open discussion of how these approaches might best be used for instruction.

GG01: 3–5 p.m. Computation in Intermediate Mechanics

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

Many of us require students to complete computational problems in Intermediate Mechanics (Classical Mechanics). While showing some sample assignments and student projects to provide a context for the discussion, we will explore questions about the appropriate role of computation in this course: How does it enhance the course? What trade-offs does it require? To what extent does it modify traditional approaches to teaching this course?

GG02: 3–5 p.m. A Research-tested Tutorial Approach to Teach Intermediate Mechanics

Panel – Bradley S. Ambrose, Grand Valley State University, Dept. of Physics, 118 Padnos Hall, Allendale, MI 49401; ambroseb@gvsu.edu

For many undergraduate physics majors the sophomore/junior level course in intermediate mechanics represents their first step beyond the introductory sequence. Over the past several years research has shown that intermediate mechanics students often encounter conceptual and reasoning difficulties similar to those that arise at the introductory level. Many difficulties suggest deeply seated alternate conceptions, while others suggest loosely or spontaneously connected intuitions. Furthermore, students often do not connect the physics to the more sophisticated mathematics they are expected to use. This presentation will highlight results from research and curriculum development work conducted in support of the Intermediate Mechanics Tutorials project (http://perlnet.umephy.maine.edu/imt), including observations from pilot site instructors who have implemented these materials in a variety of settings. (Supported by NSF grants DUE-0441426 and DUE-0442388.)

GG03: 3–5 p.m. Experiments in Intermediate Mechanics

Panel – Martin Kamela, Elon University, 2625 C.B., Physics Dept., Elon, NC 27244; mkamela@elon.edu

Laboratory exercises are incorporated into the intermediate mechanics course in an effort to increase student engagement. A common data set is collected in class using video analysis and Vernier sensors. In groups, students perform analysis of data, which they subsequently compare to simulations done in Mathematica. In this presentation I identify challenges students faced in completing the laboratory activities and discuss the advantages and limitations of incorporating experimental work into what is traditionally a theory class.

GH: The History of Two-Year College Physics

Location: Pavilion West
Sponsor: Physics in Two-Year Colleges Committee
Date: Tuesday, July 20
Time: 3–5 p.m.

Presider: Scott Schultz, Delta College, sfschult@delta.edu

GH01: 3–3:30 p.m. How the TYC Community Has Shaped My Career

Invited – Dwain M. Desbien, Estrella Mountain CC, 3000 N Dysart Rd., Avondale, AZ 85392; dwain.desbien@emcmail.maricopa.edu

There have been multiple two-year initiatives and individuals that have greatly influenced the paths I have chosen and my development as a physics professor. I will look at those events and individuals that shaped me and move forward to the opportunities that I have had to give back to our profession.

GH02: 3:30–4 p.m. Embryonic and First Stages of the TYC Physics Committee

Invited – Marvin L. Nelson, Green River Community College, 38922 212th Ave., SE, Enumclaw, WA 98022; mrvnel@earthlink.net

The Commission on College Physics provided the early impetus that led to the creation of the Committee of Physics in Two-Year Colleges as an entity within AAPT. Personal recollections of events that led up to the creation of the TYC Physics Committee. Challenges and successes will also be discussed.

GH03: 4–4:30 p.m. Lessons from the Past

Invited – Mary Beth Monroe, Southwest Texas Junior College, Physics Dept., 2401 Garner Field Rd., Uvalde, TX 78801; mbmonroe@swtjc.cc.tx.us

During the last 35 years, the AAPT and the NSF have played significant roles in providing opportunities for two year college physics faculty to realize their potential as a community to improve physics education. I will describe the TYC activities that I have been a part of and comment on the impact that these activities have had in enhancing the visibility of TYC physics faculty within AAPT and the general physics education community. Lastly, I will propose what I believe should be the "next steps" for the TYC community.

GH04: 4:30–5 p.m. Some Projects and Their Role in Recent Two-Year College Physics History

Invited – Thomas L. O'Kuma, Lee College, Physics Dept., Baytown, TX 77522-0818; tokuma@lee.edu

At the first national gathering of two-year college physics faculty, The Topical Conference on Critical Issues in Two-Year College Physics and Astronomy held in Washington, D.C., in November 1999, one of the critical issues identified was "a need to remain current in pedagogical approaches to teaching physics." Using this as a call for action, a number of projects, primarily funded by the National Science Foundation, have addressed this critical issue over the last 20 years. In this talk, I will discuss these projects and some of their influences on me, TYC physics, faculty and others. Some of the projects included will be PEPTYC, TYC WS, TYC 21, QuOpTYC, ATE PPF, SPIN-UP/TYC, TIPERs, and ICP21.

IC: Dealing with Mathematical Difficulties in Lower- and Upper-Division Physics Courses

Location: Salon Ballroom II
Sponsor: Physics in Undergraduate Education Committee
Date: Tuesday, July 20
Time: 3–5 p.m.

Presider: Lili Cui, University of Maryland Baltimore County; lili@umbc.edu

IC01: 3–3:30 p.m. Characterizing Expertise in Physics Problem Solving

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

Thomas J. Bing, Emory University

Expert physics problem solvers don't just do mathematics efficiently and powerfully; they integrate their physics knowledge and intuition with their use of mathematics using a variety of approaches and problem solving tools. We have videotaped students solving problems in upper-division physics classes in interviews and authentic classroom situations. In these observations we see that journeymen students (not novices, but not yet experts) often have difficulties with the integration of these tools. In this talk we consider a case study that illustrates how applying the lens of epistemological framing[1] to upper-division problem solving yields a new way of looking at expertise. This helps us get beyond simple correctness to get a deeper view of the development of higher-level problem solving skills in physics.

1. T. J. Bing and E. F. Redish, *Phys. Rev. STPER*, **5,** 020108 (2009).

IC02: 3:30–4 p.m. Investigating Student Understanding of Integrals in Upper-Division Thermodynamics*

Invited – John R. Thompson, The University of Maine, 5709 Bennett Hall, Orono, ME 04469-5709; john.thompson@umit.maine.edu

In research on student understanding in upper-level thermal physics courses, we are exploring student understanding of the associated mathematics. One specific focus is student interpretation of P-V diagrams and the relevant mathematical concept of integration. We analyzed student comparisons of (a) the work done by a system as well as (b) the internal energy change of that system, over two different thermodynamic processes between the same two end states.[1] We compared these data with responses to analogous mathematics questions, stripped of physical meaning, asking for comparisons of integrals of two different functions. We find that for work, difficulties with the physics concepts appear to have roots in the mathematics, while for internal energy changes, difficulties with the mathematics far outweigh those with the physics. The results from these questions will be discussed as well as interpreted through some of the literature of research on undergraduate mathematics education.

1. The physics questions come from Meltzer *AJP* 2004.

*This work supported in part by NSF Grants REC-0633951 and DUE-0817282.

IC03: 4–4:30 p.m. Upper-Division Electricity and Magnetism: Students' Ideas and Difficulties*

Invited – Rachel E. Pepper, University of Colorado, 390 UCB, Boulder, CO 80302; rachel.pepper@colorado.edu

Stephanie V. Chasteen, Steven Pollock, Katherine Perkins, University of Colorado

We describe student conceptual difficulties observed in junior-level Electricity and Magnetism based on our work researching and transforming the first semester of this course. The transformed course has provided many opportunities to expose and identify student difficulties, including: analysis of conceptual homework and exam questions; student observations during weekly interactive small-group tutorials and homework help room sessions, and interactive lecture; analysis of results from our upper-

Tuesday afternoon

division E&M conceptual post-test (the CUE) and our new pre-/post-tutorial assessments; and formal student interviews. We present examples of common student difficulties and curricular design efforts to address these difficulties. Assessments show some improvement in student performance in transformed courses compared to traditional courses; however, we find the persistence of many conceptual difficulties, including connecting mathematical methods to physical meanings. All reform materials are available through http://www.colorado.edu/sei/departments/physics.htm.

*This work was funded the University of Colorado's Science Education Initiative and the National Science Foundation Grant No. 0737118.

IC04: 4:30–4:40 p.m. Developing Scientific Thinking in the Physics Labs

CANCELED

Maria C. Babiuc-Hamilton, Marshall University, One John Marshall Dr., Huntington, WV 25755; babiuc@marshall.edu

Physics relies heavily on the ability of manipulating abstract symbols. How many of you wished, over and over again, that your students would see beyond numbers and be able to handle physics formulas with much more ease? Educational research shows a direct correlation between mathematics preparation and the success of college students in science. Physics labs are perfect environments to help students handle formulas, and offer incredible opportunities to develop scientific thinking, by bridging the empirical data with the abstract theory. However, the regular lab sessions do not offer enough time. By opening the doors of the labs for the students, allowing them to take the data at their own pace, and to learn from their own mistakes, we offer the necessary learning time to build scientific thinking skills. We encourage more advanced students to share their knowledge. By accentuating the importance of lab reports, we ensure a context-rich education.

IC05: 4:40–4:50 p.m. Student Difficulties with non-Cartesian Unit Vectors in Upper-Level E&M

Brant Hinrichs, Drury University, 900 N. Benton Ave., Springfield, MO 65802; bhinrichs@drury.edu

An upper-level E&M course (i.e. based on Griffiths) involves the extensive integration of vector calculus concepts and notation with abstract physics concepts such as field and potential. We hope that students take what they have learned in their math classes and apply it to help represent and make sense of the physics. To assess how well students are able to do this integration and application, I have developed several simple concept tests on position and unit vectors in non-Cartesian coordinate systems as they are used in upper-level E&M. In this talk I describe these concept tests and present results that show students at different levels (pre-E&M course, post-E&M course, first-year graduate students) and in different disciplines (physics, electrical engineering) have difficulty using non-Cartesian unit vectors appropriately.

IC06: 4:50–5 p.m. Addressing Students: Math Deficiencies in Introductory Physics with Online Tutorials

Craig Wiegert, University of Georgia, Dept. of Physics and Astronomy, Athens, GA 30602-2451; wiegert@physast.uga.edu

Daniel Seaton, University of Georgia

Scott J. Thompson, Georgia Gwinnett College

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.

PANEL DISCUSSION: Writing About Science in Children's Books, Magazines, Newspapers, and Popular Prose?

Location: Council Suite
Date: Tuesday, July 20
Time: 1:20–2:50 p.m.

Presider: Bernard Khoury

This special panel discussion will examine the ethos of publishing science in popular forms. Joining together two award-winning children's book authors with a celebrated local free-lance journalist and science writer who is the author of two books, the panel will examine what it takes to translate science and sell it in the forms of children's books, magazine and newspaper articles, general audience books and other forms of popular prose. The panel will also invite audience members to ask questions on any aspect of publishing and to share stories of publishing failures and triumphs. Two of the panelists are the 2009 winners of the American Institute of Physics Children's Writing Award for their book *The Great Number Rumble: A Story of Math in Surprising Places* (Annick Press, 2007), which takes the reader on a journey as math gets banned at school, chaos rules, kids toss their textbooks, and the math-loving main character proves that life isn't half as fun without his favorite subject. (See details of award, page 17)

The panel will be moderated by Bernard Khoury, AAPT Executive Officer Emeritus. Recently retired after many years of service as a physicist and educator, Khoury was the AAPT Executive Officer for 16 years, a member of the Governing Board of the American Institute of Physics, Associate Vice President for Academic Affairs at the University of Maryland System, and Executive Director of the Graduate Records Examination (GRE) Program.

PANELISTS:

Cora Lee, science writer based in Vancouver, Canada

Gillian O'Reilly, science writer who lives in Toronto, Canada

Richard A. Lovett, full-time free-lance writer

Jason Socrates Bardi, senior writer and media relations manager at the American Institute of Physics

PST2: Poster Session II

Location: Exhibit Hall
Date: Tuesday, July 20
Time: 9:20–10:50 p.m.

Odd number poster authors will be present 9:20–10:05 p.m.
Even number poster authors will be present 10:05–10:50 p.m.

(Posters should be mounted by 8:30 a.m. Tuesday and taken down by 11 p.m. Tuesday)

LECTURE/CLASSROOM

PST2A01: 9:20–10:05 p.m. Lessons Learned by a First Time Modeling Teacher

Jon P. Anderson, Centennial High School, 4757 North Rd., Circle Pines, MN 55014; jpanderson@isd12.org

I will discuss what I learned when implementing a modeling curriculum into my Introductory physics course for the first time. I attended a three-week summer workshop on modeling instruction at Florida International University in the summer of 2009. Subsequently, during the 2009-10 academic year, I have taught this course four times (block schedule) and have had the opportunity to make changes each quarter. I will discuss what worked, what didn't work, what mistakes I made and hopefully others will avoid, and what temptations I faced as an experienced teacher of physics and one with years of accumulated curricular materials to fall back on.

PST2A02: 10:05–10:50 p.m. Developing and Deploying Computational Exercises in Introductory Physics

Marcos Caballero, Georgia Institute of Technology, 837 State St., Atlanta, GA 30332; caballero@gatech.edu

Michael Schatz, Georgia Institute of Technology

Matthew Kohlmyer, North Carolina State University

Students taking introductory physics are rarely exposed to numerical computation, that is, using a computer to solve science and engineering problems. An introductory physics course at Georgia Tech utilizes numerical computation as a tool for describing physical phenomenon not easily described using analytic methods. Students are taught to develop visual 3D models of a variety of physical phenomenon (e.g., the motion of a spring-mass system exposed to viscous drag in 3D). We present an overview of the computational component of this curriculum, the development of exercises to enhance students' understanding of numerical computation and visualization introduced in the mechanics curriculum, and preliminary measurements of performance and attitudes.

PST2A03: 9:20–10:05 p.m. Motivating First-Year College Students to Continue as a Science Major*

Kathleen M. Koenig, Wright State University, 3640 Colonel Glenn Highway, Dayton, OH 45435; kathy.koenig@wright.edu

Michael Edwards, Lei Bao, The Ohio State University

Only one-third of students who enter Wright State's College of Science and Mathematics (CoSM) earn a degree from the college in six years. Half of those who leave the college do so during freshmen year. Of the 379 students who entered CoSM as freshmen in fall 2009, 66% placed into intermediate algebra or below (i.e. remedial math). None of these students are able to enroll in their majors courses until they complete the math pre-requisites which can take up to one academic year. It is during this time that we lose many of our potential science majors. A general elective "Scientific Thought and Methods" course was developed four years ago to target these first-year students and improve their chances of retention in the sciences. The poster will present details of the course, related challenges, and the course's impact on retention.

*Supported in part by NSF Grant DUE 0622466.

PST2A04: 10:05–10:50 p.m. The Growing Shadow

Sunny Lee, Korea National University of Education, Dept. of Physics Education, Chonwgwon, Chungbuk, CB 363-791; jbkim@knue.ac.kr

Jung Bog Kim, Korea National University of Education

If the light source is not a point but a finite size, and if two objects with different distances from the light source are moving close to each other, at a moment, a part of one object's shadow grows up such as one shadow attracts to the other. This "growing shadow" can be explained by using light rays. We show that growing shadow does not result from either overlapping of penumbras or light diffraction. Both the size of light source and relative distances between objects should be considered for understanding growing shadow. By considering growing shadow, students are able to get higher-order thinking skills.

PST2A05: 9:20–10:05 p.m. Invention of Physical Quantities as an Underpinning for Proportional Reasoning

Suzanne White Brahmia, Rutgers University, Dept. of Physics, Piscataway, NJ 08854; brahmia@physics.rutgers.edu

Andrew Boudreaux, Western Washington University

Stephen Kanim, New Mexico State University

Mathematical reasoning skills are fundamental tools for understanding physics, and proportional reasoning is perhaps the most familiar skill. Physicists reason this way in the context of nearly every physical quantity. It is rudimentary, yet we know our students often leave our courses without having mastered this important skill. In an ongoing collaboration between Rutgers University, Western Washington University, and New Mexico State University we have developed curricular materials and methods for using invention as a preparation for instruction, building the foundation for proportional reasoning in the context of physics. This poster describes "invention sequences" that are based on the invention tasks piloted by Daniel Schwartz's group at Stanford University.* We present the materials and how their existence has affected the emphasis of the teachers and students that use them.

* http://aaalab.stanford.edu/.

PST2A06: 10:05–10:50 p.m. Physics Study Groups: Using Internal Funding for Effective Undergraduate Support

Suzanne White Brahmia, Rutgers University, Dept. of Physics, Piscataway, NJ 08854; brahmia@physics.rutgers.edu

Mary Ann Cancio, Calvin Yu, Kathleen Scott, Rutgers University

Most universities have a variety of undergraduate support programs that are reasonably well-funded, often function independently of the faculty, and are too commonly under-utilized by the students. Coordinating these programs more closely with the courses that the students take has the potential to boost student success. At Rutgers we have undertaken coordination between the faculty of the large-enrollment introductory physics courses with the already-established student support programs to create Physics Study Groups. These groups are led by undergraduate physics majors who are advised regularly by the course faculty. The result is cyclic enlightenment: mentoring for the undergraduates by the physics majors, mentoring about teaching for the physics majors by the physics faculty, and finally feedback for the faculty who can then better tailor the course to their students' needs. Everyone wins. We report on the formation of this program, its costs and some preliminary results.

PST2A07: 9:20–10:05 p.m. Effectiveness of the Master-Class Model for Teaching Physics Concepts and Skills*

Kenneth Cecire, University of Notre Dame, Dept. of Physics, 225 Nieuwland Science Hall, Notre Dame, IN 46556; kcecire@nd.edu

The QuarkNet collaboration has collaborated with the European Particle Physics Outreach Group for five years on the particle physics Masterclass. In that time, it has grown in the United States from one Institute with six students to 23 Institutes with over 400 students. At the same time, the U.S. model has been developed in response to evaluation and the needs of the program. The Masterclass is becoming a robust model for engaging students in physics and facilitating their learning.

*This work is supported by the National Science Foundation, the Department of Energy Office of Science, and the University of Notre Dame.

PST2A08: 10:05–10:50 p.m. Welcome to the Department. Let's Do Some Math

Jacob Clark Blickenstaff, University of Southern Mississippi, 505 Court St., Hattiesburg, MS 39401; jclarkblickenstaff@gmail.com

The Department of Physics and Astronomy at the University of Southern Mississippi endeavors to retain new physics majors through a two-unit course titled "Frontiers of Physics" taken in the first term of freshman year. The course has three goals: to prepare students for the math they will need in upcoming semesters of physics, to introduce students to faculty in the department, and finally to give them a background in the history of physics. Students come into the course with a range of math skills and preparation, but here work cooperatively on graph construction and interpretation, trigonometry, and basic calculus. Interspersing the mathematics with faculty research presentations and the history of physics helps to maintain student interest.

PST2A09: 9:20–10:05 p.m. OSU's Studio Physics Classroom: Building a "SCALE-UP Plus" Room

Dedra Demaree, Oregon State University, 301 Weniger Hall, Physics Dept., Corvallis, OR 97331; demareed@physics.oregonstate.edu

Sissi Li, Oregon State University

Oregon State University spent the last year constructing a SCALE-UP classroom for use in the introductory calculus-based physics sequence. Due to a generous private donation, we were able to incorporate a lot of features including a low-friction strip on the floor similar to what is used in the Workshop Physics classroom at Dickenson, a StarBoard for each table, and a high-tech control panel allowing for multi-technological modes to be used around the room. We also paid special attention to making the room flexible, so the layout and technology can easily be changed in the future. This is what we are calling the "plus" part of the SCALE-UP room name. This poster will showcase this new space, discuss the design choices, and the process of creating the space starting from a budget to full student use.

PST2A10: 10:05–10:50 p.m. Aligning Student Understanding of Magnetic Domains

Tracy G. Hood, Plainfield High School, 1 Red Pride Dr., Plainfield, IN 416168; thood@plainfield.k12.in.us

David Sederberg, Lynn Bryan, Purdue University

Magnets are formed when magnetic domains align and create magnetic poles. Typical high school textbooks include a picture of these domains shown with some net orientation in a magnetized material and randomized in a non-magnetized material. Without this diagram, though, how can students construct a mental model of magnetic domains? Approximately 100 students in a suburban Indiana school worked through three days of inquiry investigations to develop an understanding of magnetism from the macro- to the nano-scale. Evidence of student learning and a learning progression to improve the development of these mental models will be presented.

PST2A11: 9:20–10:05 p.m. Illustrating the Relationship Between Hydrogen Orbital's and Classical Orbits

Lawrence B. Rees, Brigham Young University, Dept. of Physics and Astronomy, Provo, UT 84602; Lawrence_Rees@byu.edu

We often describe Bohr orbits in terms of standing matter waves, but we seldom mention the connections that can be made between Schrodinger orbitals and classical orbits. This poster depicts how classical orbits and matter waves can be used to illustrate fundamental characteristics of hydrogen atom orbitals graphically.

PST2A12: 10:05–10:50 p.m. Physics for Everyone: Designing Inclusive Physics Problems

Barbara L. Whitten, Colorado College, 14 E. Cache la Poudre, Colorado Springs, CO 80903; bwhitten@coloradocollege.edu

Sarah K. Matthews, Jessica A. Rivas, Sarah F. Schuster, Shannon R. Dorato, Colorado College

Recently several innovative alternatives to the standard introductory physics course have been developed, with the goal of making physics more attractive to a broader range of students. Traditional physics problems appeal to traditional physics students, but may reinforce the opinion of women and students of color that physics is not for them. Sue Rosser suggests that science courses should try to incorporate and validate personal experiences that students are likely to have had. Emphasizing the applications of physics to social and environmental problems may broaden the appeal of introductory physics to nontraditional students. In this project we are designing problems that test the concepts of introductory physics, in a variety of contexts that will appeal to less traditional physics students, and illustrate the wide applicability of the principles of physics. We'll describe our guidelines and give examples of our problems.

PHYSICS EDUCATION RESEARCH II

PST2B01: 9:20–10:05 p.m. Direct and Indirect Approaches to Increasing Conceptual Survey Gains

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Patrick B. Kohl, Vince Kuo, Colorado School of Mines

Conceptual surveys such as the FCI and CSEM have become common. It is often the case that course reforms attempt to increase student gains on these surveys. There exist various approaches to improving student scores on these surveys, and while some approaches have been accused of "teaching to the test," such suggestions have generally been well-refuted. To our knowledge, there has been little direct experimentation on whether teaching to the test has the expected result. In this poster, we report the results of a two-semester experiment involving ~900 students in which we tried two different approaches to raise CSEM gains in an introductory E&M class. First, we directly inserted select CSEM questions into the lecture portion of the class as Peer Instruction-style clicker questions (explicitly teaching to the test). In a different semester, we revised Studio Physics activities to use scaffolding to more effectively teach the concepts. We compare the CSEM results from each experimental semester to previous year's results.

PST2B02: 10:05–10:50 p.m. Students' Difficulties in the Concepts of Vector Components and Vector Products

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Genaro Zavala,Tecnologico de Monterrey, Campus Monterrey

In this work we investigate students´ understanding of vector components and vector products. In the first part, we based our study on the work of Van Deventer.[1] Using multiple-choice questions asking for students reasoning, and assigning slightly modified questions to different groups of students randomly chosen,[2] we deeply analyze the preconceptions and difficulties with graphical representation of the x- and y-component of a vector found by Van Deventer. In the second part, using the methodology of Barniol and Zavala,[2] we study, based on prior research, [1,3] the effect of the way the vector arrangement is presented on the students' answers regarding the dot and cross products.

1. J. Van Deventer, "Comparing student performance on isomorphic math and physics vector representations," Masters Thesis, The University of Maine (2008).

2. P. Barniol and G. Zavala, "Investigation of students' preconceptions and difficulties with the vector direction concept at a Mexican University," *AIP Conference Proceedings*, 1179, 85-88 (2009).

3. W. Christensen, N.L. Nguyen, and D. E. Meltzer, "Student difficulties with graphical representation of vector products: crossing and dotting beyond t's and i's," PERC Conference, Sacramento, California (2004).

PST2B03: 9:20–10:05 p.m. Utilizing Multiple Studies to Understand Effective Collaboration in the Physics Classroom*

Geraldine L. Cochran, The Science House, Campus Box 8211/Research Building IV, Raleigh, NC 27695-8211; moniegeraldine@gmail.com

Mel S. Sabella, Chicago State University

The Physics Program at Chicago State University has been investigating ways to promote effective collaboration in introductory physics courses. We have utilized several methods to investigate whether student use of peer questioning and guided-inquiry promote effective collaboration. To uncover student attitudes toward collaboration and guided-inquiry, we administered a survey and interviewed students and tutors from the introductory physics courses to elicit specific ideas students had about effective instruction. Video recordings of students completing laboratory activities were analyzed using a rubric to gauge the level of collaboration in the classroom. Finally, we interviewed four of our faculty members and two students from our videos to find out what they felt constituted effective collaboration. At previous meetings, we have discussed the results of these individual research components. In this poster we synthesize these results and discuss the implications this work may have on creating learning environments that foster effective collaboration.

*Supported by the National Science Foundation CCLI Program (DUE 0632563.)

PST2B04: 10:05–10:50 p.m. The Role of Conceptual Scaffolding in Students' Solving Synthesis Problems

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Neville Reay, Lei Bao, The Ohio State University

Albert Lee, California State University Los Angeles

Conceptual understanding and problem solving are two major components in undergraduate physics education. However, studies have shown that students' increased conceptual learning does not automatically translate to increased problem solving. This phenomenon can be largely attributed to the fact that typical textbook problems are highly localized; addressing only topics covered in single chapters and thus facilitating simple "plug-and-chug." We have created synthesis problems that combine concepts that are widely separated in the teaching timeline, to militate against "plug-and-chug." To further encourage students to focus on underlying concepts, we used conceptually based clicker questions as scaffolding prior to students solving synthesis problems. Pilot studies have been conducted to explore the role of conceptual scaffolding and the effects of repeated training by this method, particularly the sustainability of conceptual scaffolding after its being removed. This paper will discuss the results from our most recent studies.

PST2B05: 9:20–10:05 p.m. Designing Scoring Rubrics for Problem Solving in Electricity & Magnetism

Jennifer L. Docktor, University of Illinois at Urbana-Champaign, 405 North Mathews Ave., Urbana, IL 61801; docktor@illinois.edu

In previous studies I developed a scoring rubric to assess introductory mechanics problem solutions on five criteria: organizing problem information visually or symbolically (Useful Description), selecting appropriate physics concepts and principles (Physics Approach), applying physics principles (Specific Application of Physics), executing math steps (Mathematical Procedures), and communicating a coherent reasoning pattern (Logical Progression). This analysis explores the extent to which these scoring categories are also appropriate for topics in electricity and magnetism, which are generally more abstract and difficult for students. I discuss the process used to design rubrics for scoring problems on Coulomb's law, electric fields from point charges and continuous charge distributions, and Gauss's law. A sample data analysis is provided to demonstrate the influence of assigning "weight" values to different solution aspects and illustrate the rubric's potential usefulness for research purposes.

PST2B06: 10:05–10:50 p.m. Negotiating the Reference Frame Shift: Impact of Appearance on Instruction*

Jared L. Durden, Florida International University, 10491 S.W. 15th Lane, Apt. #107, Miami, FL 33174; jdurd001@fiu.edu

Eric Brewe, Laird Kramer, Florida International University

We present results of a pilot study that examines the "negotiation of the reference frame shift" by focusing on the effect the instructor's physical appearance has on classroom discourse. Educational reform inspired by Physics Education Research has led to classroom models that vastly differ from the structure of traditional lectures, requiring students to adapt to new educational frameworks. We examined two reformed Introductory physics I lab sections using tutorial-guided, PER-based instruction that required student discussion and model building, and compared student discourse as a function of instructor appearance. One instructor taught both sections. In one section, he dressed as a traditional educator: collared shirt, slacks, and tie. In the second section he dressed casually: t-shirts and jeans. Through participant-based observational analysis, student exit surveys, and epistemic measurement, we found that students' perception of the teacher, based on physical appearance, plays an important role in the discourse in the classroom.

*Work supported by PhysTEC and NSF PHY-0802184.

PST2B07: 9:20–10:05 p.m. Developing Assessment Instruments on Scientific Reasoning*

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Guiqing Xu, Beijing Normal University

Li Cheng, SouthEast University

Kathy Koenig, Wright State University

Lei Bao, The Ohio State University

Lawson's classroom test of scientific reasoning has received much attention as a useful tool in assessing students' reasoning abilities. Built on the Lawson's test, we started to develop new questions that involve a wide range of contexts and additional skill dimensions. In this talk, we will discuss the validity issues of current assessment instruments and introduce the theme of the development and show examples of the new questions. Large-scale assessment results using both the exiting questions and the new questions will be presented. The results are also used for equating analysis in order to calibrate the new questions in reference to the exiting instruments. Applications of the assessment tool will also be discussed.

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

PST2B08: 10:05–10:50 p.m. Students' Responses to Different Representations of a Vector Addition Question*

Jeffrey M. Hawkins, The University of Maine, 120 Bennett Hall, Orono, ME 04469-5709; Jeffrey.hzawkins@maine.edu

Michael C. Wittmann, John R. Thompson, The University of Maine

Eleanor C. Sayre, Wabash College

Jessica W. Clark, Rochester Institute of Technology

Students use multiple methods to add vectors graphically,[1] some of them leading to correct solutions, some of them not. We discuss students' responses to four different representations of a single graphical vector addition question, designed to elicit different solution methods. These four questions have vectors arranged in either a head-to-tail or a tail-to-tail orientation and either with and without a grid. These questions were administered to several hundred students at two different universities. We present the prevalence of different methods in students' responses on the four different types of questions. Furthermore, we describe the types of language they used as well as inconsistencies between students' explanations and drawings.

1. J. M. Hawkins, J. R. Thompson, and M. C. Wittmann, AIP Conf. Proc. 1179, 161 (2009).

*Supported in part by NSF Grants REC-0633951.

PST2B09: 9:20–10:05 p.m. Improving Technical Education: Opportunities for Physics Educational Researchers*

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Herb Fynewever, Calvin College

Heather Petcovic, Western Michigan University

Liesel Ritchie, University of Colorado at Boulder

The NSF Advanced Technological Education (ATE) program is a leading funding source for promoting innovations in technical education. Operating primarily with two-year colleges, the ATE program has funded a wide variety of projects since its initiation in 1994. There has recently been a push to have more targeted research studies related to these projects and to technical education in general. During the past two years, we have participated in the Discovering the Educational Consequences of ATE (DECA) project, a collaborative project designed to build educational research capacity within the ATE community. This poster will introduce the ATE program, describe educational research opportunities within ATE, and provide an overview of the DECA project. We will also describe our study within the DECA project that deals with the impacts of a National ATE Center on its home institution and related issues of center sustainability.

*Supported by NSF #0832874.

PST2B10: 10:05–10:50 p.m. Reflective Writing as a Tool for Exploring Physics Courses

Xiang Huang, 734-7400 Sherbrooke, Montreal, QC H4B1R8; x.xianghuang@gmail.com*

It has been shown in studies on the subject that many students view science as weakly connected pieces of information to be separately learned in contrast to the web of interconnections perceived by the instructors. Kalman[1] pointed out that developing a scientific mindset may not simply be a conceptual change from personal scientific concepts to scientifically accepted concepts. It may also be a change in attitude from a view that study in science is a matter of solving problems using as independent set of tools, classified according to problem type, to a view that a science subject consists of a web of interconnected concepts. He has developed a toolbox to bring about the change. Reflective writing is one of these tools. In this study, we explore the relationship among students' writing processes, products, and attitude to physics and science courses and try to find if there is any difference in effectiveness of this tool by different course levels.

1. C.S. Kalman, *Successful science and engineering teaching: theoretical and learning perspectives* (Springer 2008)

*Sponsored by Calvin S. Kalman.

PST2B11: 9:20–10:05 p.m. A CLASS Study of Student Perceptions of Physics in Saudi Arabia and U.S.

Katherine K. Perkins, University of Colorado, UCB 390, Boulder, CO 80309; Katherine.Perkins@colorado.edu

H. Alhadlaq, F. Alshaya, S. Alabdulkareem, King Saud University

W.K. Adams, University of Colorado

C.E. Wieman, University of British Columbia and University of Colorado

The Colorado Learning Attitudes about Science Survey (CLASS) is an instrument that was designed to measure student perceptions about physics. Recently, an Arabic version of the CLASS was developed and validated to measure students' beliefs about physics at King Saud University (KSU) in Riyadh, Saudi Arabia. We have administered the CLASS before (pre) and after (post) instruction in introductory physics classes at KSU and at University of Colorado in the United States. In this poster, we present results from both populations, including students' perceptions entering college physics, shifts in students' perceptions from pre- to post-instruction, and differences between men's and women's perceptions.

*This work is funded through a collaborative agreement with The Excellence Center of Science and Mathematics Education, King Saud University, Saudi Arabia.

PST2B12: 10:05–10:50 p.m. Tracking Gender Gaps Throughout an Undergraduate Physics Degree Program

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Vince Kuo, Colorado School of Mines

In previous work, we have replicated studies of gender gaps in introductory physics courses using the Colorado School of Mines population. In addition to having a substantial science and engineering undergraduate population, CSM also has one of the largest collections of physics majors in the country. This has provided us with an opportunity to extend our work into non-introductory courses, including longitudinal tracking in some cases. While our introductory courses are taught in a studio physics mode, the other courses in our physics major are almost exclusively traditional. In this poster, we report on the character of the gender gaps in courses throughout our physics major. We have observed small gender gaps in our introductory physics classes. On a course-by-course basis the performance gaps remain small throughout the major, though longitudinal tracking indicates a somewhat more complex picture.

PST2B13: 9:20–10:05 p.m. Student Difficulties with Right Hand Rules

Mary Bridget Kustusch, North Carolina State University, Physics Dept., Box 8202, Raleigh, NC 27695-8202; mbkustus@ncsu.edu

Robert J. Beichner, North Carolina State University

Although there is much speculation about why students struggle with the use of right-hand rules in physics, there is little data that directly addresses the issue. Starting from research in vector understanding and spatial cognition, several factors have been identified as possibly contributing to the difficulty of using physical right-hand rules. We will present preliminary results of a study designed to address the degree to which these factors impact student use of a right-hand rule.

PST2B14: 10:05–10:50 p.m. Quantitative Study of Student Engagement Comparing Different Lecture Hall Designs

Sissi L. Li, Oregon State University, 301 Weniger Hall, Corvallis, OR 97331; lisi@onid.orst.edu

Dedra Demaree, Oregon State University

At Oregon State University, we have undergone curriculum reform in our large-enrollment introductory calculus-based physics sequence including the remodeling of the lecture classroom space in conjunction with our ISLE-based curriculum to promote interactions in social learning activities. We have had the opportunity to study student participation in small group activities in two lecture classroom designs—a traditional design with close packed fixed seating and a remodeled room designed to enhance student interactions. We have previously reported strong FCI gains (0.4) in both classrooms, but we want a more detailed description of if and how the classrooms are enhancing student interactions in the social learning activities. Using audiovisual data over the three-quarter sequence in 2008-2009, we observed the degree of engagement in terms of duration of interaction and group size. We will present our findings in comparing the two classrooms.

PST2B15: 9:20–10:05 p.m. Categorization of Quantum Mechanics Problems by Professors and Students

Shih-Yin Lin, University of Pittsburgh, 3941 O'Hara St., 100 Allen Hall, Pittsburgh, PA 15260; hellosilpn@gmail.com

Chandralekha Singh, University of Pittsburgh

We discuss the categorization of 20 quantum mechanics problems by physics professors and students in honors-level quantum mechanics course. Professors and students were asked to categorize the problems based upon similarity of solution. We find that while faculty members' categorization was overall better than students' categorization, the categories created by faculty members were more diverse compared to the uniformity of the categories they create when asked to categorize introductory mechanics problems. We will discuss the findings. This work is supported by NSF.

PST2B16: 10:05–10:50 p.m. Assessing the Learning Styles of Engineering Students in Mexico

Teresita Marin-Suarez, Tecnologico de Monterrey, Av. E. Garza Sada 2501, Monterrey, NL 64849; tere.marin@itesm.mx

Hugo Alarcon, Tecnologico de Monterrey

In the last decade, the use of encouraging results from research in active learning teaching strategies in physics had been promoted. In order to know how active the engineering students are, a study of learning styles with engineering students of the Tecnologico de Monterrey had been held. One of the approaches to study the learning styles has been proposed by Alonso and Honey;[1] the diagnosis CHAEA considers four learning styles: active, reflexive, theoretical, and pragmatic. This test was applied to 1627 students in first and third semesters enrolled in courses on Introductory Mechanics and Electricity and Magnetism. Results show that students' learning style is less active as they progress in their engineering program. These results invite us to pay special attention to teaching methods followed by our professors in order to direct future research to promote active learning related attitudes.

1. Alonso C., Gallego D.Y. Honey P. (1999) Los estilos de aprendizaje. Procedimientos de diagnostico y mejora. 4ª Ed. Ediciones Mensajero, Spain.

PST2B17: 9:20–10:05 p.m. Computer Coaches for General Problem Solving

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Kenneth J. Heller, Qing Xu, School of Physics and Astronomy, University of Minnesota, Twin Cities

Leon Hsu, Dept. of Postsecondary Teaching and Learning, University of Minnesota, Twin Cities

We describe three different types of computer tutors for student problem solving written in Adobe Flash to be accessible to students on the Internet. The tutors comprise a system of coaching based upon the cognitive apprenticeship model of helping students learn to improve their problem solving skills (e.g. Collins et al. 1989).[1] The tutor is presented in three different modes based upon the work of Reif and Scott (1999) that together combine the cognitive apprenticeship model with reciprocal teaching: computer coaches student, student coaches computer, and student works independently with feedback from computer.

1. Collins, Brown, and Newman, "Knowing, Learning, and Instruction: Essays in honor of Robert Glaser," pp. 453-494. Reif and Scott (1999), *Am. J. Phys.* **67**(9), 819-831. (1989)

PST2B18: 10:05–10:50 p.m. Toward a Multiple-Choice Inventory to Assess Strategic Knowledge

Andrew Pawl, MIT, 77 Massachusetts Ave., Cambridge, MA 02139; aepawl@mit.edu

Analia Barrantes, Saif Rayyan, Raluca E. Teodorescu, David E. Pritchard, MIT

Strategic knowledge is required to appropriately organize procedures and concepts in order to solve problems. We describe some of the challenges inherent in constructing a standardized instrument assessing strategic knowledge in the domain of introductory mechanics and suggest ways to overcome these challenges. We present items from a conceptual multiple-choice instrument assessing strategic knowledge relevant to freshman mechanics that we are now in the process of validating. This instrument is inspired in part by Lawson's Classroom Test of Scientific Reasoning and Van Domelen's Problem Decomposition Diagnostic. We seek teachers who are interested in testing the preliminary version!

PST2B19: 9:20–10:05 p.m. New Developments in the PhET Interactive Simulations Project*

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Wendy Adams, University of Colorado

Hisham Alhadlaq, King Saud University

Noah Podolefsky, Carl Wieman, University of Colorado

the rest of the PhET Team

The PhET Interactive Simulations project continues to develop and research new simulations and sim-related activities. We now have more than 85 simulations of physical phenomena that create animated, interactive, game-like environments in which students learn through scientist-like exploration. These simulations emphasize the connections between real-life phenomena and the underlying science, make the invisible visible, and include the visual models that experts use to aid their thinking. New additions include: Gravity Force Lab, Radioactive Dating Game, Density, Momentum Lab, Capacitors, Calculus Grapher, and an improved suite of Motion simulations. All simulations are open-source and freely available at the PhET website (http://phet.colorado.edu). Through collaborations with King Saud University, we have enhanced and extended our process for translating simulations with sims now translated into over 40 languages and used worldwide. Finally, PhET's research team has been investigating how different levels of guidance and sim complexity impact student learning with sims.

*The PhET Project is funded by the Hewlett Foundation, NSF CCLI Grant #0817582, University of Colorado at Boulder, CU JILA, and King Saud University.

PST2B20: 10:05–10:50 p.m. Modeling Applied to Problem Solving

Saif Rayyan, MIT, 77 Massachusetts Ave., 26-227, Cambridge, MA 02139; srayyan@mit.edu

David E. Pritchard, Andrew E. Pawl, Analia Barrantes, Raluca Teodorescu, MIT

Modeling Applied to Problem Solving (MAPS) is a pedagogy that helps students transfer instruction to problem solving in an expert-like manner. Declarative and procedural content from the standard syllabus is organized and learned (not discovered) as a hierarchy of General Models. Students solve problems using an explicit Problem Modeling Rubric that begins with System, Interactions, and Model (S.I.M.). System and Interactions are emphasized as the key to a strategic description of the system and the identification of the appropriate General Model to apply to the problem. We have twice employed the pedagogy in three-week review courses for students who received a D in mechanics. These courses were assessed by a final exam retest as well as pre- and post-C-LASS surveys, yielding a 1.2 standard deviation improvement in the students' ability to solve final exam problems and a statistically significant positive shift in all nine categories in the C-LASS.

PST2B21: 9:20–10:05 p.m. Changes in Students' Conceptual Understanding of Force, Velocity, and Acceleration

Rebecca J. Rosenblatt, The Ohio State University, 1040 Physics Research Building Columbus, OH 43210-1117; rosenblatt.rebecca@gmail.com

Andrew Heckler, The Ohio State University

We have developed a multiple-choice test designed to probe students' conceptual understanding of the relationships among the directions of force, velocity, and acceleration. We report here on student data taken three times over the course of instruction in introductory mechanics and electricity and magnetism. This data suggests that honors students move from the common incorrect response, for example that velocity must be in the direction of the acceleration or net force, through a "partially correct" response, that velocity can be either opposite to or in the direction of the acceleration or net force but not zero, before arriving at a correct model. This data is in agreement with previously reported results that showed these patterns among different levels of students but was not within student study. In addition, we report on the effectiveness of different small computer based training sessions given shortly before students take this quiz.

PST2B22: 10:05–10:50 p.m. Improving Students' Understanding of Gauss's Law of Electricity

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

Jing Li, University of Pittsburgh

We discuss the development and assessment of research-based tutorials on helping students learn about symmetry and Gauss's Law. We discuss the performance of students on the pre-/post-tests given before and after the tutorials in several calculus-based introductory physics courses. We also compare the performance of students who used the tutorials with those who did not use them.

PST2B23: 9:20–10:05 p.m. Addressing Student Difficulties with the Boltzmann Factor: Preliminary Results

Trevor I. Smith, University of Maine, 5709 Bennett Hall, Orono, ME 04469; Trevor.I.Smith@umit.maine.edu

John R. Thompson, Donald B. Mountcastle, University of Maine

As part of research into student understanding of topics related to thermodynamics and statistical mechanics at the upper division, we have identified student difficulties in applying concepts related to the Boltzmann factor and the canonical partition function. With this in mind, we have developed a guided-inquiry worksheet activity (tutorial) designed to help students develop a better understanding of where the Boltzmann factor comes from and why it is useful. The tutorial guides students through the derivation of both the Boltzmann factor and the canonical partition function. Preliminary results suggest that students who participated in the tutorial had a higher success rate on assessment items than students who had only received lecture instruction on the topic. We present results that motivate the need for this tutorial, the outline of the derivation used, and results from implementations of the tutorial.

PST2B24: 10:05–10:50 p.m. A Conceptual Analysis Approach to Physics Problem Solving*

Jose Mestre, University of Illinois at Urbana-Champaign, Loomis Lab, 1110 West Green St., Urbana, IL 61801; mestre@illinois.edu

Jennifer Docktor, Natalie Strand, Brian Ross, University of Illinois at Urbana-Champaign

Timothy Nokes, Elizabeth Richey, University of Pittsburgh

Students in introductory physics courses treat problem solving as an exercise in manipulating equations, symbols, and quantities with the goal of obtaining the correct answer. Although this approach is efficient for getting answers, it is far from optimal for learning how conceptual knowledge is applied in the problem solving process. The goal of this study is to refine and evaluate an approach that encourages students to begin by writing a strategic analysis of a problem based on principles and procedures, and then to follow with a documented problem solution that exhibits, side-by-side, how concepts and equations go together in a solution. We will discuss the effectiveness of this approach in several contexts: experimental studies in a clinical setting at a university and interventions in a high school classroom setting.

*Supported in part by Institute of Education Sciences grant #R305B070085.

PST2B25: 9:20–10:05 p.m. Design and Implementation of a Synthesizing Lecture on Mechanics Concepts*

Natalie E. Strand, University of Illinois at Urbana-Champaign, Loomis Lab, 1110 West Green St., Urbana, IL 61801; nstrand@illinois.edu

Jennifer Docktor, Gary Gladding, Jose Mestre, Brian Ross, University of Illinois at Urbana-Champaign

In traditional physics instruction, teachers mention major principles as they model problem solving, but most often those principles are instantiated in the form of written equations only. This inadvertently conveys to students that it is the equations, rather than the concepts, that are important. Furthermore, traditional instruction does little to relate and synthesize major ideas, especially within problem-solving contexts. We discuss the development and implementation of a short, animated, web-delivered synthesizing presentation modeled after the common learning resource from the preparation for future learning construct,[1] in which the major concepts of introductory mechanics are structured hierarchically. More specifically, the presentation is an overview of previous instruction highlighting major theorems and conservation laws in mechanics and the conditions under which they are applied. It is linked to previous problems solved by the student and intended to prepare students for future learning by illustrating how concepts guide problem-solving processes.

1. J.D. Bransford and D.L. Schwartz, "Rethinking transfer: A simple proposal with multiple implications," *Review of Research in Education*, 24, 61-100 (1999).

*Supported in part by Institute of Education Sciences grant #R305B070085

PST2B26: 10:05–10:50 p.m. Detecting Differences in Changes to Physics Diagrams

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Jose Mestre, University of Illinois at Urbana-Champaign

Constructing a useful mental representation of physics situations is integral to success in problem solving. It is known that experts identify/perceive meaningful patterns and/or changes in visual stimuli related to their domain of expertise. We present data from an experiment using the "flicker" technique, in which students who had finished a calculus-based mechanics course, as well as physics-naïve students, viewed nearly identical pairs of diagrams that are representative of typical mechanics situations. The two diagrams in each pair contain a subtle difference that either does, or does not change the underlying physics depicted in the diagram. We present results on how the speed of noticing physics-relevant changes in the diagram pairs depends on physics experience and discuss the cognitive implications of our findings.

PST2B27: 9:20–10:05 p.m. An Online Mechanics Course Targeting Problem-Solving Expertise

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Saif Rayyan, Andrew Pawl, Analia Barrantes, David E. Pritchard, MIT

We are developing an online environment to allow teachers to easily adopt our new Modeling Applied to Problem Solving pedagogy. This pedagogy stresses a systems, interactions, and models approach to facilitate organization and transfer of syllabus knowledge to problem solving in an expert manner. (The syllabus is for a standard calculus-based Newtonian mechanics course.) The environment involves an open source WIKI-text that is integrated with the tutors LON-CAPA.org and MasteringPhysics.com and also with material for classroom use. Assessment will include a new instrument to assess strategic knowledge as well as the C-LASS. Collaborators welcome.

PST2B28: 10:05–10:50 p.m. Physics Problem-Solving and Modeling: A Preliminary Study

María Elena Truyol, FaMAF - Universidad Nacional de Córdoba - Argentina, Mendoza 2742, Córdoba, 5001; mtruyol@famaf.unc.edu.ar*

Zulma Gangoso, FaMAF - Universidad Nacional de Córdoba - Argentina

Vicente Sanjosé, Universidad de Valencia - España

We study characteristics of the problem-solving processes, understood as a modeling process, generated by different types of physics word problems. We propose a comprehension model that posits the existence of three levels of representation with different ontological aspects and levels of abstraction: A Situation Model, a Conceptual-Physical Model and a Formalized-Physical Model. The comprehension also involves skills that we will call modeling abilities, necessary for the management of the representations. This classification of physics word problems is proposed around the idea of a scientific model. An experimental set of word problems is constructed. The assumption is that word problems of different characteristics generate different problem-solving processes. The participants, academics, are recorded on audio and video during a problem-solving interview. Some

Indicators are used to determine the number of actions and time spent in each stage of the problem-solving processes. Preliminary results are presented and discussed.

*Sponsored by David Sokoloff.

TECHNOLOGIES

PST2C01: 9:20–10:05 p.m. An Inside Look: Practical Strategies for Personal Response Systems (Clickers)*

Stephanie V. Chasteen, University of Colorado at Boulder, UCB 390, Boulder, CO 80301-5375; stephanie.chasteen@colorado.edu

Instructors have a variety of choices to make when using clickers in their teaching, from their goals for students, to the questions they ask, to how they facilitate the final class discussion. This poster will outline the choices available to instructors when they use clickers using Peer Instruction, and share research-based resources on clicker use (including videos and our own banks of clicker questions). I'll show a framework for classifying cognitive levels (Bloom's Taxonomy), and questions that are written at these different levels. I'll also outline the instructor choices at other stages of the clicker question (such as how long to let students talk, and whether to show them how their peers voted), and research and best practices at each of those stages. 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.

PST2C02: 10:05–10:50 p.m. Utility of an Online Synthetic Tutor for Teachers and Students*

Christopher M. Nakamura, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506-2601; cnakamur@phys.ksu.edu

Sytil K. Murphy, Dean A. Zollman, Kansas State University

Michael Christel, Scott Stevens, Carnegie Mellon University

The Pathway Active Learning Environment is an interactive synthetic tutoring system accessed via the Internet. The system combines an interactive video interface designed to simulate social interaction, with lessons designed to encourage student-centered knowledge construction. Students can ask natural language questions about physics. Appropriate pre-recorded video responses are matched to these queries. Student responses to the lesson questions and the questions they ask the tutor are logged with a time-stamp and tied to a user name they create. A time-resolved picture of each student's interactions with the system is obtained from the time-stamp and user name. This type of system has promise for providing students with interactive instruction when teachers are unavailable and also providing teachers with a diagnostic tool for characterizing student difficulties as individuals or groups. Progress on development and testing will be discussed.

*Supported in part by the U.S. National Science Foundation under grant numbers REC-0632587 and REC-0632657.

PST2C03: 9:20–10:05 p.m. Designing and Creating VPython Tutorial Videos*

Jeffrey M. Polak, North Carolina State University, Campus Box 8202, Raleigh, NC 27695-8202; jeff_polak@ncsu.edu

Shawn A. Weatherford, Ruth Chabay, North Carolina State University

As a part of the laboratory instruction in the Matter and Interactions (M&I) curriculum, students create simple computational models of physical systems in VPython. These programs produce navigable real-time 3D animations of complex physical situations. Students create these programs using only fundamental physics principles and very basic computer programming concepts. Experience with computer programming is not a prerequisite for our course, so some of the programming concepts are introduced to the students for the first time during laboratory activities. A series of tutorial videos was created to both introduce these concepts in a new medium and serve as a resource while students worked on their programs. The tutorial series was made available through the video sharing website YouTube.[1] The design principles and production techniques that went into the creation of the videos will be presented.

*Support for this project comes from NSF Award DUE-0618504.

1. http://www.youtube.com/VPythonVideos.

PST2C04: 10:05–10:50 p.m. Using Excel Solver as a Facilitating Tool for Physics Problem

Vazgen Shekoyan, Queensborough Community College, CUNY, Physics Dept., Bayside, NY 11364; VShekoyan@qcc.cuny.edu

Tak Cheung, Alex Flamholz, Queensborough Community College, CUNY

We present examples of using a spreadsheet application (Excel) in physics problem solving with an emphasis on the usage of Excel Solver. The Solver feature embedded in Excel offers students easy access to useful numerical analysis software. Cumbersome steps in a calculation can be avoided and the class contact time can be more efficiently focused on physics and not on drilling their math skills. This also has clear extensions to more complex problems where numerical methods are required. We have found that some math-disadvantaged students take up the challenge when they would have given up if presented with algebraic expressions on a piece of paper. Thus, they bypass the hurdle "I cannot do math" temporarily in a physics classroom. We discuss additional pedagogical advantages of the Solver ("what-if" type questioning, epistemic cognition, cognitive process tracer).

PST2C05: 9:20–10:05 p.m. Students' Learning Attitudes and Motivation in an Interactive Teaching Environment*

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Ma Aileen A. Corpuz, Rolando Rosalez, Liang Zeng, University of Texas-Pan American

We have been implementing a web-based system in which students use personal digital assistants (PDAs) to interact with their instructor during lecture. In this paper, we will document how the attitudes of students in this interactive classroom environment compare with that of students in a traditional lecture class as measured by the Colorado Learning Attitude About Science Survey[1] (CLASS). We will likewise present how students' motivation to learn, as measured by the Science Motivation Questionnaire[2] (SMQ), evolves over time.

*This work is supported in part by the National Science Foundation under grant 0737375.

1. http://www.colorado.edu/sei/class/.

2. Shawn. M. Glynn, and Thomas. R. Koballa, Jr. (2006). *Motivation to learn college science,* in Joel J. Mintzes and William H. Leonard (Eds.) *Handbook of College Science Teaching* (pp. 25-32). Arlington, VA, National Science Teachers Association Press.

PST2C06: 10:05–10:50 p.m. Tee Zero: A Game of Symbolic Manipulation

Tatiana A. Krivosheev, Clayton State University, 4115 Riverglen Circle, Suwanee, GA 30024; tatianakrivosheev@mail.clayton.edu

We present Tee Zero—a physics-based game currently being developed by Big Fun Development company. The purpose of the game is to improve a student's fundamental ability to work with symbols while interacting directly with scientific phenomena. Tee Zero will offer a unique opportunity for many students who are learning poorly from books, lectures, and even computer-based training: they can explore mathematics and exercise their skills on their favorite learning device: the videogame console. Tee Zero offers parents and teachers a cost-effective alternative to tutors, remedial classes, and out-of-school test prep programs. The game is expected also to be attractive to advanced middle school students, particularly in rural and urban schools, where there may be no advanced math track.

PST2C07: 9:20–10:05 p.m. LivePhoto, Active Learning with Video Analysis, Workshops and Assessment*

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Priscilla W. Laws, Maxine C. Willis, Dickinson College

Patrick J. Cooney, Millersville University

The LivePhoto Physics Project team has been creating video clips and classroom-tested video analysis activities that can be used for interactive lecture demos, in-class exercises, labs, and homework. A preliminary study showed learning gains when video-analysis materials were added to an introductory physics course at Dickinson College. Next summer, the project team will offer a five-day workshop for college and university physics instructors. Participants will learn about various ways to use video analysis in teaching and about action research and findings from physics education research related to video analysis. In addition, workshop participants will be invited to join a multi-year controlled study of the effectiveness of selected video-analysis curricular materials at diverse institutions. Preliminary results of this research study will be presented.

*Supported by NSF grants 0424063, 0717699 and 0717720

<http://livephoto.rit.edu/>

UPPER DIVISION AND GRADUATE

PST2D01: 9:20–10:05 p.m. Designing Inquiry-based Modern Physics Laboratories on Nanotechnology and Materials Science

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Benjamin L. Stottrup, Augsburg College

Modern physics and quantum mechanics are fundamental to the fields of nanotechnology and materials science. Many students taking the sophomore modern physics course at Augsburg College will also pursue careers in these applied fields. To meet the wide range of student goals in our modern physics course we are currently designing inquiry-based labs that focus on connecting more traditional content to a wide range of subjects in nanotechnology and materials science. Our goals are for students to: 1) see the physics they are learning in the questions raised about novel materials and instrumentation commonly used and 2) better understand potential careers. To achieve these goals, we are using the research-based curriculum developed at the University of Colorado as a starting point and leveraging resources of a regional user facility to characterize materials.

PST2D02: 10:05–10:50 p.m. DNA Flow Stretching for Undergraduates

Allen C. Price, Emmanuel College, 400 The Fenway, Boston, MA 02115; priceal@emmanuel.edu

Kelly Williams, Emmanuel College

Nathan Tanner, Antoine van Oijen, Harvard Medical School

We have designed and built an instrument for trapping and studying molecules of DNA. DNA molecules are stretched between a glass cover slip and a micro bead using the drag force created by buffer flow. Multiple individual molecules can be recorded in parallel using a webcam attached to the eyepiece of an upright microscope. Inexpensive and simple to assemble, the instrument is suitable for undergraduate laboratories in biophysics. To demonstrate its capabilities, we have applied this technique to measuring DNA replication by the phi29 DNA polymerase at the single molecule level.

PST2D03: 9:20–10:05 p.m. Surveying Faculty Attitudes and Approaches to Teaching Quantum Mechanics

Chandralekha Singh, University of Pittsburgh, 100 Allen Hall, 3941 O' Hara St., Pittsburgh, PA 15260; clsingh@pitt.edu

Shabnam Siddiqui, University of Pittsburgh

We conducted a survey to gather information from faculty members about the teaching of quantum mechanics (QM). Twelve faculty members (six from the University of Pittsburgh and six from other institutions) who had taught at least one undergraduate or graduate level QM course were invited to answer a total of 21 questions. These questions were based on the following key themes of the survey: (1) Goals of an undergraduate level QM course (2) Books used, course content, order of topics in the class and students' mathematics preparation (3) Experts' opinion on some of the important issues in QM (4) Teaching strategies and methods. To our surprise, the data obtained from different faculty members is quite consistent with some variations on some of the topics. The survey provides useful information on the way QM is taught and issues that need to be addressed for developing and implementing research based curriculum and teaching methods for QM course. Supported by NSF.

PST2D04: 10:05–10:50 p.m. Conceptual and Problem Solving Challenges in Geometric and Physical Optics

Betty Adams, Western Michigan University, 1424 Wickford Dr., Kalamazoo, MI 49009; b.adams@wmich.edu

Alvin Rosenthal, David Schuster, Marcia Fetters, Western Michigan University

Optics is an important topic at many levels of both physics education and research. Historical development toward our current understanding of light has yielded two very useful and ultimately compatible models for explaining and predicting our observations. "Geometric optics" involves rays depicting the path(s) of light from a source, allowing clear and relatively simple diagrams of reflection and refraction. "Physical optics" reflects our understanding of the wave nature of light, and helps explain and predict many aspects of light behavior, including refraction, diffraction, and interference/superposition. This research aims to enrich our qualitative understanding of student conceptions and difficulties regarding these topics, by studying the thinking of upper-level undergraduates while they solve problem tasks requiring consideration of both models of light. Analyzed data includes written class work, homework, assessments, and interviews. The research also seeks to provoke and explore ways to enhance student learning of these important models for light.

PST2D05: 9:20–10:05 p.m. The Critical, but Often Overlooked, Teaching of Interpretation in Modern Physics Courses

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Noah D. Finkelstein, University of Colorado

Just as expert physicists vary in their personal commitments regarding the interpretation of quantum mechanics, instructors vary in whether and how to address matters of interpretation in their introductory modern physics courses. These variations in instructional approach have demonstrable impact on student thinking. We find that, regardless of whether instructors directly address or choose to de-emphasize interpretative questions, students still develop their own attitudes and opinions regarding the interpretation of quantum phenomena. Most notably, when faculty are less explicit in addressing interpretation, students are more likely to prefer realist interpretations of quantum systems. We present both quantitative and qualitative studies on how and when students vary in their interpretations of quantum physics, along with a framework for characterizing various aspects of student interpretations, and offer suggestions for how interpretation can be more explicitly addressed in introductory modern physics courses.

PST2D06: 10:05–10:50 p.m. Mechanical Analogs of Quantum Two-level Systems: A Capstone Project

Ernest R. Behringer, Eastern Michigan University, Dept. of Physics and Astronomy, Ypsilanti, MI 48197; ebehringe@emich.edu

During winter 2010, students taking PHY 420 Capstone Project at Eastern Michigan University worked in teams to design, construct, characterize, and model mechanical analogs of two-level atomic systems described

by Shore et al. [1] The project involved Lagrangian mechanics and time-dependent quantum mechanics, thereby giving students the opportunity to augment knowledge obtained in prior or concurrent courses. A detailed description of the project and the course will be given.

1. B.W. Shore et al., "Simple mechanical analogs of rapid adiabatic passage in atomic physics," *Am. J. Phys.* 77 (12), 1183-1194 (2009).

PST2D07: 9:20–10:05 p.m. New Ways of Teaching Junior E&M – Descriptions and Results*

Stephanie V. Chasteen, University of Colorado at Boulder, UCB 390, Boulder, CO 80301-5375; stephanie.chasteen@colorado.edu

Steven J. Pollock, Michael Dubson, Paul Beale, Katherine Perkins, University of Colorado at Boulder

We describe the implementation of a fresh approach to teaching junior-level electro- and magneto-statics at the University of Colorado. We conducted several semesters of research on student thinking and faculty goals for students. Based on these results we developed consensus learning goals, clicker questions, tutorials, and a conceptual diagnostic for assessing student learning. Materials are intended to engage students interactively with the physics content and to scaffold their understanding to a more sophisticated level (to, for example, connect the abstract vector calculus of the course to a physical understanding of fields). These materials have been used successfully at CU for four semesters (and at other universities.) We will show examples of our materials and data on the impact of the transformations. Overall, we see improvement in student learning over traditional lecture-based courses, but gaps remain between what our faculty expect students to learn and what students take away from the course.

*All reform materials are available through http://www.colorado.edu/sei/departments/physics.htm. This work was funded the University of Colorado's Science Education Initiative and the National Science Foundation Grant No. 0737118.

PST2D08: 10:05–10:50 p.m. Capstone Projects for Physics Majors: An Electronics and Instrumentation Course*

Nasser Juma, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506-2601; mhuninas@phys.ksu.edu

Elizabeth Gire, Kristan Corwin, Brian Washburn, N. Sanjay Rebello, Kansas State University

It is imperative for all physics majors to have a sound background in electronics and measurement. At K-State's Physics Department, students in an upper-level undergraduate electronics course, Physical Measurements and Instrumentation (PMI), learn basic analog and digital electronics, instrumentation, and LabVIEW programming. Previously, students had few opportunities to apply their newly learned knowledge in these areas. However, recently through new capstone projects in the electronics course, PMI, students are offered an opportunity to apply their knowledge toward redesigning and automating experiments from previous upper-division physics laboratory courses. These capstone projects offer students an opportunity to solve real-world problems associated with experimental control and data acquisition, as well as help students see the relation between electronics and actual measurements that can be done in the laboratory. We will describe the capstone experiments and share feedback from students about their experiences in this course.

*Supported by NSF grant DUE-0736897.

PST2D09: 9:20–10:05 p.m. Student Reaction to the Demonstrations of the Gough-Joule effect

Mark Liff, Philadelphia University, Henry Avenue and School House Lane, Philadelphia, PA 19144; liffm@philau.edu

The student reaction to two different demonstrations of the Gough-Joule (G-J) effect was studied. The first demonstration is commonly used in teaching Polymer Physics. The apparatus is a mere rubber band hanging on a peg and stretched by a tensile load attached to the lower edge of the band. The second demonstration had been developed by me and described elsewhere: it comprises a rubber band stretched around a wooden bar. The band passes over a peg. The bar is initially balanced in the horizontal direction. Both experiments led to a conclusion that, contrary to other solids, stretched rubbers contract on heating. This is a manifestation of the G-J effect. The students' task was to explain both experiments, or, in other words, to re-discover the G-J effect. Though it appears that all elements needed for analysis of the demonstrations were within the student knowledge base, the majority of the students experienced difficulties in explanation of the experiments, especially the second demo. The nature of these difficulties is discussed.

PST2D10: 10:05–10:50 p.m. Controlling Light: Investigating Electromagnetically Induced Transparency in the Upper-Division Laboratory

Shannon Mayer, University of Portland, 5000 N. Willamette Blvd., Portland, OR 97203; mayers@up.edu

Recent advances in atomic and optical physics have given scientists the ability to control light in unique and intriguing ways. Electromagnetically induced transparency (EIT) is a technique that can be used to make a resonant optical transition transparent to resonant laser light. Because EIT allows for active control of the response a medium has to a resonant light field, it provides a unique means of coherently controlling photons and has applications in quantum computing and optical communications. In this advanced laboratory we describe the theory and experiment for investigating EIT in rubidium gas. We measure the absorption profile of a laser beam tuned across the 5S 1/2 to 5P 3/2 transition (780.2 nm) in the presence of a coupling laser beam tuned to the 5P 3/2 to 5D 5/2 transition (776.0 nm). The absorption transparency window is characterized and compared to the theoretical results. Applications of EIT to high-resolution two-photon spectroscopy are also discussed.

PST2D11: 9:20–10:05 p.m. Curriculum Development Addressing Multiplicity and Probability in Statistical Physics*

Donald B. Mountcastle, University of Maine, Dept. of Physics and Astronomy, Bennett Hall, Orono, ME 04469-5709; thermostatprof@yahoo.com

John R. Thompson, Trevor I. Smith, University of Maine

As part of our research on teaching and learning in the context of upper-division thermal physics, we are designing and implementing a small-group guided-inquiry activity (tutorial) that addresses the discrete binomial distribution and its approximation by the normal (Gaussian) distribution. The curriculum emphasizes the distribution dependence on N, the number of binary trials, making extensive use of computational software allowing N to span more than six orders of magnitude. We have administered questions before and after traditional textbook-centered instruction in a statistical mechanics course over the past six years, while the tutorial, including significant revision, was implemented during the past two years. Findings include improvement in recognition that the distributions become increasingly narrowed about the mean with increasing N. However, significant confusion remains between the concepts of microstates and macrostates, and the roles they play in determining probability. This curriculum project continues to be very much a work in progress.

*Supported in part by NSF Grants #PHY-0406764, DRL-0633951 and DUE-0817282.

PST2D12: 10:05–10:50 p.m. Researching Implementation of Instructional Change in the Advanced Physics Laboratory

Julie A. Schell, Harvard University, 29 Oxford St., Cambridge, MA 02138; schell@seas.harvard.edu

Jason E. Dowd, Eric Mazur, Harvard University

Although physics education research on the implementation of instructional change in introductory physics laboratories is on the rise, dissemination of research on such change in advanced undergraduate laboratory courses is still lagging. This gap presents a problem for faculty seeking to improve students' learning in advanced laboratories by using research-based pedagogies. In this study, we analyzed interview, observational, and course data to investigate four instructional changes implemented for the first time in an advanced physics laboratory course at one major research university (MRU). Using a mixed-method approach, featuring a qualitative and ethnographic design, we responded to the following research question: How do research-active faculty implement instructional changes in a traditional, advanced physics laboratory course at one MRU? This poster will outline our results, including the resources that facilitated, and the barriers that stymied, faculty efforts toward instructional change.

PST2D13: 9:20–10:05 p.m. Student Learning Outcomes and Assessment Methods for Physics Majors

Natalia Schkolnikov, Hampton University, Hampton, VA 23668; natalia.schkolnikov@hamptonu.edu

The Physics Department of Hampton University has started an effort to develop learning outcomes assessment tools for its undergraduate and graduate programs using a software package TracDat. This is part of a university-wide program aimed at managing strategic planning and assessment processes at the university, department, and individual level. Development of strict assessment criteria that reflect competitiveness of our graduates on the national and international level is particularly important for students from minority groups underrepresented in science majors. In our presentation, we define goals (competencies) for our undergraduate and graduate programs and identify intended student learning outcomes, which are indicators of achieving defined goals. For each learning outcome, we identify at least one assessment method and assessment criteria to determine success of meeting the expectation. In addition, we will discuss assessment results, action plans, and follow-up procedures.

PST2D14: 10:05–10:50 p.m. Peer Instruction for Quantum Mechanics*

Chandralekha Singh, University of Pittsburgh, Dept. of Physics, 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 which 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).

PST2D15: 9:20–10:05 p.m. Improving Students' Understanding of Addition of Angular Momentum

Chandralekha Singh, University of Pittsburgh, Dept. of Physics, 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.

PST2D16: 10:05–10:50 p.m. A Restructured Graduate Classical Mechanics Course at a Large University

Antoinette Stone, University of California, Davis, Dept. of Physics, Davis, CA 95616; tstone@ucdavis.edu

Lloyd Knox, University of California, Dept. of Physics, Davis

Implications from Physics Education Research for improving learning were applied to a standard graduate classical mechanics course. The revised format included reduced lecture time, increased discussion time, and increased student-initiated classroom Q&A time. Assessments were changed from two midterms and one final exam to biweekly quizzes, one midterm and one final. Discussion time was led collaboratively with a senior graduate student in a facilitation role which encouraged peer-to-peer questions and discovery. An initial diagnostic content exam was given pre and post. The language of students' questions during the discussion sections throughout the term were binned according to a student questioning-hierarchy model. Categories of questions were developed as 1)Definitions, 2) Restatement, Validation, Comparison, 3) Notation, 4) Physical link. We measure the correlation between language progression via the model and presentation of new material versus review material.

PST2D17: 9:20–10:05 p.m. Improving Students' Understanding of Quantum Mechanics*

Guangtian Zhu, University of Pittsburgh, 100 Allen Hall, 3941 O'Hara St., Pittsburgh, PA 15232; guz11@pitt.edu

Chandralekha Singh, University of Pittsburgh

Learning quantum mechanics is challenging. We are investigating the difficulties that upper-level students have in learning quantum mechanics. To help improve student understanding of quantum concepts, we are developing quantum interactive learning tutorials (QuILTs) and tools for peer-instruction. Many of the QuILTs employ computer simulations to help students visualize and develop better intuition about quantum phenomena. We are also developing tools to assess students' understanding of these concepts. We will discuss the common students' difficulties and research-based tools we are developing to bridge the gap between quantitative and conceptual aspects of quantum mechanics and help students develop a solid grasp of quantum concepts.

*Supported by NSF.

PHYSICS AND SOCIETY

PST2E01: 9:20–10:05 p.m. More Letters to the Editor – A Scientist Influencing the Public

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Stewardship of the Earth can be accomplished in many ways. Scientists as teachers have an obligation to help the public appreciate how science works as part of our contribution. How many citizens know that science cannot ever prove anything, only disprove? How many people appreciate that, as a result, all understanding in all science is subject to change should disproof occur? How many people know gravitation is still tentative? We need to be clearer about the meaning of the word "theory" and let people know that science can only disprove bad ideas, not prove correctness. All scientific understanding is tentative, but that tentativeness is no excuse for inaction based on the best science we have. We scientists need to work together to present materials that the public can see, read, and understand that do not oversimplify. As Einstein said: "Make everything as simple as possible, but not simpler."

PST2E02: 10:05–10:50 p.m. The Traveling Science Center: Students Learn the Joys of Teaching Abroad

Martin Kamela, Elon University, 2625 C.B., Physics Dept., Elon, NC 27244; mkamela@elon.edu

Elon University runs a short-term course to Kerala, India, focused on the Traveling Science Center service-learning project. Museum-style interactive exhibits are built on campus and brought to middle schools in Kerala. Elon students from various disciplines take part in the course and receive science credit for preparing exhibit posters and for monitoring the science center activities. We reach about 3000 children in the three-week January term and evaluate our efforts. The course allows Elon students to consider the importance of education and experiential science education in particular. Exposure to teaching in the course resulted in several students deciding to pursue education-related career paths.

PST2E03: 9:20–10:05 p.m. Teaching Physics with Sustainable Energies via Digital

David Rosengrant, Kennesaw State University, Dept. of Biology and Physics, 1000 Chastain Road, Kennesaw, GA 30144; 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. 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. Ultimately, the project's goal is to use digital educational technologies, distributed through the Internet, to better educate students about sustainable housing technologies and to provide an engaging "vehicle" for teaching the fundamental science principles that underlie these technologies.

PST2E04: 10:05–10:50 p.m. Alternative Energy Projects for Service Learning in Science

Barbara L. Whitten, Colorado College, 14 E. Cache la Poudre, Colorado Springs, CO 80903; bwhitten@coloradocollege.edu

Sally Meyer, Mark Morgenstern, Colorado College

Service learning is an effective tool in the social sciences for teaching students to apply knowledge to "real world" problems. Fewer people have applied these techniques in the sciences. We are implementing service learning projects involving alternative energy and conservation in courses in physics, chemistry, and environmentalscience. In the Energy Retrofit Project, students study the physics of convective, radiative, and conductive heat transfer and analyze a house near campus to determine the most cost-efficient way to reduce energy bills. We visit the house and install the changes we have proposed. Students learn to apply their scientific knowledge to practical problems and gain additional analytical and experimental skills. Nonprofit organizations, poor residents, and the community of Colorado Springs benefits from a more efficient energy system. We will describe how we organize these projects, how we integrate them into a science course, and what we believe students gain from participation.

PST2E05: 9:20–10:05 p.m. Impact of Informal Science Education on Children's Attitudes about Science

Rosemary P. Wulf, University of Colorado, 2707 Valmont Rd., Apt. 202B, Boulder, CO 80304; rosemary.wulf@colorado.edu

Laurel M. Mayhew, Noah D. Finkelstein, University of Colorado, Physics Dept.

The JILA Physics Frontier Center Partnerships for Informal Science Education in the Community (PISEC)[1] provides informal after-school inquiry-based science teaching opportunities for university participants with children typically underrepresented in science. We focus on the potential for this program to help increase children's interest in science, mathematics, and engineering. PISEC has validated the Children's Attitude Survey [1], which is based on the CLASS[2] and designed to measure shifts in children's attitudes about science and the nature of science. We present pre- and post-semester results for several semesters of the PISEC program, and demonstrate that, unlike most introductory physics courses in college, after-school informal science programs support and promote positive attitudes about science. This work is supported, in part, by NSF # 0551010, the JILA AMO PFC.

1. http://spot.colorado.edu/~mayhew/PISEC

2. W. K. Adams, K. K. Perkins, N. Podolefsky, M. Dubson, N. D. Finkelstein and C. E. Wieman, "A new instrument for measuring student beliefs about physics and learning physics: the Colorado Learning Attitudes about Science Survey." *Phys. Rev ST: Phys. Educ. Res.* **2**, 1, 010101 (2006).

PST2E06: 10:05–10:50 p.m. Teaching the Scientific Process in Introductory Physics

Art Hobson, University of Arkansas, Dept. of Physics, Fayetteville, AR 72701; ahobson@uark.edu

Science is more than a body of knowledge. It's a process for proposing, testing, and refining ideas. In thinking about how we might do better in the 21st century than we did in the 20th, we should ponder science's most basic value: All ideas are subject to testing by experience and to challenge by rational thought. Carl Sagan has said, "It is a way of thinking that is desperately needed in every area of our lives—including social, economic, political, and religious areas." Thus "how do we know" is the primary story line of my liberal-arts physics textbook Physics: Concepts & Connections. How do we know energy is conserved? "no heat engine can be 100 percent efficient" "things are made of atoms" "$E=mc^2$" "space is curved" "there was a big bang" "the universal expansion is accelerating" "dark matter exists" "quarks exist" etc.

UNDERGRADUATE POSTERS FROM CHINA

PST2F01: 9:20–10:05 p.m. The Applications of Semiconductor Nanowires: Nanogenerator

Tong Shao, Southeast University, Chien-Shiung Wu College, Nanjing, Jiangsu, P. R. China, Nanjing, Jiangsu 211189; stlm1991@sina.com

Dejun Li, Changsong Liu, Southeast University

Under the motivation of the course "Introduction to Bilingual Physics" offered by Professor Yun, we built up a group and carried out studies on the nanogenerator from a freshman's view. Semiconductor ZnO nanowire arrays based nanogenerators may effectively harvest a variety of mechanical energy from the environment and convert it into electricity, which has drawn wide attention. The invention of nanogenerator opens a new approach to generate electricity by making use of the movement of living species, which will play an important role in the life science. This paper reviews the fabrication, principles and progress of the nanogenerators, and demonstrates the bright perspectives about the future applications of novel nanogenerators.

PST2F02: 10:05–10:50 p.m. Magnetic Monopole

Xuejiao Han, Southeast University, Chien-Shiung Wu College, Nanjing 211189, Jiangsu, P.R.China, Nanjing, 213092714@seu.edu.cn

Yingsi Tang, Kunyun Zhu, Southeast University

Thanks to the course "Introduction to Bilingual Physics," we've decided to make a group and choose "Magnetic Monopole" as the topic of the research. The theory of magnetic monopole started with a 1931 paper by Paul Dirac, who predicted the existence of it through mathematical ways. However, monopole detection is an open problem in experimental physics. Thus, it should be considered as one of the most significant topics on physics in the 21st century. In this lecture, notes will be discussed such as Dirac's theory proving the existing of magnetic monopoles, the status of the searches for magnetic monopoles, possible properties of magnetic monopoles inferred from the formula given by Paul Dirac and the essentiality of the searches for these properties .

PST2F03: 9:20–10:05 p.m. The Optics and Painting

Yunjie ang, Southeast University, Chien-Shiung Wu College, Jiangsu P.R.China, Nanjing, Jiangsu 211189; cqyyj121 4@163.com

Zhixiang LIU, Guodong JIA, Southeast University

Dr. T. D. Li once said, science and art seem like the two sides of a coin. As a form of art, painting has been prospering under the influence of optics. Freshmen as we are, inspired by the concepts of education, namely the two "As Early as Possible" in Introduction to Bilingual Physics with Multimedia, we conducted simple research on this topic and completed this course paper. Combined with theories of art, this essay introduces the direct and indirect ways of how optics influences painting, and the synchronous development of optics and painting in different historical periods. At last, we present our thoughts on painting with the concept "Harmonious Independence," originated from Chinese traditional culture.

PST2F04: 10:05–10:50 p.m. Parallel Universes

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Xianghong Kong, Jie Ding, Southeast University

The Parallel Universes theory has raised many problems in science and philosophy in recent years so it becomes a much-talked-about topic in the quantum physics and cosmology field. This article will introduce the many-worlds interpretation as the basic model to show the concept of the parallel universes and four-level hierarchy of parallel universes. At the end of the article, we ponder the category of logic and philosophy to analyze the advantage of the Parallel Universes theory in order to make our own comments. As freshmen, by writing the essay we practice the ideas "To read the English materials and to do some research as early as possible" and fulfill the goal of the "Introduction to Bilingual Physics" course and enhance a lot.

PST2F05: 9:20–10:05 p.m. Electromagnetic Black Hole

Xintong Ling, Southeast University, Chien-Shiung Wu College, P.R. China, Nanjing, Jiangsu 211189; lim3300@163.com

Chenyu Xu, Pengfei Duan, Southeast University

By the learning of the Introduction to Bilingual Physics, our team decides to have further research in the subject of electromagnetic black hole. The electromagnetic black hole is a kind of device designed by Pro. Cui in Southeast University, made of a new kind of electromagnetic materials, which means to simulate the absorption of the electromagnetic waves. This new research creates a new way to absorb and control electromagnetic waves. This paper begins with the principle of electromagnetic black hole and its differences with the black hole in space. Then it presents a few useful applications of this new research and discusses its foreground.

PST2F06: 10:05–10:50 p.m. Timekeeping Techniques

Wei Qian, Southeast University, Class 71109, College of Software Engineering, P.R.China, Nanjing 211189; exebry@gmail.com

Jianhao Xiao, Huabin Fang, Southeast University

The development of physics not only promotes the advancement of timekeeping, but also changes people's view of space-time and human culture. In this paper, we will overview the great developing history of timekeeping and their various important applications. From the ancient sundial and hourglass to today's quartz watch and Caesium-based atomic clock, it can be found that the advancement of timekeeping techniques is closely related to the development of physics. Thinking about timekeeping's great effects on our daily lives as well as human culture, including positive ones and negative ones, it is concluded that the advancement of science and technology must be suitable for the sustainable development of our society.

PST2F07: 9:20–10:05 p.m. Problem-based Learning

Zece Zhu, Southeast University, P.R. China, Nanjing, Jiangsu 211189; COSEZHUYING@gmail.com

Linkai Wang, Bing Zhang, Chenkai Zhu, Southeast University

This article introduces our experience of the problem-based learning, taking the process of self-study of magnetic monopole as an example. First, it introduces the history of magnetic monopole and the theory. Then, this paper introduces the process of our learning of magnetic monopole. In the course of Introduction to Bilingual Physics, we heard the newest experiment about magnetic monopole. After that, we sought for some information and put forward our guess. Then we referenced more information and learned the relevant theory, in order to reflect on and confirm the guess. In this way, there were new problems. We sought new information and discussed it several times. Based on our experience we think the problem-based learning is an effective method.

POST-DEADLINE POSTERS

PST2G01: 9:20–10:05 p.m. Video Analysis of the Collapse of the World Trade Center

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Despite the official analysis of the building collapses at the World Trade Center by FEMA and NIST, there has been a continuing debate about the true nature of the destruction. Was it natural or caused by pre-planted explosives? Are the government studies reliable, or part of a coverup? The author has used video analysis tools, accessible to physics teachers and students, to study the kinematics of the collapses. The observations and measurements place significant constraints on the mechanisms involved. Website: http://www.911speakout.org

PST2G02: 10:05–10:50 p.m. Mechanical Modeling of Relativistic Quantum Mechanics

Robert A. Close, Clark College, 1933 Fort Vancouver Way, Vancouver, WA 98663; robert.close@classicalmatter.org

We describe how Dirac bispinors and the equations of relativistic quantum mechanics may be interpreted as ordinary classical waves. First, an analysis of torsion waves in one dimension yields a one-dimensional Dirac equation, with the four diagonal components of the 1-D Dirac spin matrix representing four different waves: positive or negative angular velocity (two polarizations) propagating up or down the axis (two propagation directions). Next, rotational transformations are developed to describe waves in three dimensions. This formalism is then applied to the unsolved problem of accurately describing the response to arbitrary rotations in an elastic solid. The resultant description yields both a Klein-Gordon equation and a nonlinear Dirac equation, including the correct quantum mechanical operators for energy, momentum, and angular momentum. Physical properties of soliton solutions are discussed.

PST2G03: 9:20–10:05 p.m. The Electromagnetic Spectrum: ROY G BIV and Beyond

Pamella W. Ferris, Riverside Middle School, 1095 Fury's Ferry Rd., Evans, GA 30809; pam.ferris@ccboe.net

With easy-to-use computer probe ware now available, even middle school students can use cutting-edge technology in their classrooms. Pique interest in multiple areas of physical science by using technology that shows students how real scientists conduct research. Using Inquiry-based strategies, students will conduct investigations and collect data by taking measurements in every area of the electromagnetic spectrum including the "invisible" wavelengths. Middle school students become real scientists and collect real data using technology that is affordable and easy to use to investigate radio waves, infrared waves, ultraviolet rays, and gamma rays. This will undoubtedly spark many middle school students' interest in science and may even encourage them to become the scientists of the future.

PST2G04: 10:05–10:50 p.m. On the Phase Difference of Voltage and Current in an RC Circuit

See Kit Foong, Nanyang Technological University, 1 Nanyang Walk, Singapore, 637616; seekit.foong@nie.edu.sg

In teaching introductory ac circuit, it is customary to examine the voltage-current phase relationship when the steady state is achieved. Standard statements such as current leads or lags voltage by 90 degrees are emphasized. How can these phase differences possibly arise? Consider the pure capacitor circuit—just when the voltage source is switched on, the current in the circuit is already at its maximum. This is clearly unacceptable simply from an energy conservation argument: energy is needed for current to occur because the conduction electrons have acquired a drift velocity, that is, additional kinetic energy in addition to the random thermal energy. We resolve these difficulties by including a resistance R which must be present in any real circuit containing the capacitor. We show that the current grows from zero initially in phase with the voltage, and the phase difference grows and becomes established fully only in the steady state.

PST2G05: 9:20–10:05 p.m. Who Does More Work? On Work Done by Gaussian Impulse

See Kit Foong, Nanyang Technological University, 1 Nanyang Walk, Singapore, 637616; seekit.foong@nie.edu.sg

Consider the following question: "A pair of twins, R and S, each gives the same hard push on a block. R's block is on a rougher floor than S's. Who does more work?" We show that S will do more work on his block if there is no constraint on the distance over which the force is applied. On the other hand, if the assumption is relaxed to—the same hard push within some distance—say due to the length of their arms, then it is possible that R does more work than S.

PST2G06: 10:05–10:50 p.m. Finding the Moment of Inertia in Lab

Karie A. Meyers, Pima Community College, 2202 W. Anklam Rd., Tucson, AZ 85709; kameyers1@pima.edu

Using hardware store components and a smart pulley or rotation sensor, students can measure the moment of inertia of an object and compare with calculated values.

PST2G07: 9:20–10:05 p.m. Projectile Motion Calculation Concept Map

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In order to support students with weak mathematical skills as they learn to solve projectile motion problems, I propose a cognitive scaffold in the form of a detailed and easily modified concept map. In addition to showing the conceptual and mathematical interconnections between the variables of projectile motion, this map is organized to highlight separate cognitive chunks that underlie the physical situation and the associated calculations.

PST2G08: 10:05–10:50 p.m. Teaching Catastrophic Behaviors in Introductory Physics

Michael B. Partensky, Brandeis University, 415 South St., Waltham, MA 02454; partensky@gmail.com

Peretz D. Partensky, UCSF, San Francisco

Valery P. Putyrsky, Ural Technical University, Yekaterinburg, Russia

Simple electro-mechanical models[1-3] introduce complex catastrophic behaviors at the introductory level. Their discussion with the students reveals the "continuity" bias. This is clearly demonstrated by adding a "new twist" to a classical textbook problem, with two mutually repelling charges q suspended on two strings, fastened to a common point. The trivial solution leads to a continuous q-dependence of the mutual separation s. What happens if the charges are opposite, and the suspension points are separated by a finite distance a? About 90% of the participating students suggested that the separation would decrease continuously with |q|, until the charges touch each other and (possibly) discharge. The consistent solution,[3] involving only slightly more complicated math than the original problem (e.g., a graphical solution of the third-order algebraic equation), displays instability, discontinuity, and catastrophic behavior. Such a discussion introduces students to the world of nonlinear phenomena. Other examples include Elastic Capacitor,[1] Elastic Dipole,[2] and motion of a mass on a vertically rotating hoop.

1. M.B. Partensky, arXiv:physics/0208048v3 (2002) .
2. M.B. Partensky and P.D. Partensky, *TPT,* **42,** 9 (2004).
3. P.D. Partensky and M.B. Partensky, *TPT,* **44,** 42 (2006).

PST2G09: 9:20–10:05 p.m. Design and Characterization of a Prototype Linear Generator as a Wave Energy Converter, WEC

Nick Raymond, Santa Rosa Junior College, Engr./Phys. Dept., Ataiiyan c/o Raymond, 1501 Mendocino Ave., Santa Rosa, CA 95401; yataiiyan@santarosa.edu*

As interest in the research and development of alternative energy increases, use of oceanic waves and tides to generate electricity is gaining momentum. The most common approach is the design of a Wave Energy Converter (WEC) through the use of linear generators. In this experiment, a prototype WEC using a linear generator is constructed and its electric output is analyzed when subjected to the periodic waves generated in a water tank.

*Sponsored by: Younes Ataiiyan

PST2G10: 10:05–10:50 p.m. Studying Springs in Series Using a Single Spring

Juan D. Serna, University of Arkansas at Monticello, 397 University Dr., Monticello, AR 71656; serna@uamont.edu

Amitabh Joshi, Eastern Illinois University

The use of springs to demonstrate Hooke's law is an integral part of every elementary physics lab. One question that often arises from spring experiments is, "If a uniform spring is cut into two or three segments, what is the spring constant of each segment?" This paper describes a simple experiment to study the combination of springs in series by using only a single spring divided into segments. The experiment can be easily performed and integrated into a standard static Hooke's law demonstration. Two different scenarios are examined: the mass-spring system with an ideal massless spring and the more realistic case of a spring whose mass is comparable to the hanging mass. Graphical representations of the force against elongation are used to obtain the spring constant of each segment. The experimental results are in excellent agreement with the theoretical predictions.

PST2G11: 9:20–10:05 p.m. The Upper-Level Laboratory at Union College

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Scott M. LaBrake, Seyffie Maleki, Chad R. Orzel, Union College

At Union College we use a team-teaching approach in the upper-level physics laboratory that involves two to four faculty and allows for a set of in-depth experiments using specialized instruments. The experiments include proton-induced X-ray emission and Rutherford back-scattering using the Union College Pelletron Accelerator, optogalvanic spectroscopy of neon and measurement of the D-lines of sodium using a dye laser, measurement of the vibrational spectrum of the iodine molecule using an argon-ion laser, measurement of the hyperfine spectrum of Rb, Mossbauer spectroscopy, X-ray diffraction, and relativistic dynamics using a beta-ray spectrometer. We will describe the general approach and discuss several of the experiments.

PST2G12: 10:05–10:50 p.m. Dynamics of a Forced One-Degree-of-Freedom Arm with Visco-elastic Muscles Exhibiting Deterministic Chaos

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Sayan Patra, Andy Chase, Dalton Sivils, Brian Shipley, Drury University

In order to improve our understanding of how the brain controls the human arm, we have developed a one-degree-of-freedom robotic arm that is driven by a single pair of servo-actuated visco-elastic muscles. Our robotic arm exhibits planar motion with one degree of freedom about a single joint. The computer-controlled servos mimic the contractive action of the sarcomeres, while sections of elastic tubing represent the elastic behavior of actual muscles. In the present experiment, we have sought to induce chaotic motion by driving the servos in a sinusoidal manner. The system represents a driven physical pendulum, with additional elastic energy components. We have found that the Hamiltonian dynamics of the system are characterized by several non-dimensional parameters, which can be independently varied. We have numerically integrated the Hamiltonian equations of motion for the system, and have thus identified regions of parameter space where chaos is expected.

PST2G13: 9:20–10:05 p.m. What Students Learn When Studying Practice Exam Problems

Witat Fakcharoenphol, University of Illinois at Urbana Champaign, 613 W Healey St., APT#3, Champaign, IL 61820; 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 studentssaw the problems, as well as their access to solutions, we obtained data about student learning by studying old exams problems. Our data suggests that in general students do 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. Our data also show that doing old exam problems does provide important formative assessment about the students overall preparedness for the exam, and particular areas of strengths and weaknesses.

PST2G14: 10:05–10:50 p.m. Interest as Predictor for Students? Aspiration to Learn Physics

See Kit Foong, Nanyang Technological University, 1 Nanyang Walk, Singapore, 637616; seekit.foong@nie.edu.sg

Darren Wong, Loganantham Kuppan, Shaik K. Munirah, Alexander S. Yeung, Nanyang Technological University

A sample of secondary 1 students (7th graders) in Singapore responded to 17 items in a survey about their self-concepts in learning physics (competence and interest), a short-term outcome (engagement) and a long-term outcome (aspiration to learn physics in future). Structural equation modeling was conducted to establish the four factors namely, (1) competence, (2) interest, (3) engagement and (4) aspiration to learn physics in the future. Path analysis examined the relations of physics self-concepts to both the short-term and long-term outcomes. The path from competence in physics to engagement was statistically significant, but not the path from competence to aspiration to learn physics in future. Paths from interest in physics to both the outcomes were positive. That is, although a sense of competence would have noteworthy short-term effects, the promotion of interest in physics tends to have both short-term and long-term effects that would benefit students.

PST2G15: 9:20–10:05 p.m. Optical Concept Assessment: An Evaluation Tool

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Mark F. Masters, IPFW

In order to assess student learning of optics, we have created a preliminary optics concept assessment exam. As optics is a broad field (wave nature of light, ray model of light, mirrors, lenses, interference, etc.), the exam is subdivided into multiple sections. In this way, it is possible to omit the uncovered sections. In the test we probe for common misconceptions, and discovered unexpected ones. We will show our initial findings as well as provide some indication of our philosophy in the design of the exam.

PST2G16: 10:05–10:50 p.m. The Perception of Science in Young Mexicans

Martín Hernández, Universidad Politécnica de San Luis Potosí, Urbano Villalón 500, Mexico SLP 78363; martin.hernandez@upslp.edu.mx

Guadalupe Palmer, Cleopatra Soni, Fabiola Fernández, Adriana González, Universidad Politécnica de San Luis Potosí

Throughout Latin America this year people are celebrating "The Bicentennials." This term is understood to celebrate the 200th anniversary of independence of the old Spanish colonies. Mexico is one of those countries that are doing retrospectives in all areas to look ahead with challenge. However, science teachers ask ourselves what degree of "scientific independence" perceived by our students on the activity of science in Mexico. We present a study of the perceptions about science of students from a public university in San Luis Potosi, Mexico. Among the most relevant results is a strong stereotype of the scientist that strengthens and disseminates the media, as well as a rigid cultural awareness that favors a science-dominated by male genre and developed by foreign scientists. Students perceive themselves unrelated to any scientific activity.

PST2G17: 9:20–10:05 p.m. Normal Modes, Fourier and Spreadsheets in a Second-Year Waves Course

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Thomas M. Foster, Southern Illinois University Edwardsville

An issue in retaining physics majors relates to passage from introductory physics, for which the necessary background is well indicated, to intermediate and upper-level courses, for which a range of mathematical and physical background and experience not normally gained in introductory physics is called for and is often implicitly assumed or hastily provided in piecemeal fashion in these later courses. To better prepare students for this transition, at Southern Illinois University Edwardsville we have developed curricular modules for a dedicated second-year course offering intensive basic treatments of how to approximate, normal modes, superposition, completeness, Fourier methods, Fourier bandwidth theorems and applications in the context of classical wave physics. Aspects of the curricular materials developed, emphasizing those on normal modes, Fourier methods and spreadsheet solution, are presented along with preliminary results on effectiveness. A comprehensive textbook manuscript suitable for use in such a course is being developed.

PST2G18: 10:05–10:50 p.m. Water Analogy for Multiple Uses of MBL Charge Sensor Measuring Large Capacitancy

Kyu Hwan Kim, Korea National University of Education, 411-E, Chayeunkwan, K.N.U.E. San 7, Darakri, Gangnaemyeon, Cheongwon-gun, 363-791; rlarbghks94@hanmail.net

Jung Bog Kim, Korea National University of Education

It was reported that large capacitance can be measured by multiple uses of an MBL charge sensor. We found that usage of a metaphor for the water tank is useful to explain this. This metaphor uses two tanks—one with a wide cross-section area, and the other with a very narrow cross-section area. We can measure the amount of water in the large tank through two times measurements of small tank. The key concept of multiple uses can be applied to measure the amount of water in a large cylindrical water tank. This is very similar to large capacitance measurement by multiple uses of MBL charge sensor.

PST2G19: 9:20–10:05 p.m. Using Google to Collect and Analyze Student Measurements

Kristen Larson, Western Washington University, Physics/Astronomy MS-9164, Bellingham, WA 98225-9164; Kristen.Larson@wwu.edu

Jim Stewart, Western Washington University

Teaching about the process of science necessarily includes teaching about critical analysis of uncertainty in repeated measurements. We demonstrate how the measurements that students make can be collected and analyzed in real time with Google Docs. Showing students how their measurements compare to the rest of the class provides a valuable opportunity to teach about uncertainty and the process of science. Student work can be compiled by the instructor after the fact, but Google makes it easy for students to submit their measurements via a web form and instantly see how their measurements fit with the rest of the class. Analysis, including histograms, fits, and virtually anything that can be done with a spreadsheet, is updated automatically and available to students. We show how the tools can be readily customized and implemented seamlessly with two examples from large undergraduate classes: measurement of the acceleration due to gravity in introductory physics lab, and measurement of the Hubble constant in introductory astronomy.

PST2G20: 10:05–10:50 p.m. Experiments that "Prove" Mass Is Not Conserved

Helene F. Perry, Loyola University Maryland, 4501 North Charles St., Baltimore, MD 21210; hperry@loyola.edu

Conservation of mass is a fundamental principle of physics. However some commonly used activities intended to illustrate mass conservation and designed for K-12 students and their pre-service teachers actually do just the opposite. These are activities that require manipulative skills or an understanding of measurement uncertainties that young students are unlikely to have. Others, when done carefully and correctly, should show that mass is (apparently) not conserved. Examples are given. Often these serve to reinforce student's and teacher's belief that "they can't do science" or perhaps worse, they don't appreciate how scientific principles are based on experimental evidence. Should we encourage the use of activities where we know students will likely "get it wrong?"

PST2G21: 9:20–10:05 p.m. Magnitude of the Instantaneous Velocity in the Circular Motion

Carlos Adrian Arriaga Santos, Universidad Politécnica de San Luis Potosí, Urbano Villalón 500, Predio La Ladrillera, San Luis Potosí, Mexico S.L.P. 78363; carlos.arriaga@upslp.edu.mx

Irma Georgina Gomez Vega, Samantha Ortega Flores, Jose Guevara Alvarez, Mario Ismael Martínez Licona, Universidad Politécnica de San Luis Potosí

The analysis of circular motion consists basically of the theoretical deduction of the equations for this movement in the elementary courses of physics. In the uniform circular motion, the expression to calculate the magnitude of the instantaneous velocity corresponds to the value of the average speed that the object has during its movement in a return of the circle. In textbooks on the university level, the concepts of instantaneous velocity and average speed express different ways, why then in this movement, are they taken like equivalents? In this work, a didactic activity appears from the experimental point of view, allowing the student to understand the relation between the value of instantaneous velocity and average speed in the uniform circular motion, obtained with a good degree of approach with the value given by the theory.

PST2G22: 10:05–10:50 p.m. Student Lab: Ohm's Law Using Microcomputer-based Lab

Joseph L. Scheiter, De La Salle University, 2401 Taft Ave., P.O. Box 3819, Manila, PHIL 1099; fscbjs@yahoo.com

Students use an MBL Science Workshop system to "discover" Ohm's Law. A variable low-voltage DC power supply is applied to a 10 W resistor. Each student group could use a different resistance, e.g., 10, 20, 30, 40, 50, 60... ohms. Using voltage and current sensors, they plot Voltage drop across load vs. Time and Current vs. Time as they increase the current. They then plot Voltage drop vs. Current, which gives a straight line and they determine the slope. Discussion leads to voltage drop being proportional to current through the load. Class results show that the slopes are close to the resistance values. The experiment is repeated using a low-voltage incandescent lamp, which does not give a straight line. The "J" curve has two slopes. Discussion leads to the lamp being a "non-ohmic" device.

PST2G23: 9:20–10:05 p.m. Teaching the Art of Experimenting Via Case Studies

John W. Zwart, Dordt College, 498 4th Ave., NE, Sioux Center, IA 51250; zwart@dordt.edu

Experimental work includes making judgment calls, such as using preliminary results to change the design of an experiment, determining whether equipment is measuring what you think it is measuring, evaluating whether data support a particular conclusion, and communicating results in a convincing manner. Helping students to develop the tacit knowledge needed to make these types of judgments is a challenge. The use of case studies can help students develop these skills. An example, based on an investigation of the expected relationship between radiated power and temperature, will be presented.

PST2G24: 10:05–10:50 p.m. Using Mobile Devices to Teach Physics in Rural Communities in Mexico

Martín Hernández Sustaita, Universidad Politécnica de San Luis Potosí, Urbano Villalón 500, San Luis Potosí, S.L.P. Mexico 78363; rafael.llamas@upslp.edu.mx

Guadalupe Palmer, Luis Zamora, Universidad Politécnica de San Luis Potosí

In recent years in Mexico there has been an impetus to use information technologies in the classroom. However, the level of telecommunications development is much higher in urban than in rural areas where sometimes no one has access to basic services. To know with detail the use of technology by students in their home communities, we made a study in the municipality of Mexquitic Carmona, San Luis Potosi, Mexico. The results show that even when the economic situation of these students is low, and there is a lack of basic services, students have access to computers, Internet, and mobile devices that can be used as teaching tools for physics teachers. On this basis we present an academic development based on these technological resources.

PST2G25: 9:20–10:05 p.m. Go Ahead, Apply Your Physics

Haraldur Audunsson, Reykjavik University, Menntavegur 1, Reykjavik, Iceland IS 101; haraldura@ru.is

Andrei Manolescu, Reykjavik University

Engineering students at Reykjavik University take two standard introductory physics courses in their first year. To encourage students to actually apply theory learned, we assign one take-home project in each course, in addition to regular lab work. Students work in teams of two and are given a very brief outline of what to do. In the mechanics course students must design and carry out a dynamic experiment, often using video to analyze their observations (air drag, braking of bikes, projectile path, etc). In the electromagnetism course they have to build a device from scratch (motor, dynamo, relay converting dc to ac). They have to show a working device and explain how it works. These projects really help us to sort out misconceptions not apparent in conventional tests. Most students are stimulated by these projects and enjoy this addition to the traditional teaching.

Wednesday, July 21

Klopsteg Award	8:30–9:35 a.m.	Grand Ballroom I
25 Years of PTRA	11:15 a.m.–12:30 p.m.	Grand Ballroom I
PER Conference Banquet	6 p.m.	Grand Ballroom II

AAPT Awards:
Klopsteg Award
Distinguished Service Citations
AIP Science Writing Award

Location: Grand Ballroom I
Date: Wednesday, July 21
Time: 8:30–9:35 a.m.

Presider: Alex Dickison

Robert Scherrer

Klopsteg Award – to Robert Scherrer, Dept. of Physics and Astronomy Chair, Vanderbilt University, Nashville, TN

Science and Science Fiction 8:30 a.m.

As a practicing physicist who has written science fiction, I will explore the similarities and differences between the process of writing science fiction and the process of "producing" science, specifically theoretical physics. What are the ground rules for introducing unproven new ideas in science fiction, and how do they differ from the corresponding rules in physics? How predictive is science fiction? (For that matter, how predictive is theoretical physics?) While science fiction has been dubbed "the literature of ideas," there are crucial differences between the role that ideas play in science fiction versus their role in science, as well as differences in the actual way in which ideas are presented. Finally, I will examine whether a background as a research scientist provides any advantage in writing science fiction, or whether it can actually be a hindrance at times.

AAPT Distinguished Service Citations

Chris Chiaverina

N. Sanjay Rebello

Harvey Leff

AIP Science Writing Award – Children's Category

Gillian O'Reilly

Cora Lee

Session HA: Online Workshops and Labs for H.S. Physics Programs

Location: Galleria III
Sponsor: Physics in High Schools Committee
Date: Wednesday, July 21
Time: 9:40–10:50 a.m.

Presider: Mary Winn, winnmmw@aol.com

HA01: 9:40–10:10 a.m. The Louisiana Virtual School: Teaching Inquiry to Online Students Using Virtual Labs, Portable Interfaces, and Online Assessments

Invited – Shelly F. Hynes, Louisiana School for Math, Science and the Arts, The Louisiana Virtual School, 715 University Parkway, Natchitoches, LA 71457; shynes@lsmsa.edu

The Louisiana Virtual School (LVS) was started in 1984 to initially support Louisiana State University satellite schools. In 1987 the Louisiana BESE Board funded the school to offer courses to rural students via telelearning. Now LVS is an online school supported by grants and the state of Louisiana and offers 60 courses to 6000 students in 304 schools across Louisiana. Teaching physics online presents some unique challenges especially with integrating hand-on, inquiry-based learning into the curriculum. Currently the LVS Physics courses utilize several resources including Explorelearning.com GIZMO's and Vernier LabQuest interfaces which are sent to each student. Homework is done mainly through WebAssign, a homework website widely used at universities across the country. This presentation will discuss the use of these in providing quality inquiry learning to online students and the successes and challenges of their implementation.

HA02: 10:10–10:40 a.m. Online Courses Don't Have to Hang You Out to Dry

Invited – Stacy Gwartney, 204 Delaware Ct., Jacksonville, TX 75766; stacy.gwartney@bullardisd.net

Eight years ago, a grant was written by 17 East Texas school districts to design online courses. This vision of one woman has grown from 17 to 34 to now a state Virtual High School. As an online teacher, I have had to take additional certification courses and learn to work with a variety of software such as Camtasia and Snagit. When the state decided to offer the courses, they had to undergo a rigorous evaluation to verify that all the TEKS were included and at the appropriate level. As a science course, our 40% lab time had to be hands on or at least mixed, but simulation labs would not count. My course uses MOODLE, which can be used by anyone teaching any subject. Online courses will never replace the classroom setting, but we need to understand they can be interactive and engaging when done properly.

HA03: 10:40–10:50 a.m. Online Satellite Motion Lab Using PhET

CANCELED

Martha Lietz, Niles West High School, 5701 Oakton St., Skokie, IL 60077; marlie@niles-hs.k12.il.us

This paper presents an online lab for high school students related to the topics of universal gravitation and circular motion. The students use the PhET* simulation My Solar System to create circular orbits for a planet orbiting a central star. The students vary the radius and determine the speed necessary to create a circular orbit for each radius. They then plot the data and use this to calculate "G", the universal gravitational constant for the PhET "universe." Other variations to this activity will also be discussed, including binary star systems.

*http://phet.colorado.edu/simulations/sims.php?sim=My_Solar_System

Session HB: Physics Education Research Around the World II

Location: Galleria II
Date: Wednesday, July 21
Time: 9:40–10:30 a.m.

Presider: Scott Bonham, Western Kentucky University, Scott.Bonham@wku.edu

HB01: 9:40–9:50 a.m. Remembering Len Jossem, International Ambassador of Physics Education

Gordon J. Aubrecht, Ohio State University at Marion, 1465 Mt. Vernon Avenue, Marion, OH 43302; aubrecht@mps.ohio-state.edu

As a person who was a friend of Len's for almost 40 years, I remember a person of rare qualities who influenced physics education and physics education research around the world. I share some memories of this dedicated man.

HB02: 9:50–10 a.m. Large Scale Assessment of Scientific Reasoning*

Lei Bao, The Ohio State University, 191 W Woodruff Ave., Columbus, OH 43210; lbao@mps.ohio-state.edu

Jing Han, The Ohio State University

Quiqing Xu, Beijing Normal University

Yibing Zhang, Ningxia University

Kathy Koenig, Wright State University

Student ability in scientific reasoning is an important area for education and research. However, there are a limited number of validated quantitative instruments for assessing scientific reasoning. In this talk, we will review the recent research on student reasoning and introduce our development of standardized instruments for assessing reasoning. Testing results of both U.S. and Chinese students will be discussed. We will show detailed analysis of students' performances on specific reasoning skills at different age groups and discuss the implications to research and teaching in scientific reasoning.

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

HB03: 10–10:10 a.m. Attitudes and Beliefs in Physics: From High School to Faculty

Simon P. Bates, University of Edinburgh, School of Physics and Astronomy, Edinburgh, Scotland EH93JZ; s.p.bates@ed.ac.uk

Ross K. Galloway, Katherine A. Slaughter, University of Edinburgh

We report the results of administering the Colorado Learning Attitudes about Science Survey (CLASS) to various cohort groups, from high school students who are studying physics, through undergraduate students at different levels at the University of Edinburgh, to graduate students, post-doctoral staff and faculty at U.K. physics departments. We find a number of intriguing results, some confirming those of previous studies, others that confound them. We find that freshman undergraduates enter our programmes with high levels of expert-like thinking compared to data from previous studies elsewhere. There are significant and marked differences in this first-year cohort as a function of degree intention and (to a lesser extent) gender. The degree of expert-like thinking is found to decrease in later undergraduate years, especially in the categories related to problem solving. Graduate students onward display levels of expert-like thinking comparable with faculty, suggesting a selection effect dominates at the undergraduate-graduate transition.

HB04: 10:10–10:20 a.m. A Data Handling Diagnostic: Design, Pilot Testing, and Evaluation

Ross K. Galloway, University of Edinburgh, School of Physics and Astronomy, JCMB, King's Buildings, Edinburgh, Scotland EH9 3JZ; ross.galloway@ed.ac.uk

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

We report the details of the design, pilot testing, and evaluation of a prototype diagnostic instrument to assess data-handling skills in undergraduate Physical Sciences. The instrument comprises 23 MCQ items, ranging in difficulty from determination of mean value to statistical consistency of curves fitted to data. It covers concepts in accuracy and precision, line-fitting to data with uncertainties, and extraction of quantitative relationships from graphical data. Pilot testing has been undertaken with more than 700 students in Physics and Chemistry at universities around the U.K. and Ireland at different educational levels. The results of this study indicate that there are alternate conceptions that persist throughout undergraduate instruction, despite considerable time and effort devoted to laboratory study, where it is often assumed such skills are developed. A statistical analysis of the reliability of individual questions, along with that of the whole instrument, is presented, together with proposed revisions to the instrument.

HB05: 10:20–10:30 a.m. Quantitative Analysis of the Role of WLS in Physics Education

Haiyun HU, Beijing Institute of Technology, No. 5, Zhongguancun South St., Beijing, P.R. China 100081; huhy@bit.edu.cn

Zhaolong LIU, Xiaoli Wu, Qing Zhao, Beijing Institute of Technology

This work investigates how the Web-based Learning System (WLS) can be used to assist physics study in higher education. We first describe the design strategy and the methods of implementation by taking the WLS developed by Beijing Institute of Technology. Then it is followed by a quantitative analysis in the data of access status and final examination results for 786 students to show the role of the system in College Physics study. It can be concluded that the WLS is quite useful for supporting students in their physics study.

Session HC: Innovative Microcomputer-based Laboratory Activities Utilizing Recently Developed Sensors or Hardware

Location: Broadway III/IV
Sponsors: Educational Technologies Committee, Physics in Two-Year Colleges Committee
Date: Wednesday, July 21
Time: 9:40–11:10 a.m.

Presider: Taha Mzoughi, Kennesaw State University, tmzoughi@kennesaw.edu

Advances in microcomputers, IC chips, wireless devices, and laboratory interfaces have inspired many into developing labs, demos, and activities for teaching physics.

HC01: 9:40–10:10 a.m. LumaScope, an Inexpensive CMOS- and USB-based Inverted Fluorescence Microscope

Invited – Brian Rasnow, California State University Channel Islands / Etaluma Inc., Applied Physics, One University Drive, Camarillo, CA 32012; brian.rasnow@cscui.edu

The LumaScope is an unconventional inverted fluorescence digital microscope developed using inexpensive webcam and USB technology and a philosophy of simplicity. Etaluma Inc. first conceptualized the LumaScope as a research and point-of-care medical diagnostic device, focusing on ease-of-use, immediate accessibility, an order-of-magnitude lower cost, and compact size. Its potential as a classroom tool was readily apparent, and its current design reflects the requirements of use in teaching labs. Microscopes are under-used in teaching physics because they have been expensive, bulky, and complex. LumaScope minimizes these issues, enabling its integration into more physics and interdisciplinary laboratories. Its fluorescence and bright-field capabilities and nearly diffraction-limited resolution demonstrate many optical principles. Other applications include measuring diffusion and mixing, biochemistry, and microbiology. Its small size and automated time-lapse imaging make LumaScope ideal for monitoring dynamic phenomena in environmentally controlled chambers. I will discuss the design of the LumaScope and some educational applications under development.

HC02: 10:10–10:40 a.m. Use of Arduino Microcontroller in a Physics Digital Electronics Course

Invited – David E. Pellett, UC Davis, Physics Dept., One Shields Ave., Davis, CA 95616; pellett@physics.ucdavis.edu*

Our one quarter upper-division physics course in digital electronics concludes with an introduction to microcomputer architecture and systems, assembly language, control and data acquisition applications, and sampled waveforms. A problem was the disconnect between the systems studied and those available at low cost for students to experiment with on their own. To address this, we have begun using the Atmel AVR microcontroller and the Arduino prototyping platform. The microcontroller has an attractive architecture, instruction set, and free development suite with simulator. The Arduino is inexpensive and easily programmed in the Arduino language, a C/C++ variant. Code may be developed under Linux, Mac OS X or Windows and downloaded to the Arduino over a USB connection. Software, documentation and examples are available on the web. Arduino users among our graduate students and alumni made key contributions to new experiments. We describe the course and the activities incorporating this microcontroller.

*Sponsored by Prof. Taha Mzoughi

HC03: 10:40–11:10 a.m. Applications of Arduino Microcontrollers in Undergraduate Laboratories

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

The Arduino is an open-source microcontroller system that is easy to use in a broad range of situations. These inexpensive devices can be used for embedded experiment control, for timing of digital events, for low-resolution analog measurements, for control of high-resolution sensors, or all of these simultaneously. Programming the Arduino requires no special hardware or technical skill beyond introductory-level c programming. In this talk I will describe and demonstrate several applications of Arduinos in undergraduate physics and cross-disciplinary labs.

Session HE: Upper-Level Undergraduate Physics

Location: Pavilion East
Sponsor: Physics in Undergraduate Education Committee
Date: Wednesday, July 21
Time: 9:40–11:10 a.m.

Presider: Mary Lowe, Loyola University Maryland, mlowe@loyola.edu

HE01: 9:40–9:50 a.m. Orientation Change for Two-Dimensional Articulated Figures of Zero Angular Momentum

John Di Bartolo, Polytechnic Institute of NYU, 6 Metrotech Center, New York, NY 10025; jdibarto@poly.edu

This talk examines the motion of a simple system of connected rigid bodies with no net angular momentum. Although it is possible for such a system to move in a particular way that preserves its orientation, we consider the conditions where orientation of the system changes, even in the absence of an external torque. A general formalism is developed for calculating the change of orientation of an articulated figure with two degrees of freedom, and this formalism is then used to show that the orientation changes described above are indeed possible. To provide concrete examples of such motion, the formalism is applied to a simple figure made of three equivalent rods and then to a primitive model of the human body. Finally, to illustrate how these systems evolve over time, the differential equations governing their movement are solved numerically, and animations of the moving figures are shown.

HE02: 9:50–10 a.m. Decoherence Demonstration

Scott C. Johnson, Intel, 4635 NW 175th Place, Portland, OR 97229; scott.c.johnson@intel.com

The main question raised by the Schrodinger's Cat paradox, why don't we see superpositions of macroscopic objects like a live and dead cat, is partially answered by the decoherence effect. In this talk, I will give a demonstration using animated graphs of Gaussian wave packets that I claim vividly demonstrates decoherence in a way that is understandable to a student who has completed a modern physics course. (The calculations themselves are at the level of a senior project.)

HE03: 10–10:10 a.m. Developing and Evaluating Animated Visualizations for Teaching Quantum Mechanics Concepts

Bruce Sinclair, School of Physics and Astronomy, University of St. Andrews, North Haugh, St. Andrews, Fife, UK, KY16 9SS; ak81@st-andrews.ac.uk

Tom J. Edwards, Aly D. Gillies, Chris A. Hooley, Margaret Douglass, School of Physics and Astronomy, University of St. Andrews

There has been substantial research done in recent years concerning student difficulties and misconceptions in quantum mechanics. Visualizations and animations can play an important role in helping students to construct mental models of quantum-mechanical concepts. As a UK Higher Education Academy Development Project, we have built on existing prior pedagogical research, including work done at the University of St. Andrews, to create ~30 visualizations and animations to specifically target student misconceptions and areas of difficulty. We have used the animations and visualizations in quantum mechanics courses in the 2009/10 academic year. We have aimed to evaluate their educational effectiveness through student questionnaires and a diagnostic survey. The visualizations as well as instructor resources will be made available as open educational resources in summer 2010.

HE04: 10:10–10:20 a.m. Just in Time Teaching in an Upper-Division Elective

Jeff Loats, Metropolitan State College of Denver, Physics Dept., 1201 5th St., Campus Box 69, Denver, CO 80217; jeff.loats@gmail.com

Having used Just in Time Teaching (JiTT) for five years in introductory courses, I have recently used it in an upper-division course (nuclear and particle physics) for the first time along with Peer Instruction and "clickers." The presentation will include my experiences, student attitudes toward these techniques, and my advice for others who wish to apply these evidence-based pedagogies in the upper-division curriculum.

HE05: 10:20–10:30 a.m. Using Mathematica to Understand the Zeeman Effect and Perturbation Theory

Tamar More, University of Portland, 5000 N. Willamette Blvd., MSC 120, Portland, OR 97203; more@up.edu

The Zeeman effect, in which spectral lines are split due to a static magnetic field, represents an opportunity for students to engage with a number of essential concepts in quantum mechanics: the idea of "good" quantum numbers and a "good" basis, transformation from one basis to another, degeneracy, the splitting of states, the addition of spin and orbital angular momenta, and selection rules all come into play. We present a set of guided activities using Mathematica to help students to explore how the energy shifts (the eigenvalues of the perturbation matrix) and the states (the eigenstates of the matrix) evolve as the magnetic field changes. We will also discuss some of the insights our students have gained as a result of actively engaging with the material.

HE06: 10:30–10:40 a.m. Colorado's Transformed Upper-Division E&M and QM courses: Description and Results*

Katherine Perkins, University of Colorado, UCB 390, Boulder, CO 80309; Katherine.Perkins@colorado.edu

Steven Pollock, Stephanie Chasteen, Steve Goldhaber, Rachel Pepper, Michael Dubson, Paul Beale, University of Colorado

Over the past three years, the physics faculty at the University of Colorado have worked to transform our upper-division E&M and QM courses with the goals of (a) improving student learning and (b) developing materials and approaches that other faculty may adopt or adapt to their teaching environment. This work began with faculty working groups meeting regularly to define explicit course learning goals. These learning goals served as the foundation for the course transformations that applied the principles of active engagement and learning theory to these upper-division courses. The development of the full curriculum was guided by the results of observations, interviews, and analysis of student work. In this talk, we will outline the reforms—including consensus learning goals, "clicker" questions, tutorials, modified homeworks, and more—and present evidence of the effectiveness of these reforms relative to traditional courses. All of our curriculum materials are available at http://www.colorado.edu/sei/departments/physics.htm.

*This work is funded by University of Colorado's Science Education Initiative and NSF CCLI Grant #0737118.

HE07: 10:40–10:50 a.m. Improving Students' Understanding of Addition of Angular Momentum*

Chandralekha Singh, University of Pittsburgh, Dept. Physics, 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 students' common 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.

HE08: 10:50–11 a.m. Tutorials in Upper Level Electromagnetism

Paul van Kampen, Centre for the Advancement of Science and Mathematics Teaching and Learning, Dublin City University, Dublin, x Dublin 9; Paul.van.Kampen@dcu.ie

Leanne Doughty, Centre for the Advancement of Science and Mathematics Teaching and Learning

Upper-level electromagnetism can be a hard topic to teach and to learn. Student and teacher alike must deal with a plethora of physical concepts and mathematical techniques that typically have been "covered," but not internalized, in prerequisite courses. We have redesigned a typical junior level electromagnetism course so that it synthesizes previously seen concepts and techniques. The 12-week course consists of one lecture and two tutorials per week. The aim of the lectures is mostly to make students familiar with the necessary vocabulary and to acquaint or reacquaint them with the material. The tutorials are patterned after *Tutorials in Introductory Physics*[1] and typically deal with a topic first conceptually and then mathematically. All tutorials are characterized by quasi-Socratic questioning.

1. L.C. McDermott et al, *Tutorials in Introductory Physics* (Prentice-Hall, Upper Saddle River, NJ, 2002).

HE09: 11–11:10 a.m. Improving Students' Understanding of Quantum Measurement*

Guangtian Zhu, University of Pittsburgh, 100 Allen Hall, 3941 O'Hara St., Pittsburgh, PA 15260; guz11@pitt.edu

Chandralekha Singh, University of Pittsburgh

The issues related to the measurement of a physical observable in a quantum system are very different from the measurement in a classical system. We are investigating students' difficulties related to quantum measurement (in the standard interpretation) by administering written tests and interviewing advanced undergraduate and graduate students in quantum mechanics courses. We are also developing Quantum Interactive Learning Tutorials (QuILTs) and tools for peer instruction to improve students' understanding of these concepts. We will discuss the development and assessment of these learning tools and their effectiveness in improving students' understanding of quantum measurement.

*Sponsored by NSF

Session HF: Student Understanding of Energy

Location: Pavilion West
Sponsor: Physics Education Research Committee
Date: Wednesday, July 21
Time: 9:40–11 a.m.

Presider: Eric Brewe, Florida International University, ebrewe@fiu.edu

HF01: 9:40–9:50 a.m. Going Rogue: In Search of Passionate and Unencumbered Talk about Energy in the Blogosphere*

Lane Seeley, Seattle Pacific University, 3307 3rd Ave. West, Seattle, WA 98119; seelel@spu.edu

Eleanor Close, Lezlie DeWater, Rachel Scherr, Seattle Pacific University

People have deeply held beliefs about their experience of energy in the physical world. Energy is also widely regarded as a topic of extreme political, social, and ethical relevance. Unfortunately, in formal educational contexts, energy concepts are often treated as a dogmatic descriptive framework that has little personal or social relevance. This situation impedes formative assessment because students are not empowered to express their own ideas on their own terms or raise issues that they find personally relevant. We will describe efforts by the SPU Energy Project to uncover authentic "talk" about energy both inside and outside of a formal educational context. These efforts are undertaken to reveal the landscape of authentic "student" thinking about energy in a socially relevant context. This knowledge will support our efforts to help teachers cultivate authentic talk about energy in the classroom.

*Supported in part by NSF DRL 0822342 and the Seattle Pacific University Science Initiative.

HF02: 9:50–10 a.m. Ontology in the Flesh: Embodied Learning Activities for Conceptual Understanding of Energy

Sarah B. McKagan, McKagan Enterprises, 2436 S Irving St., Seattle, WA 98144; sam.mckagan@gmail.com

Rachel E. Scherr, Eleanor W. Close, Hunter G. Close, Seattle Pacific University

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 an example of a "embodied learning activity" about energy: that is, an activity in which we deliberately arrange for human bodies to symbolize entities in physical phenomena involving energy transfers and transformations. Our observations suggest that this "energy theater" uniquely promotes engagement with deep conceptual questions about energy.[2]

1. Lakoff, G. and M. Johnson, P*hilosophy in the flesh: The embodied mind and its challenge to Western thought* (Basic Books, New York, 1999).

2. Supported in part by NSF DRL 0822342 and the Seattle Pacific University Science Initiative.

HF03: 10–10:10 a.m. Energy in Action: The Construction of Physics Ideas in Multiple Modes*

Eleanor W. Close, Seattle Pacific University, 3307 3rd Ave. West, Suite 307, Seattle, WA 98115; closee@spu.edu

Hunter G. Close, Rachel E. Scherr, Seattle Pacific University

Sarah B. McKagan, McKagan Enterprises

In a course organized around the development of diverse representations, no single mode of expression offers a complete picture of participants' understanding of the nature of energy. Instead, we argue, their understanding is actively constructed through the simultaneous use of a range of quite different kinds of representational resources (Goodwin, 2000),[1] including not only words but also gestures, symbolic objects, participants moving their bodies in concert, and whatever other communicative modes the course invites them to use. Examples are provided from a teacher professional development course on energy.

*Supported in part by NSF DRL 0822342 and the Seattle Pacific University Science Initiative.

1. C. Goodwin, "Action and embodiment within situated human interaction," *Journal of Pragmatics* **32,** p. 1489-1522 (2000).

HF04: 10:10–10:20 a.m. Empathizing With Energy: Understanding Physics by Identifying with Hypothetical Entities*

Hunter G. Close, Seattle Pacific University Dept. of Physics, 3307 3rd Avenue West, Seattle, WA 98119; hclose@spu.edu

Rachel E. Scherr, Eleanor W. Close, Seattle Pacific University

Sarah B. McKagan, McKagan Enterprises

Current thinking in embodied cognition poses metaphor as a neural mechanism by which we adapt our sensory-motor systems to create forms of abstract reason (Lakoff and Johnson, 1999).[1] In particular, mentally taking on the role of an entity in a physics phenomenon and symbolically re-enacting the (perhaps metaphorical) movement of that entity appears to be particularly helpful for figuring out physical theories (Ochs, 1996).[2] We observe participants in a teacher professional development course on energy taking the perspective of energy in a physical scenario involving both energy transfer and transformation. Evidence suggests that this perspective-taking is common, fruitful, and pedagogically valuable. Examples are provided from a teacher professional development course on energy.

*Supported in part by NSF DRL 0822342 and the Seattle Pacific University Science Initiative.

1. G. Lakoff and M. Johnson, *Philosophy in the flesh: The embodied mind and its challenge to Western thought*, (Basic Books, New York, 1999).
2. E. Ochs, P. Gonzales, and S. Jacoby, "When I come down I'm in the domain state": Grammar and graphic representation in the interpretive activity of physicists, in *Interaction and grammar,* (Cambridge University Press: Cambridge, p. 328-369, 1996).

HF05: 10:20–10:30 a.m. Individual and Group Understanding of Energy in an Embodied Learning Activity*

Rachel E. Scherr, Seattle Pacific University, 3307 3rd Ave., West, Seattle, WA 98119; rescherr@gmail.com

Hunter G. Close, Eleanor W. Close, Seattle Pacific University

Sarah B. McKagan, McKagan Enterprises

In a collaborative group learning activity, cognition may potentially be attributed to individuals, to the group, or to the system of human and non-human participants (Hutchins, 1995; Johnson, 1998). We explore various possible attributions in an "embodied learning activity" about energy—that is, an activity in which human bodies symbolize units of energy in a physical phenomenon. In this type of activity, ideas about what energy is and what it does are apparent in both individual and group action. In some cases, the group's ideas appear not to be shared by individual participants, and vice versa. We observe one mechanism by which this information mismatch is resolved by the participants. The goal of the analysis is to better appreciate the different scales of meaningful activity in which participants engage.

1. J. Johnson, "Mixing humans and nonhumans together: The sociology of a door-closer," *Social Problems* **35**(3), 298-310, (1998).
2. E. Hutchins, "How a cockpit remembers its speeds" *Cognitive Science* **19**(3),265-288 (1995).

*Supported in part by NSF DRL 0822342 and the Seattle Pacific University Science Initiative.

HF06: 10:30–10:40 a.m. Depicting Energy: A Collaboration between Physics and Art*

Lezlie S. DeWater, Seattle Pacific University, 3307 3rd Ave. West, Suite 307, Seattle, WA 98119-1997; dewater@spu.edu

Hunter Close, Rachel Scherr, Lane Seeley, Stamatis Vokos, Seattle Pacific University

Science requires careful communication and disciplined representation of ideas. Communicating developing ideas through symbolic representations precedes and promotes the construction of scientific models. We believe that augmenting the number and kinds of representational tools available to learners in the context of energy will allow them to make their thinking about energy concepts more distinctly visible. In order to more fully engage design principles in our work with energy representations, the physics department at Seattle Pacific University embarked upon an uncommon collaboration with SPU visual communication majors. The visual communication students were asked to depict various energy concepts and to communicate their understanding in poster form. We will share how this collaboration spontaneously catalyzed learning communities, motivated genuine interest in understanding energy, and impacted undergraduate physics and visual communication students, as well as K-12 teachers.

*Supported in part by NSF DRL 0822342 and the Seattle Pacific University Science Initiative.

HF07: 10:40–10:50 a.m. The Comprehensive Approach of Energy Concept and Promotion of Scientific Literacy

Sunny Lee, Korea National University of Education, Dept. of Physics Education, Chongwon, Chungbuk, CB 363-791; jbkim@knue.ac.kr

Jung Bog Kim, Korea National University of Education

Energy is the central concept in physics and a very important issue in our life. But, in our science class, the concept of energy is being treated by only an equation, such as *mgh*, or $\frac{1}{2}mv^2$, which look like no connection with our actual life. For that matter, we propose a new approach to teaching energy. First, before dealing with the equations, we should realize the energy in actual life. For teaching the fact that the form of energy is changed but the total is not changed, accurate observation in various phenomena is required first. In each step of energy transformation, variable quantity and invariable quantity should be considered and discussed. Through this procedure, students can feel energy. Second, energy is not made but changed. After observation about energy form, then the ways for getting useful energy should be studied. Usefulness of energy is taught while energy is changed into other energy forms. Then various ways of making electric energy should be introduced. Third, social problems of energy should be considered in science and technology. Scientific analysis about solving energy problems should be done. Through this procedure, students understand and realize the usefulness of science and technology. Students have much power of judgment and thinking about social problems concerned with science.

HF08: 10:50–11 a.m. Successfully Doing Energy First: Using a Models Approach

Wendell H. Potter, University of California, Davis, Physics, One Shields Ave., Davis, CA 95616; whpotter@ucdavis.edu

You can't teach "energy" until students have gotten "work." (Remember: "Energy is the ability to do work.") You can't teach "work" until students have "force" and "motion." So, you can't teach energy before mechanics. You can't teach energy first! Period! End of discussion. Or is it? For 14 years we have successfully begun our one-year calculus-based course for life science majors with a unified approach to energy using it in both thermal and mechanical systems. Traditional Newtonian mechanics and kinematics comes after completing thermodynamics. How is this possible? Thoroughly adopting a models approach to conceptualizing, organizing, and sequencing content is the key to our success. This provides a rational approach to answering questions of precisely what prior content understanding is required and at what level in order to move forward at each step. This talk will illustrate precisely how a models approach is used to accomplish this.

Session HG: Education in a Planetarium

Location: Broadway I/II
Date: Wednesday, July 21
Time: 9:40–10:40 a.m.

Presider: Eric Hintz, BYU, doctor@tardis.byu.edu

HG01: 9:40–10:10 a.m. Promoting and Gauging Conceptual Change in Planetarium Audiences at Formal and Informal Institutions

Invited – Michelle M. Krok, San Francisco State University, 1600 Holloway Ave., San Francisco, CA 94132; mkrok@sfsu.edu

Although the planetarium is a useful tool toward inspiring public awareness of astronomy, the desire of many planetarium instructors is to build the public understanding of astronomy. In this session we will explore basic tools and resources that planetarium instructors at both informal and formal educational institutions can utilize to promote and gauge conceptual change in their audiences. Literature regarding research on learning in the planetarium will be presented, as well as how to incorporate active learning strategies increasingly being used in traditional astronomy classrooms. Because planetarium teaching is dominated by visualizations, we will also discuss the contributions to misconceptions that common planetarium visualizations may induce, as well as how to use the planetarium to dispel misconceptions.

HG02: 10:10–10:40 a.m. Non-Verbal Instruction in Planetariums with Full-Dome Graphics Capability

Invited – M. Jeannette Lawler, Brigham Young University, N283 ESC, Provo, UT 84602; lawler@byu.edu

Michael Jones, Heather Jones, Eric Hintz, BYU

Planetariums are a particularly difficult venue for deaf audiences. Currently, planetariums rely on either closed-captions or live interpreters. There are problems with both methods. Closed-captions require proficient reading skills, making them problematic for children. American Sign Language interpreters must be illuminated, which is not desirable in planetariums. The audience must divide attention between the verbal and visual portion of the presentation to follow either captions or an interpreter. Additionally, research suggests that either technique will negatively impact the learning of hearing children.[1, 2, 3] Research has shown that children can conceptualize and even reinvent fundamental scientific concepts based on non-verbal instruction.[4] BYU is developing animations for use in planetariums with full-dome graphics capability that transmit information primarily non-verbally. This will allow us to compare the effectiveness of a mixed verbal/visual presentation designed for hearing children with a presentation that is primarily non-verbal in teaching both hearing and deaf children.

1. R. Mayer, C. Johnson, "Revising the Redundancy Principle in Multimedia Learning," *Journal of Educational Psychology* **100**, 380-386 (2008).

2. J. Sweller, "The redundancy principle in multimedia learning," In R. Mayer (Ed.), *Cambridge handbook of multimedia learning New York (*Cambridge University Press, 159-168, 2005).

3. R. Moreno, R. Mayer, "Verbal Redundancy in Multimedia Learning: When Reading Helps Listening," *Journal of Educational Psychology* **94**, 156-164 (2002).

4. Y. Kafai, M. Giang, "Can students re-invent fundamental scientific principles: evaluating the promise of new-media literacies," in T. Willoughby and E. Wood (Ed.) *Children's learning in a digital world* (Blackwell Pub., Malden, MA, 2008).

Session CKB06: Crackerbarrel: Using History to Teach Physics

Location: Galleria I
Sponsors: History and Philosophy of Physics Committee, Interests of Senior Physicists Committee
Date: Wednesday, July 21
Time: 12:30–1:40 p.m.

Presider: Hugh Henderson, Hugh_Henderson@birdville.k12.tx.us

Our committees invite you to an open discussion on using history to teach physics. We plan on having crackers and cheese, like an old crackerbarrel, so that we can munch and discuss what we love the best--teaching physics!

Session CKB07: Crackerbarrel: Web Resources for Teaching Astronomy

Location: Galleria II
Sponsor: Space Science and Astronomy Committee
Date: Wednesday, July 21
Time: 12:30–1:40 p.m.

Presider: Kevin Lee, klee6@unl.edu

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

Plenary: PTRA at its 25th Anniversary

Location: Grand Ballroom I
Sponsor: Physics in High Schools Committee
Date: Wednesday, July 21
Time: 11:15 a.m.–12:30 p.m.

Presider: Elizabeth Chesick

PTRA , Physics Teaching Resource Agents, is one of the more innovative programs to be developed by a science professional organization. The idea that physics teachers could be engaged to meet together for common learning experiences and then, individually, go out into the community, to assume leadership roles, to network with other physics teachers and be resource and an educational assistant was a unique idea in 1985. The speakers will discuss the origin of the idea, its implementation, its development over 25 years, and its present and future plans.

Speakers Include:

George A. Amann, James Nelson, Jan Mader, John Roeder, John Layman, Karen Jo Matsler, Lawrence Bader, Lila Adair, Robert Beck Clark

Session IA: Teacher Preparation Around the World

Location: Galleria II
Sponsors: International Physics Education Committee, Teacher Preparation Committee
Date: Wednesday, July 21
Time: 1:45–2:25 p.m.

Presider: Robert Poel, Western Michigan University, klee6@unl.edu

This session will describe and contrast elementary and secondary teacher science preparation programs that lead to official state certification around the world. It will focus on elementary programs (K-8 in the U.S.) in two or three selected Asian and European countries and the science content and pedagogical eduction required for official state certification. [Other meetings will feature secondary physics teacher preparation around the world.] Emphasis will be placed on evaluating the successes and shortcomings of each program on various criteria with a final discussion session led by a reactant who contrasts those programs and requirements with those in the U.S.

IA01: 1:45–2:15 p.m. Physics Teacher Preparation in Argentina: Present and Future

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

Science preparation of elementary teachers (grades 1-6) in Argentina will be discussed related to physics teacher preparation. The latter take care of the secondary education (grades 7-12), where general science (grades 7-9) and physics (grades 10-11) are taught. As a general picture, there is very little teaching of science at the elementary level. In secondary schools in the last 20 years physics teaching hours have been lost and have been taken by other sciences--notably biology and computer science. In any case, the teaching is traditional, with very low levels of conceptual learning, and carried out by ill-prepared teachers. There is under way a reform in pre-service physics teacher preparation, guided by the advice of a National Commission that has very recently made some important recommendation regarding physics and pedagogical content of physics teacher preparation.

IA02: 2:15–2:25 p.m. Integrating Teaching and Learning in Pre-Service Teacher Education

Derya Kaltakci, Middle East Technical University, OFMAE Bolumu, Egitim Fakultesi, Orta Dogu Teknik Universitesi, Ankara, Turkey, 06531; kaderya@metu.edu.tr

Providing a learning environment in which pre-service teachers can experience teaching what they learn should be fundamental in teacher education programs. In this study, a Methods of Science Teaching (MST) course will be presented as an example for this model. The main aim of the MST course is to help prospective teachers to grasp the general teaching methods as applied to science teaching. In the course prospective teachers are expected to gain the necessary theoretical knowledge about the special teaching methods for science and have the ability to apply this theoretical knowledge in their teaching practices. With this aim, two sequential courses of MTS I and II at Middle East Technical University were modified and have been conducted with a new approach for the last eight semesters. In this approach the course has been divided into basically three parts: theoretical, modeling, and microteaching. In the theoretical part, the teaching methods and strategies are discussed with its related theoretical information. In the modeling part, prospective teachers are provided with example physics lessons on each specific teaching method by teaching assistants. In the final part of the course, short microteaching activities in teaching physics concepts with specific teaching methods are performed by the prospective teachers. This new approach in the course provides both theoretical and practical knowledge in teaching methods through different ways for prospective physics teachers.

Session IB: Astronomy Teaching Innovations and Student Projects

Location: Galleria III
Sponsors: Space Science and Astronomy Committee
Date: Wednesday, July 21
Time: 1:45–2:35 p.m.

Presider: Eric Hintz, BYU, doctor@tardis.byu.edu

We will discuss ways to involve students in hands-on activities that excite them about astronomy, and science in general. This could be K-12 class activities, college descriptive astronomy laboratory activities, or undergraduate student research. Another possibility is the use of publicly available online data for activities. Any way to let students explore the heavens by doing.

IB01: 1:45–1:55 p.m. Homework Questions that Promote Critical Thinking

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

This talk will present examples of homework questions designed to promote critical thinking in astronomy and other introductory sciences. Many of these questions do not apply specifically to astronomy. Instead, they attempt to compel students to think about scientific reasoning, terminology, logic, and effective communication. Collectively, these ideas form the critical thinking foundation for all science. These questions are part of the Learning Critical Thinking Through Astronomy textbook project (http://www.sticksandshadows.com/lctta/lctta.html).

IB02: 1:55–2:05 p.m. Earth Rotating Around Its Axis – How Do We Know?

Ann-Marie Pendrill, University of Gothenburg, Dept. of Physics, Goteborg, SE 412 96; Ann-Marie.Pendrill@physics.gu.se

How do we know? This is a question that can be applied to many phenomena of different levels of difficulty and at all levels of education, and is an essential part of scientific work. We find that new students are not used to this type of question, e.g., they often refer to day and night as evidence for a spinning Earth, even if they are, of course, aware that for most of its history, mankind believed that day and night were caused by the Sun moving around the Earth. Slowly rotating carousels or panorama towers give possibilities to explore physics in rotating systems and to gain first-hand experience of methods to measure rotation, without the need for an external reference. Simple experiments can lay a foundation for an understanding of ways to demonstrate that the Earth spins around its axis.

IB03: 2:05–2:15 p.m. WISE/Spitzer Space Telescope Research Program for Teachers and Students

CANCELED

Susan Kelly, Blind Brook High School, 840 King St., Rye Brook, NY 10573; susankelly.ct@gmail.com

Bryan Mendez, WISE

The Spitzer Science Center (SSC), National Optical Astronomy Observatory (NOAO), and WISE (SSL) have designed a program for teacher and student research using observing time and archived data acquired through Spitzer Space Telescope and Wide Infrared Survey Explorer Telescope (WISE). This program addresses NASA's goal to inspire and motivate students to pursue STEM careers. NASA's fundamental objective to improve student proficiency in science is supported through this unique opportunity for students to acquire and analyze infrared data. Student research experiences will be described.

IB04: 2:15–2:25 p.m. Transit Observations of HAT-P-10

James Kernohan, Milton Academy, 170 Centre St., Milton, MA 02186; jim_kernohan@milton.edu

Roy Gould, Harvard Smithsonian Center for Astrophysics

Using Internet-accessible telescopes, my students took images of the star HAT-P-10 and were able to verify the existence of an exoplanet. I will present some of the images they took along with their data showing the relative brightness of the star over the course of a night. The decrease in intensity is due to the orbiting exoplanet. With this data, they were able to determine the size of the planet as well.

IB05: 2:25–2:35 p.m. Tree Leaf Shadows to the Sun's Density: A Surprising Route

A. James Mallmann, Milwaukee School of Engineering, 1025 North Broadway, Milwaukee, WI 53202-3109; mallmann@msoe.edu

Rays of sunlight that strike raindrops produce the rainbow, with evidence for the spectrum of sunlight. Rays of sunlight that strike airborne ice crystals produce halos, sun pillars, and other patterns of light and color in the sky. Analysis of these patterns makes it possible to determine the types and orientations of the ice crystals responsible. Shadows are far more common patterns, available for viewing any day of the year. I found it surprising to discover that the shadow patterns produced when sunlight strikes tree leaves provide all the information needed to determine the density of the Sun. It seems unlikely that the Sun's density could be determined without knowing either the Sun's mass or its volume. It seems even more unlikely that information available in the shadows of tree leaves and a few principles of introductory physics can be used to determine the average density of the Sun.

Session ID: PER: Problem Solving

Location: Broadway III/IV
Date: Wednesday, July 21
Time: 1:45–3:45 p.m.

Presider: Eleanor Sayre, Wabash College, le@zaposa.com

ID01: 1:45–1:55 p.m. Comparing Expert and Novice Eye Movements While Solving Physics Problems

Adrian Carmichael, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506-2601; adrianc@phys.ksu.edu

Adam Larson, Elizabeth Gire, Lester Loschky, N. Sanjay Rebello, Kansas State University

Eye movement data has been shown to enhance our understanding of students' problem- solving behaviors in physics and also help us identify differences between novices and experts.[1] In this study we compare the eye movement data of experts and novices using introductory conceptual physics problems. The problems chosen all utilize concepts that have an inherent spatial component in their visual representation. To become aware of the critical concept in each problem, the solver must attend to that spatial component of the figure. To gain additional information about how the experts and novices answered each problem, we interviewed the participants about the reasoning process they used and compared these answers to the eye movements. We will discuss our results from interviews as well as eye-tracking data from both experts and novices.

1. Robert Tai, John Loehr, and Frederick Brigham, *International Journal of Research & Method in Education* **29**, 185-208 (2006).

ID02: 1:55–2:05 p.m. Assessing Student's Ability to Solve Textbook-Style Problems: Update, Part I

Jeffrey Marx, McDaniel College, 221 Roops Mill Rd., Westminster, MD 21158; jmarx@mcdaniel.edu

Karen Cummings, Southern Connecticut State University

Development of students' 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 15-item survey to help assess students' abilities at solving textbook-style problems. In fall 2009, we beta-tested this instrument on introductory physics students (pre-instruction and post-instruction) at several institutions and on a pool of "experts." In this, the first of two talks, we will present details of the survey instrument, its administration, and some results from our first round of testing.

ID03: 2:05–2:15 p.m. Assessing Student's Ability to Solve Textbook-Style Problems: Update, Part II

Karen Cummings, Southern Connecticut State University, 501 Crescent St., New Haven, CT 06515; cummingsk2@southernct.edu

Jeffrey D. Marx, McDaniel College

We have developed an instrument to help assess students' ability to solve textbook-style problems. In the fall of 2009 and spring 2010, we beta-tested this assessment on physics students of various levels (pre-instruction and post-instruction) at several institutes and on a pool of "experts." In this, the second of two talks, we will present updates on this project including details of the survey instrument, its administration, and/or some results from our first round of testing.

ID04: 2:15–2:25 p.m. Design and Implementation of a Synthesizing Lecture on Mechanics Concepts*

Jennifer L. Docktor, University of Illinois at Urbana-Champaign, 405 North Mathews Ave., Urbana, IL 61801; docktor@illinois.edu

Natalie Strand, Gary Gladding, Jose Mestre, Brian Ross, University of Illinois at Urbana-Champaign

In traditional physics instruction, teachers mention major principles as they model problem solving, but most often those principles are instantiated in the form of written equations only. This inadvertently conveys to students that it is the equations, rather than the concepts, that are important. Furthermore, traditional instruction does little to relate and synthesize major ideas, especially within problem-solving contexts. We discuss the development and implementation of a short, animated, web-delivered synthesizing presentation modeled after the common learning resource from the preparation for future learning construct, [1] in which the major concepts of introductory mechanics are structured hierarchically. More specifically, the presentation is an overview of previous instruction highlighting major theorems and conservation laws in mechanics and the conditions under which they are applied. It is linked to previous problems solved by the student and intended to prepare students for future learning by illustrating how concepts guide problem solving processes.

1. J.D. Bransford, D.L. Schwartz, "Rethinking transfer: A simple proposal with multiple implications," *Review of Research in Education,* **24**, 61-100 (1999).

*Supported in part by Institute of Education Sciences grant #R305B070085.

ID05: 2:25–2:35 p.m. Using Analogy for Learning Introductory Physics

Shih-Yin Lin, University of Pittsburgh, 3941 O'Hara St., 100 Allen Hall, Pittsburgh, PA 15260; hellosilpn@gmail.com

Chandralekha Singh, University of Pittsburgh

Identifying the physics principles involved in solving problems is a critical step in problem solving. A major goal in physics education is to help students discern the deep similarities between problems based upon the physics principles so that they can transfer what they learned by solving one problem to solve another problem based upon the same principle. We conducted an investigation in which more than 800 algebra and calculus-based introductory physics students were asked explicitly in the quizzes to browse over and learn from a solved problem and then solve another problem that has different surface features but the same underlying physics principles. Different interventions were implemented for different groups to help students process through the physics principles involved deeply. Students' performance on the quizzes after the intervention was analyzed and compared. We will present the findings. This work is supported by NSF.

ID06: 2:35–2:45 p.m. A Conceptual Analysis Approach to Physics Problem Solving

Jose Mestre, University of Illinois at Urbana-Champaign, Loomis Lab, 1110 West Green St., Urbana, IL 61801; mestre@illinois.edu

Jennifer Docktor, Natalie Strand, Brian Ross, University of Illinois at Urbana-Champaign

Timothy Nokes, Elizabeth Richey, University of Pittsburgh

Students in introductory physics courses treat problem solving as an exercise in manipulating equations, symbols, and quantities with the goal of obtaining the correct answer. Although this approach is efficient for getting answers, it is far from optimal for learning how conceptual knowledge is applied in the problem solving process. The goal of this study is to refine and evaluate an approach that encourages students to begin by writing a strategic analysis of a problem based on principles and procedures, and then to follow with a documented problem solution that exhibits, side-by-side, how concepts and equations go together in a solution. We will discuss the effectiveness of this approach in several contexts: experimental studies in a clinical setting at a university and interventions in a high school classroom setting.

*Supported in part by Institute of Education Sciences grant #R305B070085.

ID07: 2:45–2:55 p.m. Facilitating Problem Solving Across Representations in Introductory Electricity and Magnetism*

Dong-Hai Nguyen, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506-2601; donghai@phys.ksu.edu

Elizabeth Gire, N. Sanjay Rebello, Kansas State University

Solving physics problems posed in multiple representations is an important skill that should be addressed in training future scientists and engineers and there has been extensive research in physics education in this area. Following our previous study facilitating students' problem solving across multiple representations in a first-semester calculus-based physics course, we investigated the difficulties students encounter when solving problems posed in multiple representations in introductory electromagnetism and the scaffolding that might help students overcome those difficulties. We conducted individual teaching/learning interviews with 15 students four times during their second semester calculus-based physics course. In these interviews, students were asked to solve several problems in verbal, graphical, and equation representations and were given verbal hints when they encountered difficulties. We present some interview protocols, the difficulties students encountered and hints that appeared to help students overcome those difficulties.

*This research is supported in part by NSF grant 0816207.

ID08: 2:55–3:05 p.m. Toward a Multiple-Choice Inventory Assessing Strategic

Andrew Pawl, MIT, 77 Massachusetts Ave., Cambridge, MA 02139; aepawl@mit.edu

Analia Barrantes, Saif Rayyan, Raluca Teodorescu, David E. Pritchard, MIT

Strategic knowledge is required to appropriately organize procedures and concepts in order to solve problems. We describe some of the challenges inherent in constructing a standardized instrument assessing strategic knowledge in the domain of introductory mechanics and suggest ways to overcome these challenges. We present items from a conceptual multiple-choice instrument assessing strategic knowledge relevant to freshman mechanics that we are now in the process of validating. This instrument is inspired in part by Lawson's Classroom Test of Scientific Reasoning and Van Domelen's Problem Decomposition Diagnostic. We seek teachers who are interested in testing the preliminary version!

ID09: 3:05–3:15 p.m. Modeling Applied to Problem Solving

Saif Rayyan, MIT, 77 Massachusetts Ave., 26-227, Cambridge, MA 02139; srayyan@mit.edu

David E. Pritchard, Andrew E. Pawl, Analia Barrantes, Raluca Teodorescu, MIT

Modeling Applied to Problem Solving (MAPS) is a pedagogy that helps students transfer instruction to problem solving in an expert-like manner. Declarative and procedural content from the standard syllabus is organized and learned (not discovered) as a hierarchy of General Models. Students solve problems using an explicit Problem Modeling Rubric that begins with System, Interactions, and Model (S.I.M.). System and Interactions are emphasized as the key to a strategic description of the system and the identification of the appropriate General Model to apply to the problem. We have twice employed the pedagogy in three-week ReView courses for students who received a D in mechanics. These courses were assessed by a final exam retest as well as pre- and post-C-LASS surveys, yielding a 1.2 standard deviation improvement in the students' ability to solve final exam problems and a statistically significant positive shift in all nine categories in the C-LASS.

ID10: 3:15–3:25 p.m. Detecting Differences in Changes to Physics Diagrams

Natalie E. Strand, University of Illinois at Urbana-Champaign, 1110 West Green St., Urbana, IL 61801-3080; nstrand@illinois.edu

Jose Mestre, University of Illinois at Urbana-Champaign

Constructing a useful mental representation of physics situations is integral to success in problem solving. It is known that experts identify/perceive meaningful patterns and/or changes in visual stimuli related to their domain of expertise. We present data from an experiment using the "flicker" technique, in which students who had finished a calculus-based mechanics course, as well as physics-naïve students, viewed nearly identical pairs of diagrams that are representative of typical mechanics situations. The two diagrams in each pair contain a subtle difference that either does, or does not change the underlying physics depicted in the diagram. We present results on how the speed of noticing physics-relevant changes in the diagram pairs depends on physics experience and discuss the cognitive implications of our findings.

ID11: 3:25–3:35 p.m. An Online Mechanics Course Targeting Problem-Solving Expertise

Raluca E. Teodorescu, MIT, 77 Massachusetts Ave., Cambridge, MA 02139; rteodore@mit.edu

Saif Rayyan, Andrew Pawl, Analia Barrantes, David E. Pritchard, MIT

We are developing an online environment to allow teachers to easily adopt our new Modeling Applied to Problem Solving pedagogy. This pedagogy stresses a systems, interactions and models approach to facilitate organization and transfer of syllabus knowledge to problem solving in an expert manner. (The syllabus is for a standard calculus-based Newtonian mechanics course.) The environment involves an open source WIKI-text that is integrated with the tutors LON_CAPA.org and MasteringPhysics.com and also with material for classroom use. Assessment will include a new instrument to assess strategic knowledge as well as the C-LASS. Collaborators welcome.

ID12: 3:35–3:45 p.m. Vector Addition: Effect of the Context and Position of the Vectors

Genaro Zavala, Tecnologico de Monterrey, Campus Monterrey, Ave. Garza Sada 2501, Monterrey, NL 64849; genaro.zavala@itesm.mx

Pablo Barniol, Tecnologico de Monterrey, Campus Monterrey

In this work we first investigate the effect of the context on 2D vector addition tasks. We analyze student´ responses in three isomorphic problems: displacements, forces, and no physical context. Students were asked to draw two vectors and the addition vector. We analyze students' procedures and the difficulties when drawing the addition vector and prove that the context matters not only compared to the context-free case but also, among contexts. In the second part we analyze the effect of the position of the vectors in 2D vector addition tasks (with no physical context). We study students´responses in the same problem with three different arrangements of the vectors and compare the frequencies of the errors in the three different positions to inquire students' conceptions in the addition of vectors.

Session IE: High-Performance Computing

Location: Grand Ballroom II
Sponsor: Educational Technologies Committee
Date: Wednesday, July 21
Time: 1:45–3:45 p.m.

Presider: David Joiner, Kean University, djoiner@kean.edu

Two trends in computing architecture have changed the high-performance computing (HPC) landscape. While commodity-based clusters have reduced the cost of supercomputing, many-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 processes is becoming part of HPC programming models on the desktop as well as on the supercomputer. This session will illustrate uses of HPC in undergraduate physics teaching and research.

IE01: 1:45–2:15 p.m. Invitation to Embarrassingly Parallel Computing

Invited – Barbara J. Breen, University of Portland, 5000 N Willamette Blvd., Portland, OR 97203; breen@up.edu

A surprising number of physics problems are well suited to "embarrassingly parallel" computations that do not require complicated software algorithms or specialized hardware. As faculty and students at small institutions, we are readily incorporating parallel computing in diverse levels of our curricula, and we are embracing the opportunity to utilize high-performance computing to attack contemporary research problems in summer research, senior theses, and course work. In this talk I describe how we do this in specific examples such as arrays of one-way coupled oscillators, ray-tracing in curved spacetime, solar escape as a three-body problem and gravitational interaction of a line segment and a point mass.

IE02: 2:15–2:45 p.m. Computational Quantum Mechanics in the Undergraduate Curriculum

Invited – Richard G. Gass, University of Cincinnati, Dept. of Physics, ML 0011, Cincinnati, OH 45221-0011; Richard.Gass@UC.Edu

Quantum Mechanics offers a fertile field for computation. The subject is both mathematical and conceptually difficult, and because Plank's constant is small undergraduates have poor quantum intuition. Computation can be invaluable in helping students build intuition and opens up new classes of problems, many of which are of current experimental interest. These factors make quantum mechanics a natural arena for teaching students about computation and for using computation to teach quantum mechanics. I will describe materials I have devolved for computational quantum mechanics at the undergraduate level ranging from desktop computation to HPC.

IE03: 2:45–3:15 p.m. Algorithmic Agility and High Performance Computing: Lessons from Pair Potentials

Invited – Robert M. Panoff, Shodor, 300 W. Morgan St., Suite 1150, Durham, NC 27701; rpanoff@shodor.org*

Over 25 years ago, the variation of computer architectures of the supercomputers of the day (capable of some 100 million operations per second) required nearly every budding computational physicist to exploit a range of algebraic reformulations to sum pair potentials in a variety of many-body problems. Being a "computational physicist" was synonymous with knowing when to use long vectors, short vectors, indirect addressing, precomputed tables, interpolation, and cache concurrency. Since the everyday desktop or even netbook approaches 1 billion operations per second, many of these hard-earned lessons have been lost. With the advent of new (re-cycled) architectures to achieve terascale or petascale computing,[1] achieving the shortest time-to-science by maximizing computation and minimizing communication will require a return to algorithmic thinking.

*Sponsored by David Joiner.

1. Sharon C. Glotzer, R. M. Panoff, Scott Lathrop, "Challenges and Opportunities in Preparing Students for Petascale Computational Science and Engineering," *Computing in Science and Engineering,* **11**,(5), pp. 22-27, Sep./Oct. 2009, doi:10.1109/MCSE.2009.134

IE04: 3:15–3:45 p.m. High Performance and Parallel Computing for Beginners and Dummies*

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

Some of the basic concepts and concerns of high performance and parallel computing will be discussed at a beginner's level. This will begin with a discussion of the theory of a high- performance computer's memory and central processor's design, and then progress to parallel computers. There will be a survey of some techniques and concerns important for writing programs that are optimized for HPC and parallel computers (e.g. using virtual memory and cache). Also discussed will be the type of problems appropriate for different types of parallel computers, and when it makes sense to use parallel computation at all.

*Work supported by the National Science Foundation, CCLI program.

Session IF: *Panel:* Out of One, Many: Researchers from Five Different Perspectives Analyze the Same Student Video

Location: Pavilion East
Sponsors: Research in Physics Education Committee, Physics in High Schools Committee
Date: Wednesday, July 21
Time: 1:45–3:45 p.m.

Presider: Brant Hinrichs, Drury University, bhinrichs@drury.edu

This invited panel session will bring together five experts with different theoretical perspectives for an in-depth conversation centered on a single classroom video. Focused discussion will highlight how the experts analyze compare, contrast, and compliment one another, and enable participants to see the strengths and limitations of these different perspectives in a specific context. Want to know more? Go to <http://public.me.com/ddykstra> and open the "Different Perspectives" folder to watch the actual classroom video, read its transcript, and view what each researcher will present. Come prepared to contribute to the discussion!

IF01: 1:45–3:45 p.m. Cultivating Multiple Sensitivities to Student Thinking

Panel – Andrew Boudreaux, Western Washington University, 516 High St., Bellingham, WA 98225-9164; boudrea@physics.wwu.edu

As researchers and instructors, we use observations of actions, statements, and written work to make what inferences we can about student thinking. Recent work in PER has emphasized the importance of explicit theoretical frameworks in how and what we attend to when considering such observations. This presentation will offer the perspective of a "physics-oriented" PER practitioner for whom theoretical frameworks principally offer informed modes of uncovering student thinking. In this view, a given framework is a tool for listening (or, more generally, observing) students in a certain way. The value of the framework rests in large part in its ability to contribute to the design of instructional environments and strategies that move students toward desired learning goals. This perspective will be illustrated through the analysis of video data from a Physics and Everyday Thinking class.

IF02: 1:45–3:45 p.m. "Seeing" the Development of Physical Theory in Students' Minds

Panel – Dewey I. Dykstra, Boise State University, Physics Dept., Boise, ID 83725-1570; ddykstra@boisestate.edu

We have only our experiences of students' behaviors, verbal, gestural, kinesthetic, affective, symbolic, diagrammatic, etc., from which to imagine what might be their understandings of the phenomena to which we direct their attentions. When students work alone, they are deprived of one of the necessary components for development, namely social interactions in an intellectually challenging situation. In these evidence rich settings of students constructing and mutually negotiating for meaning of physical theory for a phenomenon, we have a window on the development of physical theory in their minds. Through this window we can observe the students constructing and testing new explanations for experiences that do not fit their initial expectations about those experiences, the development of physical theory in students' minds. A video of students constructing new understanding will be used to illustrate this perspective.

IF03: 1:45–3:45 p.m. Thinking About Energy with Bodies and Objects: Cognition as a Sensorimotor and Material Activity*

Panel – Rachel E. Scherr, Seattle Pacific University, 3307 3rd Ave., West, Seattle, WA 98119; rescherr@gmail.com

Hunter G. Close, Seattle Pacific University

Sarah B. McKagan, McKagan Enterprises

The practice of using rich records of naturally occurring activities as evidence of student knowledge promotes and supports a particular point of view: that learning and expertise show best in what students do and say to learn together. This talk and action is composed of events such as gestures, facial expressions, object manipulations, and single turns at talk. Our particular analytic interest is in the ways in which our sensorimotor systems generate, display, and limit the kinds of things we think about (Lakoff and Johnson, 1999),[1] and in how material artifacts shape student interactions (). We analyze a sequence in which the construction of a whiteboard helps structure students' moment-to-moment thinking about energy. Even as social constraints limit the participants' use of their bodies, significant embodiment is involved in both what the participants say and how they say it.

1. G. Lakoff, M. Johnson, *Philosophy in the flesh: The embodied mind and its challenge to Western thought* (Basic Books, New York. 1999).

*Supported in part by NSF DRL 0822342 and the Seattle Pacific University Science Initiative.

IF04: 1:45–3:45 p.m. The Rules of Discourse In Learning Interactions

Panel – Rosemary S. Russ, Northwestern University, Learning Sciences Program, 2120 Campus Dr., Chicago, IL 60208; r-russ@northwestern.edu

When multiple people engage in conversational interaction, either casually or with a well-defined goal, that interaction is governed by a set of tacit rules that give rise to certain regularities in the conversation. There is a rich tradition of research that examines the moment-to-moment dynamics of naturally occurring talk-in-interaction—such as everyday conversation, tutoring, interviewing, and large group classroom discourse—to identify these rules of discourse. Knowing these rules for different interactions facilitates comparison across forms of talk and identification of continuities between them. In this work I use techniques from Conversation Analysis to understand the rules of discourse that govern the interaction of two students as they generate an explanation for magnetic attraction. Doing so allows me to examine which other conversational forms the interaction resembles, and thus speculate about which patterns of participation may either support or inhibit their learning in this interaction.

*Sponsored by Brant Hinrichs.

IF05: 1:45–3:45 p.m. Physics Learning as the Objectification of Discourse

Panel – Valerie K. Otero, University of Colorado, Boulder, 249 UCB, Boulder, CO 80309; valerie.otero@colorado.edu

In research on disciplinary knowledge, language is often treated as a communication medium rather than as a legitimate part of cognition. Both language and concepts are involved in the learning process, yet they are almost impossible to analytically distinguish from one another. I tackle this problem head-on using the notion of objectification of discourse to define the development of conceptual understanding. Objectification of discourse is the process that begins as an interpersonal affair and as a result, turns into a matter of one's relation with the human-independent world. This Vygotskian perspective integrates elements of a behaviorist perspective and can shed light on how learners come to understand, and participate in, the discourse of physics. Using a video snippet from a Physics and Everyday Thinking class, I will illustrate early phases of this learning process and demonstrate the interpersonal focus of students' discourse highlighting how this leads to scientific, mechanistic reasoning.

Session IG: Science and Religion

Location: Pavilion West
Sponsor: Science Education for the Public Committee
Date: Wednesday, July 21
Time: 1:45–3:45 p.m.

Presider: Olga Livanis, olivani@schools.nyc.gov

IG01: 1:45–2:15 p.m. Science and Observance: Must Traditional Judaism be Fundamentalist?

Invited – Herbert Levine, University of California, San Diego, Dept. of Physics, MC 0319, La Jolla, CA 92093; hlevine@ucsd.edu

In recent years traditional Judaism has become more fundamentalist in its beliefs about the natural world, as can be seen by controversies over comments by respected figures who have strayed from literalist interpretations of biblical pronouncements regarding questions such as the age of the Earth and the truth of Darwinian evolution. This trend dismays anyone who, like myself, tries to incorporate Jewish religious values into a world view shaped by modern scientific investigations. In my talk I will explore how the rabbinical authorities of previous generations felt about the clash between secular knowledge and Jewish traditions and how we might use some of their ideas to construct a more sensible fusion of tradition and scientific objectivity.

IG02: 2:15–2:45 p.m. An Atheist Physicist's Perspective on the Science-Religion Landscape

Invited – Matthew B. Koss, College of the Holy Cross, 1 College St., Worcester, MA 01610; mkoss@holycross.edu

It may not be possible to form a consensus view on many of the issues of science and religion. It may not even be possible to reduce the rancor between theists of a literalist/fundamentalist disposition and atheists committed to a metaphysical naturalism just short of scientism. All these noncommensurate positions, and others, are part of the science-religion landscape. Even more problematic then the mere existence of multiple entrenched positions is the frequent occasion of ad hominem and snarky comments embedded in even the most rational and polite of arguments about science and religion. This makes it difficult to recognize the claims, warrants, and reasoning in these arguments. As a committed rationalist, I want to understand the best reasons for any articulated position. To do this in science and religion, I want to make and use a good map in order to view the regions in this landscape.

IG03: 2:45–3:15 p.m. A Religious Physicist Looks at the Science/Religion Landscape

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

Science's distinctive blend of rationalism and empiricism has been experienced by many as the major source of illumination for both the practical and epistemological terrain since the beginning of the early modern period and the "Scientific Revolution." As a consequence, other approaches, notably those characterized as religious, have been seen, particularly of late, as tangential, atavistic, or irrelevant to the progress and flourishing of Western knowledge and society, in conflict with or dangerous to those enterprises. This presentation will examine some features of the topography of the interaction between science and religion by scrutinizing the basic disciplinary maps and compasses, and by exploring some characteristics of the boundaries between these regimes. The present expedition is an initial attempt to mark some dead ends, pitfalls, and impasses, as well as to check the possibilities for blazing more productive trails by employing different surveying instruments (or perhaps recalibrating the ones we have).

IG04: 3:15–3:45 p.m. Using Students' Metaphysical Beliefs as Resources in the Physics Classroom

Invited – Stamatis Vokos, Seattle Pacific University, 3307 3rd Ave. West, Suite 307, Seattle, WA 98119-1957; vokos@spu.edu

Spirituality profoundly shapes the worldviews of many people, often in more personally significant ways than do physics concepts. Many instructors, however, might feel unprepared to engage with their students' metaphysical ideas during physics class. In a multi-religious society, is it ever appropriate to engage these ideas in the classroom? How does one do so without either hijacking the classroom for religious instruction couched in scientific-sounding terms or deriding religion in the name of scientism? The author served three times as a physics instructor of Tibetan Buddhist monks in India through the Dalai Lama's Science for Monks project. He also co-teaches a course for honors students at Seattle Pacific University on the interplay of Christian thought and the emergence of natural science. In this talk, he will argue that there is great, untapped value in engaging with the learner as a spiritual being, as well as an intellectual and emotional one.

Session IH: Post Deadline I

Location: Galleria I
Date: Wednesday, July 21
Time: 9:40–11:10 a.m.

Presider: Beverly Trina Cannon, cannonb@hpisd.org

IH01: 9:40–9:50 a.m. Video Analysis Places Constraints on WTC Collapse Mechanism

David S. Chandler, Eleanor Roosevelt Community Learning Center, 31191 Rd. 180, Visalia, CA 93292; david@mathwithoutborders.com

Measurements from video analysis of the roofline of the North Tower of the World Trade Center indicate that it accelerated downward with constant acceleration until it disappeared into the cloud of debris. From the fact that the top section of the building accelerated through its collision with the lower section of the building, we can deduce that the force of interaction was less than the static weight of the top section. Some have suggested that rubble accreted to the top section would assist in demolishing the lower section of the building, but a variable mass model indicates that it in fact diminishes the ability of the top section to act as a pile driver to demolish the lower section of the building. This analysis has great significance for a major national debate, but it is within the grasp of first-year physics students.

IH02: 9:50–10 a.m. Matching How We Teach to How We Assess the Power of Context

James Finley, Rutgers University, 10 Seminary Place, New Brunswick, NJ 08901; tbartiro@gmail.com

Tara Bartiromo, Eugenia Etkina, Rutgers University

While attempting to measure student learning on the newly developed kinematics and dynamics, PUM developers created multiple-choice and open-ended assessments. Both tests assessed the same content and the multiple-choice selections included items taken from the FCI and FMCE. Results on those matching items were below expectations in some areas and showed inconsistencies in student performance on the PUM-based questions and questions of nationally recognized tests. In an effort to identify the reason for this, we analyzed the assessments and modules, specifically comparing the context of the students' learning to the assessment context. We found discrepancies between these that help explain inconsistencies in student responses. Students do well on the questions that match the learning context and much worse on the questions that do not match.

IH03: 10–10:10 a.m. Physics Concepts Instructional Approach Based on in-lab Videos

Sergio Flores, University of Juarez, Avenida del charro 450 Nte. Col. Partido Romero Ciudad Juarez Chih., Ciudad Juarez, Mexico, Chih 32310; sergiflo1@hotmail.com

Maria D. Gonzalez, New Mexico State University

Monica Quezada, Juan E. Chavez, Alejandro Sanchez, University of Juarez

Many introductory physics students have understanding problems when they try to learn physics concepts through the knowledge real representation during lab sessions. The research group named Physics and Mathematics in Context from the University of Ciudad, Juarez, Mexico, has developed an instructional approach based on videos to help students to recognize and learn the properties of concepts as forces, Newton's second law, and tension force. 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.

IH04: 10:10–10:20 a.m. Estimating the Density of a Floating Watermelon Based on Photograph

See Kit Foong, Nanyang Technological University, 1 Nanyang Walk, Singapore, 637616; seekit.foong@nie.edu.sg

Chim Chai Lim, Nanyang Technological University

Based on a photograph, the density of a watermelon floating in a pail of water is estimated with different levels of simplification—without and with considering refraction and three dimensional effects. The camera is first assumed to be located at a certain height, and then the assumption is relaxed so that the camera may be located at arbitrary height above the pail of water. The watermelon was approximated as a sphere. The result of the theoretical estimations was verified experimentally.[1]

1. S. K. Foong and C. C. Lim, "Can you tell the density of the watermelon from this photograph?", to appear in *Phys. Educ.*, May/July 2010.

IH05: 10:20–10:30 a.m. nTIPERs Part II*

Curtis J. Hieggelke, Joliet Junior College, 1215 Houbolt Rd., Joliet, IL 60431; curth@comcast.net

David P. Maloney, Indiana University-Purdue University Fort Wayne

Steve Kanim, New Mexico State University

We will describe various alternative task formats that can be used to improve student learning and understanding of physics concepts in mechanics. The exercises we have developed in these formats are based, in part, on efforts in Physics Education Research and thus are called TIPERs (Tasks Inspired by Physics Education Research). We will feature TIPERs that are being developed in the area of mechanics. The formats will include Ranking Tasks, Working Backwards Tasks, What, if anything, is Wrong Tasks, Qualitative Reasoning Tasks, Bar Chart Tasks, Conflicting Contentions Tasks, Linked Multiple Choice Tasks, Changing Representations Tasks, and Comparison Tasks.

*This work is supported in part by grants #0632963 and 0633010 from the Division of Undergraduate Education of the National Science Foundation.

IH06: 10:30–10:40 a.m. Fysics Is Phun

Mikhail Kagan, Pennsylvania State University, Abington College,1600 Woodland Rd., Abington, PA 19001; mak411@psu.edu

How to excite students' enthusiasm for a physics course? How to gently force them to find something out on their own? How to make them eager to learn something beyond the scope of the course? How many times have we asked ourselves these questions? One possible solution is to organize a physics game. While it is a shared belief that only strong students benefit from science related games, "Fysics is Phun" does not suffer from this problem. In fact, the participants are expected not to know the correct answers. "Fysics is Phun" is a team-based game in which the competitors outwit each other by creating plausible false statements and by making their rivals fall for the fakes they created.

IH07: 10:40–10:50 a.m. Shadow or Image?

Jung Bog Kim, Korea National University of Education, Dept. of Physics Education, Cheongwon, Chungbuk Korea, 363-791; jbkim@knue.ac.kr

Distinguishing shadow from image in geometrical optics may progress students' conceptions. Both shadow and image are showing shapes of an object. Because students in Korea have been taught in the same terminology for shadow and image, they have difficulties in conceptual change from misconceptions. In this paper, we will suggest some novel situations that are not easily found in the typical textbook. We will show a pinhole camera, a growing shadow, an image of shadow, and a negative object for negative or positive lenses.

IH08: 10:50–11 a.m. Feynman Diagrams

George E. Kontokostas, PARTHENONOS, ATHENS, 175 62; gakon67@hotmail.com

Purpose: Teaching Feynman diagrams with interactive technology. *Results:* Understanding how the diagrams work. Using simple rules we can teach how the particles interact and we can predict their formation. Using special pedagogical methods and with the help of technology, we note that the most students were able to design the three interactions and to predict the formation of some particles.

IH09: 11–11:10 a.m. The Etymology of Physics – Why Does this Symbol Stand for that?

James J. Lincoln, Tarbut V'Torah High School, 5 Federation Way, Irvine, CA 92603; ihatephysics@gmail.com

Why do we use h for Planck's constant, or I for current? What does the "a" in F=ma really stand for? Who decided, and when, to use c for the speed of light? I have done some historical research on several symbols and constants, tracking down when they first appeared in literature and what they actually stand for. The results have been enlightening and that they will help both teachers and students understand the meaning behind the choice for the symbols we use.

Session II: Post-Deadline Session II

Location: Broadway I/II
Date: Wednesday, July 21
Time: 1:45–3:45 p.m.

Presider: John Roeder, Calhoun School, New York, JLRoeder@aol.com

II01: 1:45–1:55 p.m. Problems Without Borders

Michael B. Partensky, Brandeis University, Dept. of Chemistry and Rabb School of Graduate Studies, 415 South St., Waltham, MA 02454; partensky@gmail.com

The increasing role of interdisciplinary studies in science and technology can be addressed in introductory physics by offering the problems transcending the boundaries of the educational topics and subjects. As an example, we discuss a classical localization problem, pinpointing a radioactive source using an array of detectors.[1,2] It involves aspects of physics, geometry, statistics, and engineering, all integrated with Mathematica -based computer simulations. This conceptually transparent discussion can lead to interesting student research projects. Their challenges and insights include the computer modeling, dealing with the non-uniqueness of the inverse detection problem, an analogy between its geometric interpretation (circles of Apollonius) and method of image charges (electrostatics), and the role of fluctuations.

1. J. Cox and M.B. Partensky, arXiv: physics/0701146v10.
2. M.B. Partensky, *Phys. Teach.* **46**,104 (2008).

II02: 1:55–2:05 p.m. Computer Simulations in Promoting Physics in Jamaica

CANCELED

Michael Ponnambalam, University of the West Indies, Physics Dept., Kingston, Jamaica 00007; 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 an 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 Virtual Lab in promoting the teaching of physics to the university students as well as in enhancing physics outreach to high schools, and even the primary schools, will be discussed.

II03: 2:05–2:15 p.m. Pre-MAP: Increasing Undergraduate Diversity Through Research

Philip Rosenfield, University of Washington, Dept. of Astronomy, Box 351580, UW, Seattle, WA 98195-1580; philrose@astro.washington.edu

Eric Agol, University of Washington, Dept. of Astronomy

The Pre-Major in Astronomy Program (Pre-MAP) is a research and mentoring program for freshmen, introducing them to astronomy research during their first quarter, followed by mentoring, research opportunities, and community building, with the goal of having under-represented students choose astronomy and STEM majors. We present best-practices to make this accessible to the astronomy community and beyond, including instruction on how to create and run a Pre-MAP course, exercises from the course, how to recruit research mentors, how to make web pages for the program, and much more.

II04: 2:15–2:25 PM nTIPERs Part 1

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

Curtis J Hieggelke, Joliet Junior College

Steve Kanim, New Mexico State University

TIPERs (Tasks Inspired by Physics Education Research) support active learning approaches and can be easily incorporated into instruction in small pieces. One focus of TIPERs is making connections between the mathematical formalism of introductory physics and the underlying physics concepts. These tasks are intended to help students make sense of the equations they are using rather than just using these equations algorithmically. Other TIPERs focus on conceptual issues students struggle with. These tasks help students to think about fundamental concepts in alternative and multiple ways in order to promote robust learning. This talk will show how students handle several tasks.

*This work is supported in part by grants #0632963 and 0633010 from the Division of Undergraduate Education of the National Science Foundation.

II05: 2:25–2:35 p.m. Average Annual Ionizing Radiation Received by a U.S. Resident

John E. Tansil, Southeast Missouri State University, Physics & Engineering Dept., One University Plaza, Cape Girardeau, MO 63701; jtansil@semo.edu

Over the last 25 years, the average annual effective dose of ionizing radiation per individual in the U.S. population has increased by 70% from 3.6 mSv to 6.2 mSv. Almost all of this increase is due to the increasing use of ionizing radiation in diagnostic and interventional medical procedures which currently account for 50% (3.1 mSv) of the total radiation dose. The other contribution to the total dose is from background radiation with radon the primary contributor (2.3 mSv) and smaller contributions from internal radioactive nuclei (0.4 mSv) and other sources. We will discuss the contributions to the total radiation dose from the standpoint of presentation to pre-health professional students.

*Ionizing Radiation Exposure of the Population of the United State*s, Report No. 160, National Council on Radiation Protection and Measurements, Bethesda, MD, 387pp. (2008).

II06: 2:35–2:45 p.m. Interactive Introductory College Physics Education with Clickers

Serif Uran, Pittsburg State University, 1701 S. Broadway St., Pittburg, KS 66762; suran@pittstate.edu

Classroom Performance Systems, Student Response Systems, or Audience Response Systems allow instructors to receive immediate feedback from students wirelessly with the use of small handheld devices commonly referred to as clickers. Many universities have been using these systems in different subjects. I started using clickers in my College Physics I and Engineering Physics II classes to promote participation and learning about four years ago. I would like to provide some quantitative and qualitative information about their benefits and drawbacks in moderate to large introductory physics classes at Pittsburg State University.

II07: 2:45–2:55 p.m. Connecting Everyday Life to Theory in Upper-Level Electricity and Magnetism

Amelia G. VanEngen Spivey, University of Puget Sound, 1500 N. Warner St., #1031, Tacoma, WA 98416-1031; aspivey@pugetsound.edu

Randy Worland, University of Puget Sound

Students often find it difficult to connect the physical ideas encountered in lecture-based physics courses to their everyday lives. We discuss a variety of techniques that can be used in the upper-level electricity and magnetism course to combat this perceived disconnect between physical theory and "real world" experience. This presentation includes descriptions of classroom activities (such as films and lecture demonstrations) and student assignments (such as student presentations, research papers, and experimental laboratory projects). Over the past five years, we have used these techniques to supplement traditional lectures in the upper-level electricity and magnetism course at a small liberal arts college. We find that strengthening the ties between everyday life and electromagnetic theory increases student engagement and seems to enhance students' understanding of the key course concepts and their applications.

II08: 2:55–3:05 p.m. Electromagnetic Induction Lab with a Falling, Oscillating and Swinging Magnet

Darren J.S. Wong, National Institute of Education, Nanyang Technological University, Singapore, Blk 142 Marsiling Rd. #10-2094, Singapore,

730142; darren.wong@nie.edu.sg

See Kit Foong, Paul C.K. Lee, National Institute of Education, Nanyang Technological University, Singapore

We investigate the electromagnetic induction phenomenon by a falling, oscillating, and swinging magnet and a coil, with the help of a datalogger. For each situation, we discuss the salient aspects of the phenomenon, with the aid of diagrams, and relate the motion of the magnet to its mathematical and graphical representations. Using the various representation modes to guide student thinking on how the variation of the magnetic flux can be used to predict the induced emf should help students develop a deeper and more coherent conceptual understanding of the phenomenon.[1]

1. D. Wong, P. Lee & S. K. Foong, "Datalogger Demonstration on Electromagnetic Induction with a Falling, Oscillating and Swinging Magnet", to appear in *Phys. Educ.*, July 2010.

II09: 3:05–3:15 p.m. Physics from the News: The Deepwater Horizon Disaster

Albert A. Bartlett, University of Colorado, Boulder, CO 80309-0390; Albert.Bartlett@Colorado.EDU

A surprising (at least to me) phenomenon from hydrostatics may have played a key role in initiating the blowout and fire, April 20, 2010, that burned for two days before sinking the drilling ship, the Deepwater Horizon, resulting in a large and environmentally destructive oil spill in the Gulf of Mexico.

II10: 3:15–3:25 p.m. Basic Concepts in Nuclear Science Illustrated Through Experiments with Radon

Eric B. Norman, University of California, Dept. of Nuclear Engineering, Berkeley, CA 94720; ebnorman@lbl.gov

Christopher T. Angell, Alexis C. Kaplan, John D. Seelig, Marisa Pedretti, Lawrence Livermore National Laboratory

Introductory lecture courses in nuclear science discuss the concepts of alpha-, beta-, and gamma-decay, the exponential nature of the radioactive decay law, secular equilibrium, and the naturally occurring decay chains. For many students, these concepts can seem very abstract and difficult to make use of in solving problems. To help make these ideas more concrete, we have developed several simple experiments based on the decays of naturally occurring radon isotopes and their daughters. The sources of radon we use are readily available without any licensing requirements. These experiments can be performed at several different levels of sophistication depending upon the equipment that is available. The results of experiments performed with Geiger counters, silicon surface barrier detectors, and high-purity germanium detectors will be described.

II11: 3:25–3:35 p.m. High School Students + Meade LX200 + DSLR = Astrophotography

Michael E. Bait, Granville High School, 248 New Burg St., Granville, OH 43023; mbait@laca.org

To help my high school students learn about the sky, I have given planetarium shows, I have used various animation and demonstration tools in the classroom, and I have had students take part in observations. Because observations were so well received, I decided to expand this experience by having students do astrophotography. Students have imaged double star systems, open clusters, globular clusters, nebulae, and galaxies. Each session students mounted the 8-in Meade on a permanent pier, focused the scope, made preparations for imaging one object for the night, and took around 100 30-second exposures. The next day they used Images Plus software to calibrate, align, and stack those exposures. After further digital processing, students produced their final image and were required to write a paragraph about the object. They then used Photoshop to combine their paragraphs with their image and created posters.

II12: 3:35–3:45 p.m. Beyond Cognitive Load and Dual Coding: Some Thoughts on the Current Theory of Multimedia Learning as Applied to Physics

Zhongzhou Chen, 1110 West Green St., Urbana, IL 61801; zchen22@illinois.edu

Current multimedia learning theories, based on cognitive load theory and dual coding theory, are able to provide us with a set of concrete multimedia design principles. However, these theories face certain challenges as well as limitations when applied to complex domains such as physics. From a theoretical perspective, current theory fails to provide a specific description of the integration of different modalities. From a practical perspective, current design principles are insufficient to determine the detailed quality of audio and visual representations, thereby providing minimal guidance for improving the quality of multimedia materials. In an attempt to overcome these limitations, we turn to one of the latest developments in cognitive science: grounded cognition. Grounded cognition resolves the "integration difficulty" by assigning different roles to audio and visual modals, and is capable of providing much more detailed guidance for improving the quality of multimedia instruction design. Initial experiments on the use of grounded cognition in introductory physics instruction will be discussed.

Session IJ: Post-Deadline Session III

Location: Galleria I
Date: Wednesday, July 21
Time: 1:45–2:35 p.m.

Presider: TBA

IJ01: 1:45–1:55 p.m. Undergraduate Research Experiences in Astroparticle Physics with U.S. Underground Laboratories

Michael Dragowsky, Case Western Reserve University, 10900 Euclid Ave., Cleveland, OH 44106; dragowsky@case.edu

Daniel Akerib, Case Western Reserve University

Peggy Norris, Sanford Underground Science and Engineering Laboratory

Research in astroparticle physics has a strong allure for the general public, and this carries over into REU and internship programs, as well as attracting enrolled undergraduate students to join research groups. A challenge of providing meaningful research experiences are the inherently multi-year time scale for conducting astroparticle physics experiments, and that the experimental sites are seldom at the home institution. This paper will illustrate how the challenge is met at Case Western Reserve University, considering projects with short horizons that are necessary for summer REU students and longer term projects for senior project theses. In addition, engagement of physicists in outreach programs at the Soudan Underground Laboratory in Minnesota and the recently formed Sanford Underground Laboratory in South Dakota will be discussed.

IJ02: 1:55–2:05 p.m. Deconstructing the Organization Used by U.S. Physicists Teaching Energy with a Case Study Collaboration in Africa

Abigail R. Mechtenberg, University of Michigan, 450 Church St., Randall Laboratory, Ann Arbor, MI 48105; amechten@umich.edu

Traditionally physicists begin teaching energy within the contextual organization of potential energy, kinetic energy, and work. Many months later if students survive the course, they are then introduced to electrical energy. This organization transcends almost all physics education research (PER) paradigms. Although this makes sense from a historical organization of facts as well as from a behaviorists' and/or constructivists' theoretical framework, this is not necessary (and can be detrimental) from a socio-constructivism view as well as potentially unethical from a science, technology, and society (STS) perspective for Africa. This oral presentation will describe the STS setting for an African-based physics of energy textbook. Weaved into the textbook is how students construct their understanding of energy through designing electricity producing devices in the classroom laboratory as well as the applying-the-knowledge garage building prototypes.

IJ03: 2:05–2:15 p.m. Gateway to Physics: A Curricular Approach to Recruiting and Retaining Physics Majors

Cherilynn A. Morrow, Georgia State University, Dept. of Physics & Astronomy, 29 Peachtree Center Ave., Atlanta, GA 30303; cmorrow@gsu.edu

Brian D. Thoms, Georgia State University

This paper describes the research and evaluation plan for a newly approved two-credit seminar course entitled Gateway to Physics. The course has no prerequisites and is intended to recruit and retain physics majors by reaching out to freshmen and sophomores who express interest or declare a major in physics. The Gateway course (taken before the introductory sequence) is intended to counter the more typical gatekeeper effect of early science classes that tend to filter out a significant and more diverse talent pool from the STEM disciplines. Several faculty members and community-based professionals will serve as guest presenters to: 1) share the excitement and relevance of physics as a lens for understanding the natural world; 2) survey the evolution of ideas in physics from ancient to modern times; 3) explore compelling interconnections between physics and other disciplines; and 4) see the study of physics as a distinguishing preparation for a variety of professions, including medicine, law, art, business, and education. We will use a broad spectrum of popular resources and experiential opportunities to fulfill course objectives.

IJ04: 2:15–2:25 p.m. Development of Scientific Reasoning in Traditional vs. Inquiry-based Physics

Bruce R. Patton, The Ohio State University, Dept. of Physics, Columbus, OH 43210; patton.1@osu.edu

Jennifer Esswein, The Ohio State University

Growth in scientific reasoning ability was measured in four pedagogically different introductory physics courses at a large Midwestern university. ANOVA was used to examine differences in reasoning ability change between the courses, in addition to examining the relationship between degree of student involvement in various course components and increase in thinking skills as they relate to learning science. The inquiry-based course held the largest gains, while more traditional approaches showed no statistically significant changes from pre to post. The comparison of the inquiry-based learning environment and the more traditional lecture approaches will be presented. Findings help identify the desired features that will aid teachers in producing an effective classroom strategy.

IJ05: 2:25–2:35 p.m. Teaching Physics with Clickers at Savannah State University

Pengfei Li, Savannah State University, Drew-Griffith 219, Savannah, GA 31404; lipengf@savannahstate.edu

Jonathan Lambright, Savannah State University

At Savannah State University (SSU), a Historical Black College and University (HBCU), an in-class response system (clicker) was used in an algebra-based physics introductory course. Two types of clicker questions: "easy-hard-hard" series and "rapid fire" series, were designed to improve students' interaction in class and help students understand physics concepts. Students like using clickers and feel more engaged in lectures after using them. In this talk, the preliminary results of this study will be discussed.

Session JA: PERC Bridging Session

Location: Grand Ballroom II
Sponsor: Research in Physics Education Committee
Date: Wednesday, July 21
Time: 4–5:30 p.m.

(Moved to Pavilion East)

Presider: Paula Heron, University of Washington, pheron@phys.washington.edu

JA01: 4–4:30 p.m. Why Science as Pursuit Should Have Priority in Elementary School

Invited – David Hammer, University of Maryland, Physics and Curriculum & Instruction, Deptof Physics, College Park, MD 20742; davidham@umd.edu

Research and development in early science education has reflected the pedagogical common sense that learning begins with basic ideas and progresses from there. In math, children first learn counting, then addition and subtraction, etc. The challenge for science educators has been to develop a workable sequence in science, in part because "basic" concepts in science (e.g. energy) are difficult for their subtlety. In this talk, I will contest that common sense and argue that the priority in elementary science should be on students' pursuit of coherent, mechanistic understandings of natural phenomena. First, students must assemble and disassemble ideas such as energy many times over their careers; they should learn to do that with ideas. Second, focusing on canonical concepts has led students and teachers to practices at odds with science, including assessing the quality of ideas by their fit with authoritative accounts rather than by their fit with available evidence.

JA02: 4:30–5 p.m. Rethinking Our Goals: What Will Our Students Remember When They Forget Everything?

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

The question of the purpose of education is similar to the question about the purpose of life: it is difficult to keep the answer in mind when one is submerged in everyday routines and minor distractions. But if we stop briefly while grading an exam, preparing a lab, or running a review session and ask ourselves what students will remember 20 years from now, the question and its answer might change completely what we do every day. Our PER group has tried to answer this question and as a result we are changing our approach to teaching introductory physics. We still want students to understand electromagnetic induction and thin lenses; but a larger goal is to empower them with the understanding of reasoning processes that help them make independent decisions and solve complex problems in their future lives. I will share the successes and challenges of this work.

JA03: 5–5:30 p.m. Development of Functional Understanding in Physics: Promoting Ability to Reason*

Invited – Lillian C. McDermott, University of Washington, Box 351560, Seattle, WA 98195; lcmcd@phys.washington.edu

A functional understanding of a concept in physics connotes the ability to interpret and apply it appropriately. The need to help students learn how to do the requisite reasoning is often ignored in introductory physics, a neglect that often continues in upper division courses. The emphasis in most recent research at the university level has been on the qualitative understanding of concepts, models of student thinking, and problem solving ability. These are all important, but there is also a need to conduct research to guide the development of instructional materials that promote the development of basic scientific reasoning skills (e.g., interpretation of proportions, construction of proper analogies, control of variables, use of limiting arguments, deductive and inductive logic). Examples will illustrate how the study of physics can cultivate ability in scientific reasoning.

*The research and related curriculum development discussed in this presentation have been supported, in part, by a series of NSF grants, of which the most recent are: DUE #0618185 and DR-K12 #0733276.

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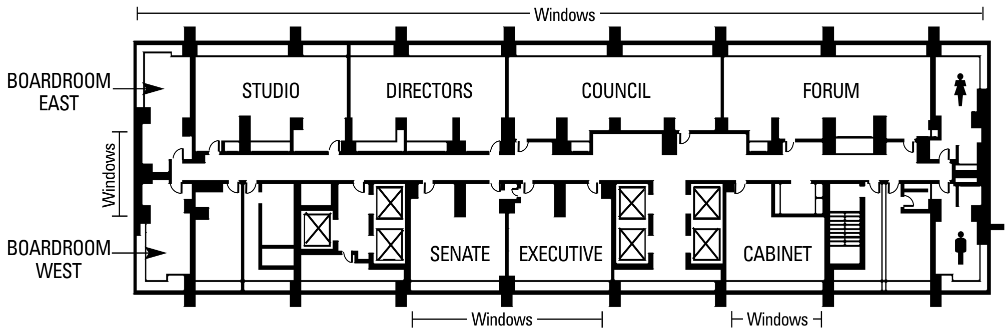

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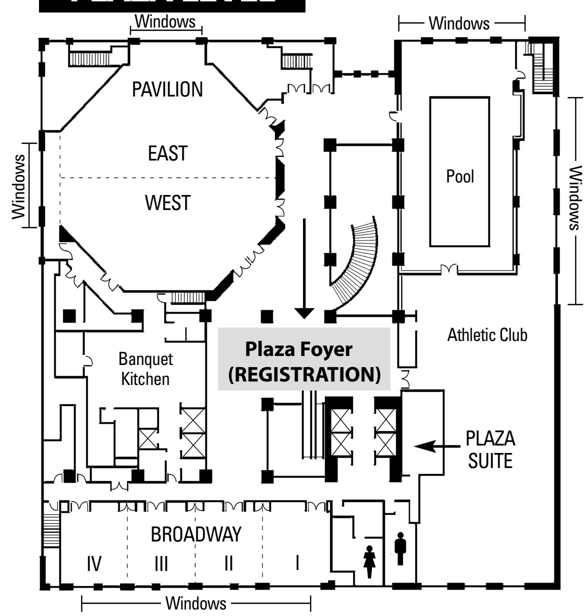

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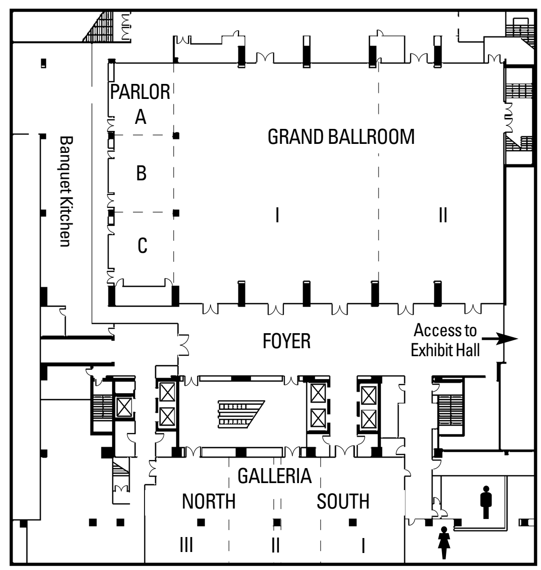

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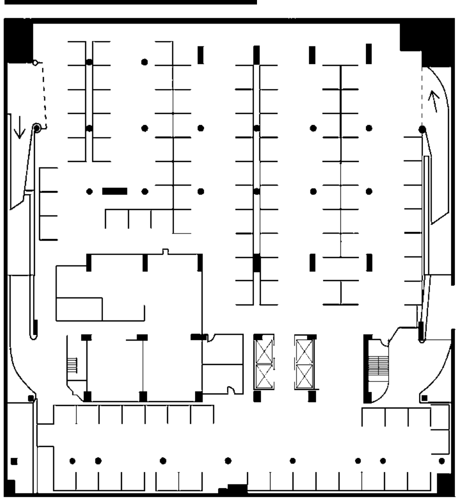

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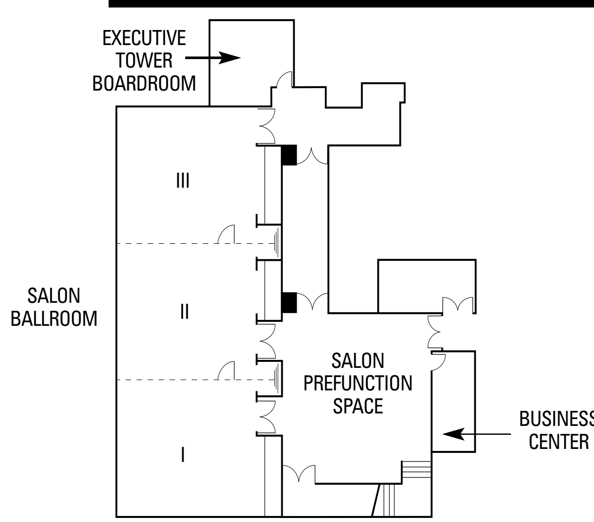

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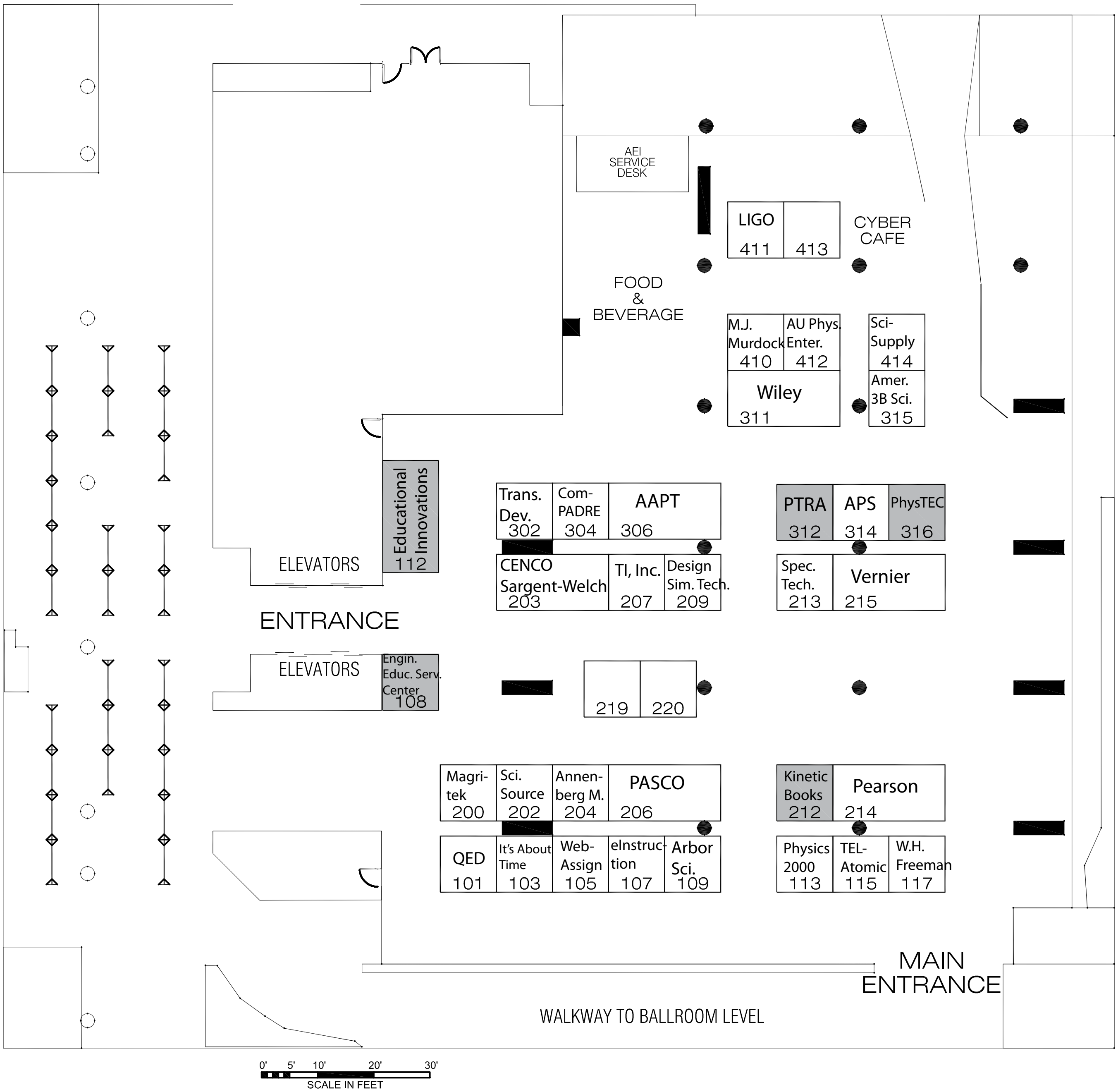

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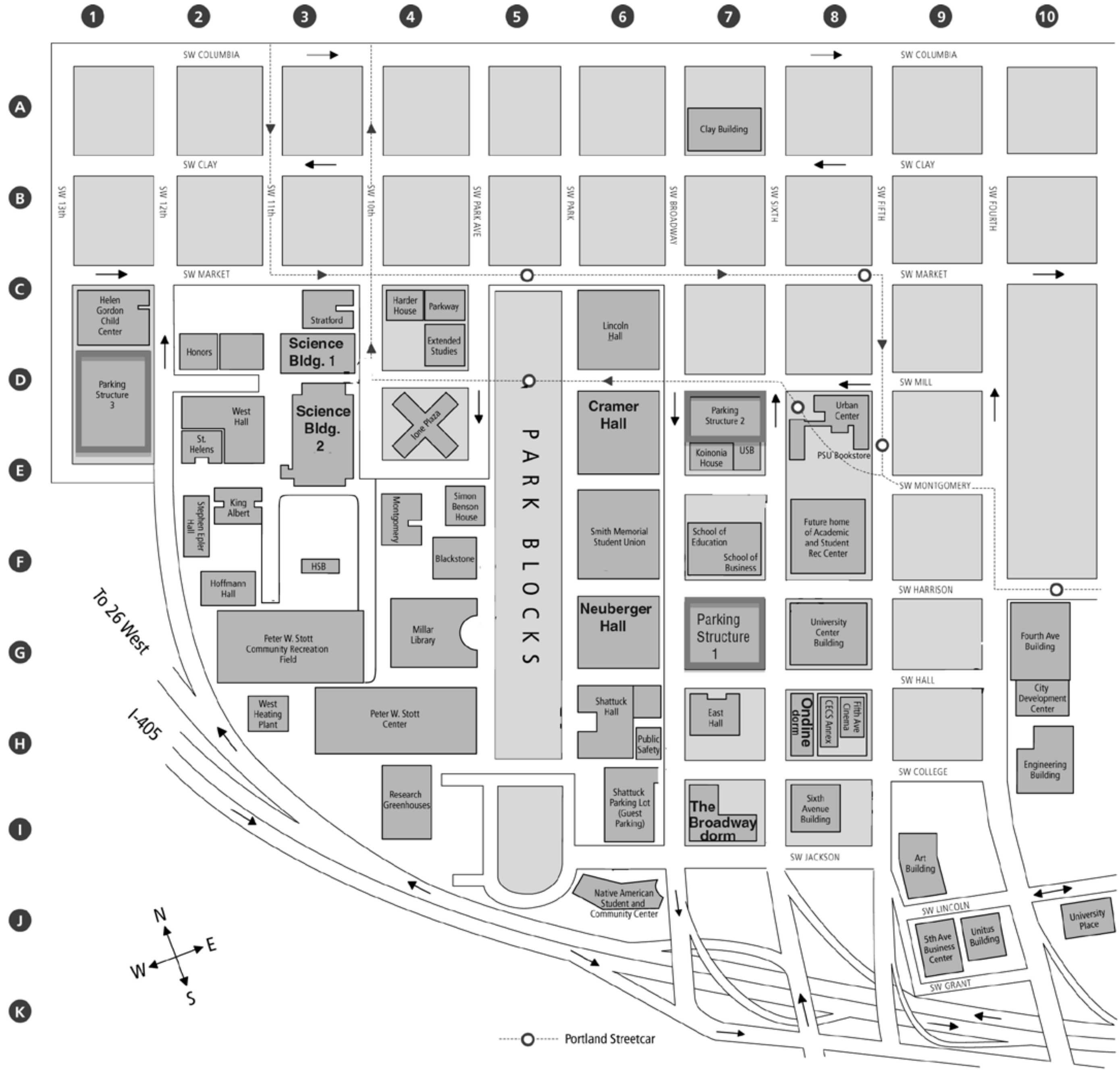
Portland State University Map



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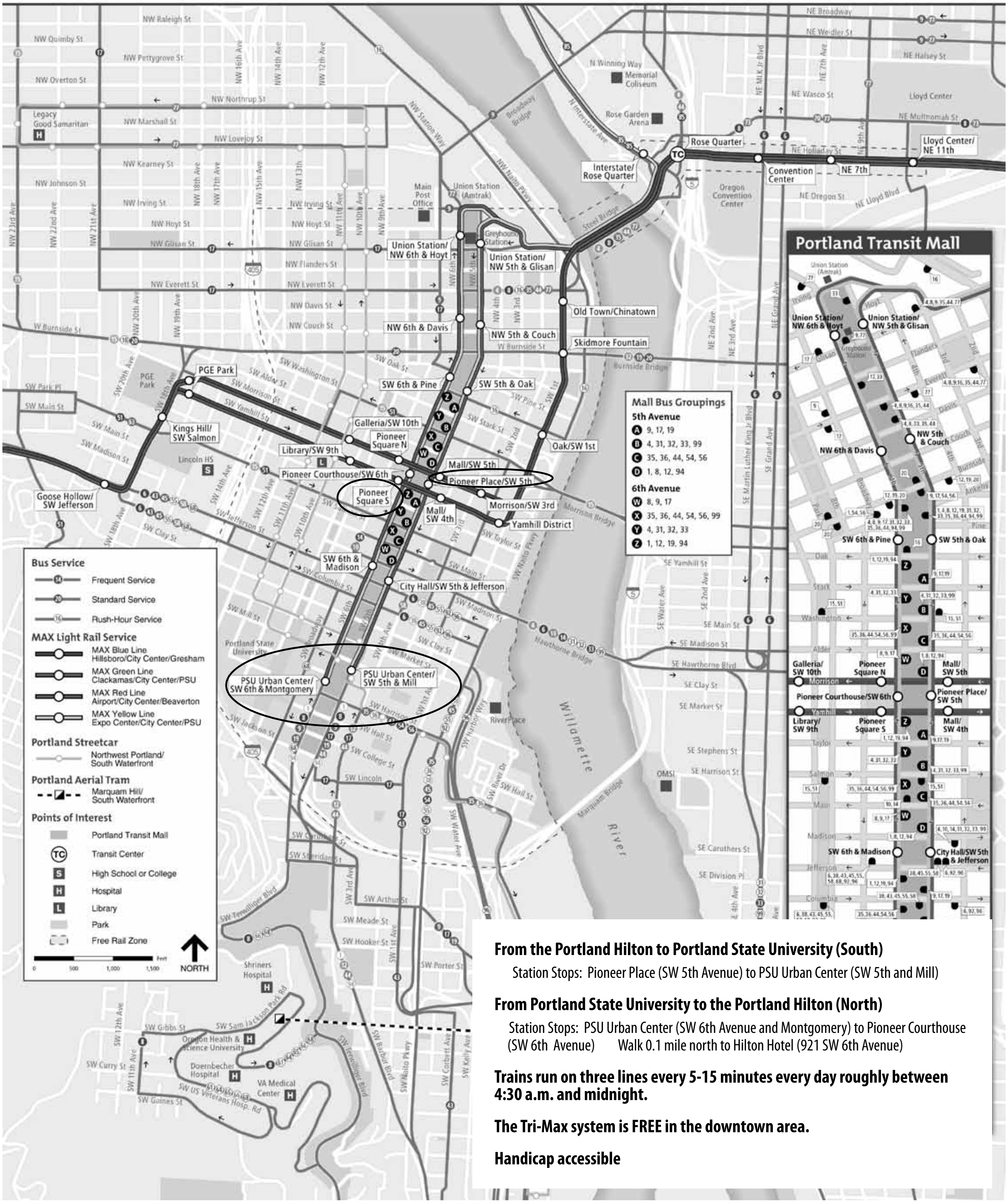

From the Portland Hilton to Portland State University (South)

Station Stops: Pioneer Place (SW 5th Avenue) to PSU Urban Center (SW 5th and Mill)

From Portland State University to the Portland Hilton (North)

Station Stops: PSU Urban Center (SW 6th Avenue and Montgomery) to Pioneer Courthouse (SW 6th Avenue) Walk 0.1 mile north to Hilton Hotel (921 SW 6th Avenue)

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