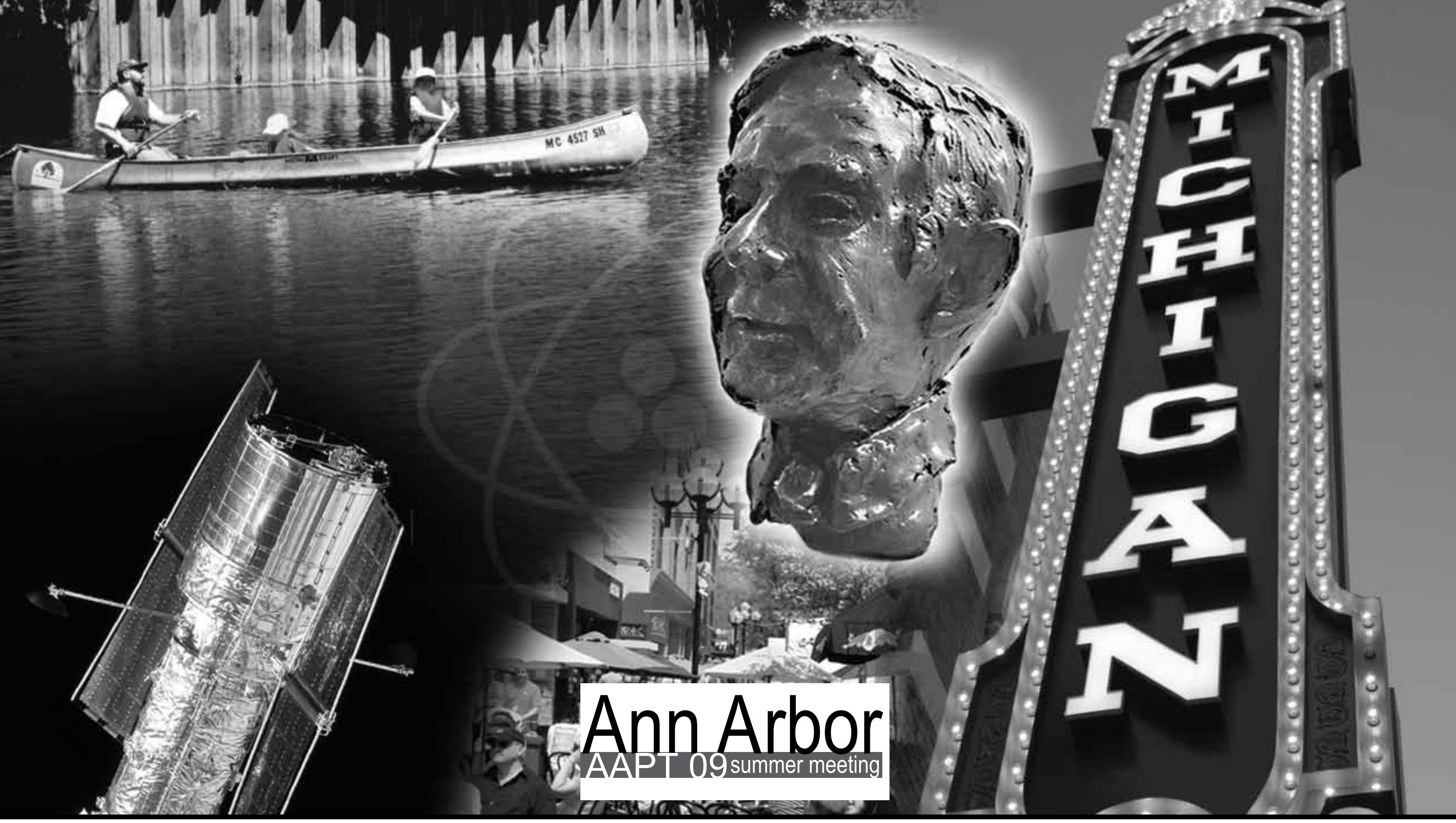

AAPT 2009
Summer Meeting

July 25–29
University of Michigan
Ann Arbor

www.aapt.org

AAPT
PHYSICS EDUCATION

American Association of Physics Teachers
One Physics Ellipse
College Park, MD 20740
301-209-3300, fax: 301-209-0845
meetings@aapt.org, www.aapt.org

Welcome to Ann Arbor and the University of Michigan!

This summer's AAPT meeting offers about three dozen workshops and seven dozen sessions on a wide variety of topics; the apparatus, photo, and video contests; exhibits by numerous vendors of books and equipment; the traditional picnic and demo show; and the great book give-away. In addition (and of particular importance), 18 area committee meetings offer attendees an invaluable opportunity to contribute to the planning of next summer's meeting in Portland, OR. Attendance at these meetings is not limited to members of the committees. All interested persons are invited to join committee members in laying out the workshops and sessions to be proposed for the meeting in Portland.

Officially, the theme of this meeting is *Discovering the Universe: From Democritus and Galileo to Fundamental Particles and Cosmology.* This theme is broad enough to cover nearly all aspects of our common endeavors but also precise enough to convey a particular focus on the ways in which we come to know the physical world from its very largest to its very smallest components. Together, this guide and the supplementary addendum available at registration provide details on the specific events and opportunities available to you at this meeting.

Any meeting will be still-born without the dedicated and diligent contributions of many, many individuals. Profound thanks are due to the area chairs and area committees, to the organizers of and presiders at events, to the invited speakers and those who have contributed talks and posters, to the exhibitors, and—most of all—to the program sorters (Kathy Harper, Richard Flarend, David Sokoloff, Myron Campbell), to the AAPT staff in the Conferences and Programs Department (Tiffany Hayes, Cerena Cantrell, Janet Lane, Natasha Randall, and Annette Coleman), to the AAPT staff in the Communications Department (Marilyn Gardner, Jane Chambers, Terrence Hunt, Matthew Payne, and Chad Phillips), and to Myron Campbell and his colleagues at the University of Michigan. Please make it a point to thank any of these individuals you happen to see, and especially to thank those at the registration desk for their devoted service in making the meeting a success.

Enjoy the meeting and—time permitting—Ann Arbor and environs. I guarantee that, wherever your interests lie in the K-20 spectrum, whatever subareas of physics excite you, whether your interests are in physics, astrophysics, physics pedagogy, theory, experiment, or …, you will find more than enough in this meeting to keep you busy and make your attendance worthwhile.

Sincerely,

David M. Cook

AAPT President-Elect and 2009 Program Chair

First time at an AAPT meeting?

Welcome to the Ann Arbor AAPT Summer Meeting! 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 ideas and experiences. This is especially true during lunch and dinner.
- Area Committee meetings are not only for members of the committee but also for friends of the committee. You are welcome to attend any Area Committee meeting. You should be able to find one or two committees that match your interests. Their meeting times are listed on page 20 in this guide. Area Committee meetings are often relatively small and are a great place to meet other people with interests similar to yours.
- Be sure to attend the First Timers' Gathering from 7–8:30 a.m. on Monday in MI League, Koessler. 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, which will be up all day and at which presenters will be stationed during times indicated in the schedule, and 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.

Special Thanks:

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

Paper Sorters: Myron Campbell, Richard Flarend, Kathy Harper, and David Sokoloff

Our local organizer: Myron Campbell, chair, University of Michigan Physics Department, and staff

AAPT Executive Board

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Seminole Community College
Sanford, FL

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Editor, *The Physics Teacher*

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

Warren Hein (ex officio)
AAPT Executive Officer

AAPT Sustaining Members

ALTAY Scientific Spa
American 3B Scientific
Arbor Scientific
AU Physics Enterprises
Carolina Biological Supply Co.
Design Simulation Tech, Inc
Educational Innovations, Inc.
Heliocentris Energy Systems, Inc.
Johns Hopkins Univ. Center for Talented Youth
Kinetic Books
Klinger Educational Products Corp
PASCO Scientific
Pearson
Physics Academic Software
Physics2000.com
Rice University
Sargent Welch CENCO Physics
School Specialty Science
Spectrum Techniques LLC
SVS Labs
TeachSpin Inc
Tel-Atomic Inc
The Science Source
Vernier Software
W H Freeman & Company
WebAssign
Ztek Co.

Meet with an Executive Board Member

During the times of the exhibits, one or more members of the AAPT Executive Board will be at the AAPT booth in the Exhibit Hall on a schedule that will be posted at the booth. Any attendee wishing to meet and talk with a representative of the Board is invited to stop by the AAPT booth during one of the posted times.

UM Plans Carillon Concert for AAPT

WHEN: Tuesday, 7–7:30 p.m. during the summer picnic.

WHERE: Burton Memorial Carillon Tower, located near Michigan League and can be heard from Rackham, where the picnic will be held. The observation deck and bellchamber will be open to conference attendees.

WHAT: A carillon is a musical instrument consisting of at least two octaves of carillon bells arranged in chromatic series and played from a keyboard that permits control of expression through variation of touch.

AAPT Programs and Conferences Team

Contact: Tiffany Hayes, Cerena Cantrell, Natasha Randall, Janet Lane, and Annette Coleman; meetings@aapt.org.

The office phone number for AAPT in the Michigan League, Kalamazoo room is 743-647-8440.

For emergencies, please call the Michigan League information desk's phone number, 734-647-5343.

meeting bus schedule

AAPT will provide daily shuttle bus service from the hotels to the University of Michigan Campus. The buses will run a continuous loop according to the schedule below. They will be labeled Shuttle.

Bus Pick Up Hotel stops: (1) Four Points Sheraton and (2) between Holiday Inn and Kensington Court

Bus Drop Off on Campus: Across from Michigan League (south side of street)

Bus Pick Up on Campus: Across from Michigan League (north side of street)

Friday, July 24

5:30 p.m. – 8:30 p.m.

Saturday, July 25

6:30 a.m. – 9:30 a.m.

11:00 a.m. – 3:00 p.m.

5:00 p.m. – 7:00 p.m.

Sunday, July 26

6:30 a.m. – 9:30 a.m.

11:00 a.m. – 2:00 p.m.

5:00 p.m. – 11:00 p.m.

Monday, July 27

6:30 a.m. – 9:30 a.m.

11:00 a.m. – 2:00 p.m.

6:00 p.m.– 11:00 p.m.

Tuesday, July 28

6:30 a.m.– 9:30 a.m.

11:00 a.m. – 2:00 p.m.

6:00 p.m.– 11:00 p.m.

Wednesday, July 29

6:30 a.m. – 9:30 a.m.

1:00 p.m. – 4:00 p.m.

PER – Wednesday, July 29

8:00 p.m. to 11:00 p.m.

PER – Thursday, July 30

7:30 a.m. to 9:30 a.m.

Visit the Exhibit Hall

Stop by our Exhibit Hall, located on the 2nd floor of the Michigan League, and visit our many physics company exhibitors (see p. 21), and take advantage of their products and expertise.

Hours: Sunday: 8–10 p.m. and Monday & Tuesday: 10 a.m.–6 p.m.

Exhibit Hall Snacks

Monday

10 a.m.– Coffee and Assorted Muffins

5–6 p.m. – Happy Hour (Mojito Punch)

Tuesday

10:00 a.m.– Coffee and Fresh Baked Scones

5–6 p.m. – Happy Hour (Sangria Punch)

Look for *AAPT'S CYBER CAFE* open during the regular Exhibit Hall hours.

located in the Michigan Room

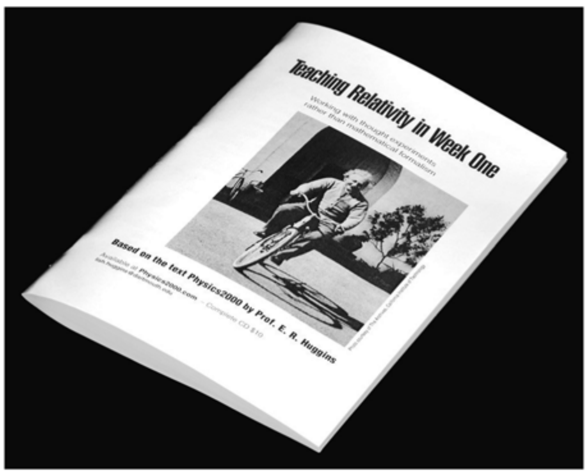
Watch for a lunch cart outside the Exhibit Hall each day where lunches can be purchased.

It's not your grandfather's physics text.

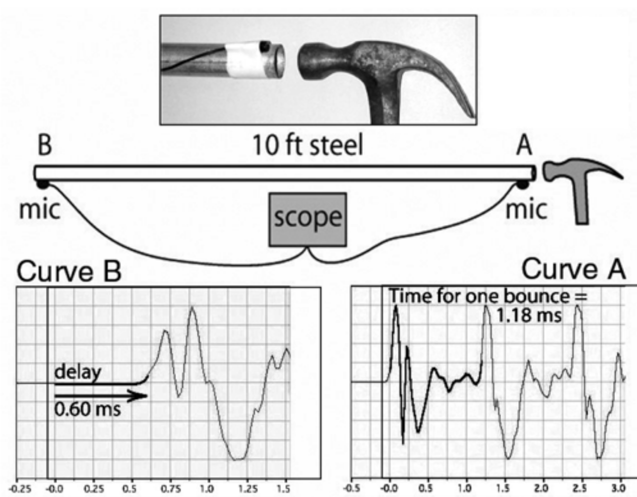
Physics2000 non calculus

Four years in development and class testing.
Available July 15, 2009. *(See us at booth #25.)*

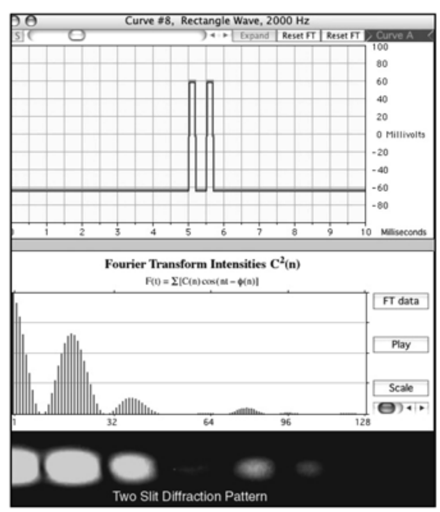
Free Workshop: Physics2000.com
Monday Noon 12:00 - 2:00 PM Room USB 1250



Come to the popular Physics2000 workshop where you learn how to include 20th century physics in the basic Introductory Physics course. This is done by starting with **Special Relativity** in Week 1, using thought experiments rather than mathematical formalism. For example, you can easily show that, by combining the already familiar **Lorentz contraction** with **Coulomb's law,** you end up with the **Magnetic Force law**, **Maxwell's formula for the speed of light** and the **formula for the magnetic field of a current in a straight wire**.



Speed of Sound in a Steel Pipe
Using MacScope's stereo input, we find that a sound pulse travels down a 10 ft. (3.048m) steel pipe in .60 milliseconds.



Fourier Optics
The Fourier transform of a slit structure is proportional to the diffraction pattern.

Attendees receive complimentary copies of the Physics2000 CD and texts.

About Ann Arbor

Photos: Ann Arbor Area CVB

Ann Arbor was founded in 1824 when John Allen and Elisha Rumsey left Detroit on a one-horse sleigh and headed west to establish a new community. Originally registered as Annarbour, it is believed that the "Ann" honors their wives Ann and Mary Ann and "arbour" refers to a grove or shady opening found in the Michigan woods. Eventually, the words were separated and the town became known as Ann Arbor—it remains the only city in the world with that name.

Ann Arbor is home to the University of Michigan, which moved from Detroit to Ann Arbor in 1837. One of the top public universities in the world, the university provides Ann Arbor with a distinct college-town atmosphere. It also shapes Ann Arbor's economy, employing about 38,000 workers, including about 7,500 in the medical center. The city's economy is also centered on high-technology, with several companies drawn to the area by the university's research and development capacity.

Ann Arbor is about 25 miles west of Detroit, is situated on the Huron River, and is surrounded by an agricultural and fruit-growing area. Called "Tree Town," the city has more than 50,000 trees along city streets and in its parks.

Things to Do

Ann Arbor Art Center: 117 W. Liberty St., Ann Arbor. The Art Center is located in the historic Walker Building in downtown Ann Arbor. The former carriage factory has been renovated to include exhibition, retail sales and instructional space.

Ann Arbor Hands-On Museum: 220 E. Ann St., Ann Arbor, 734-995-5439, www.aahom.org.
Ignite your imagination! Explore nine unique galleries containing more than 250 interactive exhibits. Learning made fun for all ages in an informal environment where hands-on experience is the best teacher.

University of Michigan Nichols Arboretum
Washington Hgts. @ Nichols Dr., Ann Arbor, 734- 647-7600 http://sitemaker.umich.edu/mbgna. The Arb, near U-M hospital and downtown, offers trails, riverfront, and peony and lilac gardens.

Exhibit Museum Planetarium: The Exhibit Museum Planetarium, located at the Museum of Natural History on University of Michigan's campus, has served as an astronomy resource for the community since 1958. They offer star talks about the current night sky each season and programs on contemporary topics in astronomy for the general public. –Weekday shows July 1–Aug. 28. Planetarium cost is $4.75 for adults, seniors and children. Museum is free.

Henry Ford Museum: 20900 Oakwood Blvd., Dearborn, MI, 313-982-6001. The nation's "largest indoor-outdoor history museum" complex is named for its founder, the noted automobile industrialist, Henry Ford. Based on his desire to preserve items of historical significance and portray the Industrial Revolution, the property houses a vast array of famous homes, machinery, exhibits, and Americana. The collection contains many rare exhibits including JFK's presidential limousine, Abraham Lincoln's chair from Ford's Theatre, Thomas Edison's laboratory, the Wright Brothers' bicycle shop, and the Rosa Parks bus.

Michigan League Food Court

Beansters: Monday–Friday, 7 a.m. –5 pm (Closed Sat/Sun)

Taco Bell: Monday–Thursday, 11 a.m.–7 p.m., Friday, 11 a.m.–4 p.m. (Closed Sat/Sun)

U- Go's Convenience Store: 7 days a week, 7 a.m.–10 p.m.

Wendy's: Monday–Friday, 7 a.m.– 3 p.m. (Closed Sat/Sun)

For more information visit: http://uunions.umich.edu/league/food/restaurants

Traveling in Ann Arbor

Airport Shuttle Information

Detroit Metropolitan Airport (Metro) is 25 miles east of Ann Arbor. You must make a reservation for all airport shuttles services.

–Ann Arbor/Detroit Metro Airport Super Shuttle
Reservations: 734-507-9220
Website: http://www.annarborsupershuttle.com/

–Ann Arbor Airport Shuttles
Reservations: 734-394-1665
Website: http://www.annarborairportshuttle.net/1.html

–Michigan Flyer
Information: 517-333-0400
Website: http://www.michiganflyer.com/index.html

Rental Car Information

Avis is proud to offer special rates for the summer meeting. To reserve a car, contact Avis at 1-800-331-1600 and reference the Avis Worldwide Discount (AWD) number J945158.

Taxi Information

You are unable to hail a taxi cab from a curb in Ann Arbor. However, you may find cabs in frequented spots, such as the Michigan Union on the UM campus, at the Amtrak station, or on the southwest corner of Main and Washington downtown. You may also call any of companies listed below to bring a taxi to you within 5 to 15 minutes:

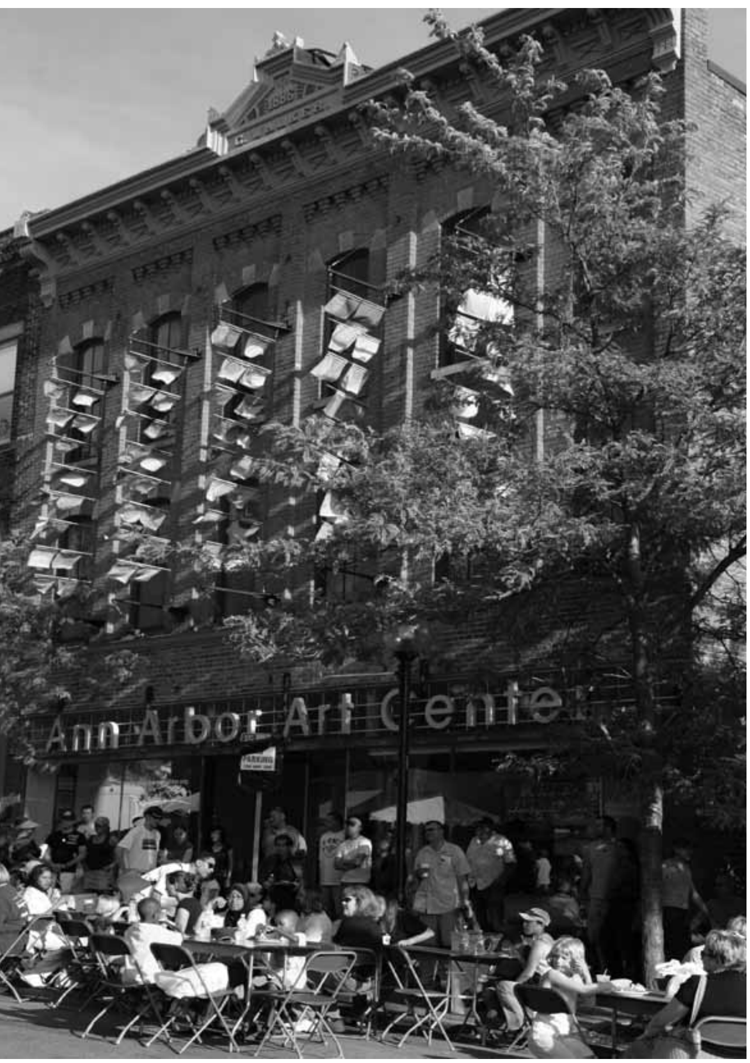
Ann Arbor Cab Service: 734-272-8009
A Cab & Treetown Transportation: 734-668-2222 or 734-213-1100
Campus Cab: 734-444-5354
Reliable Taxi: 734-637-6130
Select Ride: 866-663-8898
University Taxi: 734-368-4800
Yellow Cab: 734-663-3355

Ground Transportation

Ann Arbor Transit Authority (AATA)–For help with trip planning or any additional information, visit TheRide.org or call 734-996-0400. The AATA offers a convenient and reliable transportation alternative. Current fare is $1 for adult riders, 50 cents for children. Exact change is required.

Photos: Ann Arbor Area CVB

special events



Awards Dinner
Monday, July 27
Michigan League Koessler, 6–7:30 p.m.

The dinner honors and highlights the many achievements of the 2009 AAPT awardees.

Detroit City Tour
Wednesday, July 29
Board bus outside of Michigan League, 3-7 p.m.

Round-trip transportation with a narrated tour guide, including admission to the world-renowned Motown Historical Museum.

First Timers' Gathering
Monday, July 27
Michigan League Koessler, 7–8:30 a.m.

Learn about AAPT and the summer meeting during this social breakfast event.

Great Book Giveaway
Wednesday, July 29
Michigan League Concourse, 8–9 a.m.

This AAPT favorite offers many physics books to be raffled. Get your free raffle ticket at the AAPT booth.

Henry Ford Museum and Greenfield Village Tour
Sunday, July 26
Board bus outside of Michigan League, 8 a.m.–5 p.m.

This tour will allow you to see the influence of automobiles on American life. See and hear spectacular tales of American innovators of flight. Take a personal tour of the house of the future. Take a ride in the car of the 20th century, the Model T. Explore Edison's Menlo Park laboratory.

Michigan State Univ. Cyclotron Lab Tour – Workshop
Saturday, July 25
Michigan State Univ., 8 a.m.–5 p.m.

Sign up for Workshop W01 for a behind the scenes tour, lectures, demos, and hands-on experiments.

Physics Exhibit Show
Sunday, July 26, 8–10 p.m. (Welcome Reception), Monday, July 27, 10 a.m.–6 p.m., Tuesday, July 28, 10 a.m.–6 p.m.
Michigan League Ballroom, Hussey, Michigan

See modern and historical physics equipment from our exhibitors.

Spouses' Gathering
Monday, July 27
Michigan League Henderson, 9:30–10:30 a.m.

Create connections with other spouses and partners of AAPT attendees. Start with a light breakfast and plan an outing in beautiful Ann Arbor.

Summer Picnic and Evening Demo Show
Tuesday, July 28

Rackham – Picnic + open mic
6–7:30 p.m.

Power Center – Demo Show
7:30–8:30 p.m.

These two popular gatherings feature great food, fun, and physics demonstrations. Also enjoy a special Carillon Tower bell concert from 7–7:30 p.m.

Young Physicists' Meet and Greet
Monday, July 27
Michigan League Henderson, 12–1:30 p.m.

A place for 20 and 30 something physicists to mix and mingle.

"400 Years of the Telescope" Film
Monday, July 27
Dennison 182, 12:20–1:30 p.m.

Tuesday, July 28
Dennison 182, 11:50 a.m.–1 p.m.

Free viewing of the PBS historical film. (Bring your lunch.)

Arthur Eisenkraft

Robert A. Millikan Medal

Arthur Eisenkraft, University of Massachusetts Boston

Physics for All: From Special Needs to Olympiads

Monday, July 27, 3:30–4:30 p.m.
Mendelssohn Theater

Arthur Eisenkraft is Distinguished Professor of Science Education and Director of the Center of Science and Math in Context (COSMIC), at UMass Boston. He and AAPT Executive Director Jack Wilson created the process that identified and supported the first U.S. Physics Olympics Team to compete in the International Physics Olympiad, in 1986. In 1991, Eisenkraft became the Executive Director of the XXIV International Physics Olympiad, hosted by the U.S. for teams from 40 countries. He was one of the originators of *Quantum* magazine, and also developed the Active Physics curriculum project, which was funded by research grants from the National Science Foundation. He has served as chairman of the prestigious Toshiba Exploravisions Awards, the Duracell Science Scholarship Competition, and originated the Toyota Tapestry Grants. In 1999, Eisenkraft was elected to the presidential chain of the National Science Teachers Association. He has appeared on The Today Show, National Public Radio, Public Television, The Disney Channel, and numerous radio shows. He has published more than 80 articles, presented more than 110 papers and workshops, and has been featured in *The New York Times*, *Education Week*, *Physics Today*, *American Journal of Physics,* and *The Physics Teacher.*

Lee Smolin

Klopsteg Memorial Award

Lee Smolin, Perimeter Institute for Theoretical Physics, Waterloo, Canada

The Role of the Scientist as a Public Intellectual

Tuesday, July 28, 10:30–11:30 a.m.
Mendelssohn Theater

Lee Smolin, a theoretical physicist, is a founding and senior faculty member at Perimeter Institute for Theoretical Physics in Waterloo, Canada. He is also Adjunct Professor of Physics at the University of Waterloo. He is the author of more than 140 scientific papers and has made major contributions to the quantum theory of gravity, being a co-inventor of loop quantum gravity and deformed special relativity. He has also worked in cosmology and is the inventor of a theory called cosmological natural selection, which applies a Darwinian methodology to the question of how the laws of physics are chosen. He has research interests also in elementary particle physics, the foundations of quantum mechanics, astrophysics, theoretical biology, and economics. Smolin has also written three books, *The Life of the Cosmos* (1977), *Three Roads to Quantum Gravity* (2001), and *The Trouble with Physics* (2006), which explore the philosophical ramifications of developments in contemporary physics and cosmology. Born in New York City, Smolin was educated at Hampshire College and received his Ph.D. from Harvard University. Before moving to Canada to be part of founding Perimeter Institute, Prof. Smolin held professorships at Yale, Syracuse, and Penn State Universities. He occasionally plays jazz guitar and sails small boats for recreation.

Excellence in Pre-College Physics Teaching Award

Deborah Roudebush, Oakton High School, Herndon, VA

What Your Mother Never Told You About... Physics Teaching

Tuesday, July 28, 2:30–4:15 p.m.
Mendelssohn Theater

Deborah Roudebush

Deborah Roudebush is an outstanding high school teacher who has demonstrated her excellent skills in the classroom, as well as outside. She earned her B.S. degree in Physics at Ohio University. She received a Masters degree from Michigan State University in 1979 with an emphasis in Physics Education and her Ed.D. in Adult and Community Education from Ball State University in 1984. She became a National Board Certified Teacher in 2001. Roudebush has served as an AAPT Physics Teaching Resource Agent (PTRA) since 1992, participated in the D.C. Urban initiative, served as Rural Initiative–James Madison University Lead Teacher, and D.C. MSP Lead Teacher in 2008. She has been active in QuarkNet since 2000, serving as Teaching & Learning Fellow with QuarkNet centers. She has participated in the National Academy of Sciences since 2004 and is a member of the College Board AP Physics Redesign Commission. She was recognized as a Presidential Awardee for Excellence in Science Teaching in 2001.

Excellence in Undergraduate Physics Teaching Award

Mario Belloni, Davidson College, Davidson, NC

Using Technology to Increase Student Engagement Inside and Outside of the Classroom

Tuesday, July 28, 2:30-4:15 p.m.
Mendelssohn Theater

Mario Belloni

At Davidson College, **Mario Belloni** is well known as an author, public speaker, researcher, workshop leader, motivator of students, award winning professor, and an innovator in the use of technology for teaching physics. Belloni earned his B.A. in Physics and Economics at the University of California, Berkeley. He received his Masters and Ph.D. degrees in Physics at the University of Connecticut. Belloni began his teaching career in 1997 as Visiting Assistant Professor of Physics at Eckerd College, moving in 1998 to Davidson College, where he is currently Associate Professor of Physics. He received the AAPT Distinguished Service Citation in 2006 and has served as a member of the Planning Committee for the Section Representative/Area Chair Governance (2007), as a member of the AAPT Meetings Committee (2007-08), and as a member of the AAPT Membership and Benefits Committee (2004-07). Belloni is currently Chair of the AAPT Committee on Educational Technologies, North Carolina AAPT Section Representative, and a member of the comPADRE Quantum Physics Editorial Board. He has published more than 25 papers in peer-reviewed journals, including the *American Journal of Physics* and *The Physics Teacher.* He has given more than 40 invited presentations and led more than 50 workshops.

AAPT Distinguished Service Citations

Tuesday, July 28, 2:30–4:15 p.m.
Mendelssohn Theater

Alan Gibson
Connect2Science

Alan Gibson is a selfless and tireless warrior in the ongoing war against ignorance, a model educator-citizen, a loyal friend, and an outstanding leader in the MI-AAPT, as well as the Detroit Metro Area Physics Teacher groups over the past 30 years. He has served as the MI Section Representative, as Vice Chair of the Section Representatives from 2005-2007, as Chair of the Section Representatives from 2007-2009, and as a member of the AAPT Executive Board 2005-2009. Al was in the original PTRA program of 1985 and has been active in the Rural PTRA program. He has served as chair of the International Education Committee and the High School Committee, as well as a member of several other committees. In addition to all of his contributions at the local, state, and national levels, Al has served as an ambassador on Physics "missions" to the Far East. Al was recognized as a Technology Scholar by Radio Shack. He is recipient of the Presidential Award for Excellence in Math and Science Teaching (1988) and was a finalist for the Michigan Science Teacher of the Year. He has received the highest awards of Outstanding Leadership/Service from the DMAPT and the MI AAPT where they recognized him, saying, "Al has inspired thousands of students and teachers by his dedication to his profession. His amazing talents as an educational leader are only surpassed by his humbleness."

Dave Maiullo
Rutgers, The State University of New Jersey

David Maiullo is best known for the many public physics demo shows he performs in his community, both in the usual locations (libraries, schools, senior centers, science fairs, etc.) and in the unusual (bars, outdoors before rock bands play, street fairs, Coney Island). These efforts led to his recognition with the Ernest E. McMahon Award for Public Outreach from Rutgers University in 2000 and Rutgers University's President's Staff Excellence in Service award in 2006. David plays an invaluable role in the preparation of physics teachers in New Jersey and in the greater physics teaching community. He leads workshops for New Jersey teachers, and his efforts are integral to the NJAAPT and Rutgers relationship. David was the 2006 recipient of the NJAAPT Lifetime Achievement Award. He has served as Past-president and as a member of the Physics Instructional Resource Association (PIRA), an AAPT affiliate, and continues his work at the Summer Meeting with the Lecture Demo Workshop(s), which he has led for five years. Additionally, David has provided outstanding service as an Apparatus Committee Chair, as well as serving on the committee for years.

Bruce Mason
University of Oklahoma

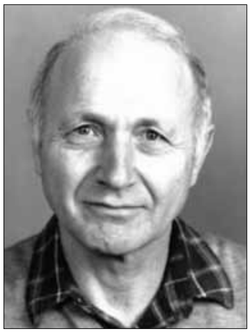
Bruce Mason is a faculty member of the Homer L. Dodge Department of Physics and Astronomy at the University of Oklahoma. He received a B.A. degree in Physics from Oberlin College and M.S. and Ph.D. degrees from the University of Maryland. He also held a postdoctoral research position at the University of Illinois in condensed matter theory before coming to Oklahoma. In the mid-1990s, Bruce became interested in the potential for technology to engage students in new ways and in the possibility of encouraging faculty to make use of these new tools. Through this interest, he became the founding editor of the MERLOT-Physics resource collection and the director of the comPADRE Digital Library, a collaboration of the AAPT, APS, AIP, and AAS. comPADRE is part of the National STEM Digital Library funded by the U.S. National Science Foundation. The editors and staff of the comPADRE project have developed a network of resource collections to provide online resources and information to support communities of instructors and students in physics and astronomy. Bruce serves on the AAPT Publications Committee and the Educational Technologies Committee. He has given numerous workshops, tutorials, and talks at AAPT national and section meetings and at other local, national, and international conferences. Bruce is also the Secretary/Treasurer of the American Physical Society's Forum on Education.

award winners

AAPT Distinguished Service Citations

Mary Winn
Hillsborough County FL
Schools, retired

Mary Winn taught high school physics for 30 years (20 of them as Science Department Chair) after earning her B.S. in physics at Tulane. With PTRA since 1992, she regularly gives workshops to high school teachers in her state and co-authored the PTRA workshop manual *The Role of Demonstrations in Physics*. Mary co-authored, with Jan Mader, AAPT's popular book, *Teaching Physics for the First Time,* and has presented several PTRA workshops on this topic. She has also served on the Committee on Minorities in Physics, the Committee on Membership and Benefits, and the Committee on Physics in Pre-High School. Mary has been a member of the Florida AAPT for more than 30 years. Additionally, she is a mentor for new physics teachers in Hillsborough County, FL. Perhaps her most unique and respected contribution to AAPT is her heroic work for the annual High School Physics Photo Contest. She has worked tirelessly, promoting and receiving submissions, arranging viewing times, and determining awards each spring since 2001, and her success is easily measured in the growth of the contest from 35 to more than 800 photos submitted annually.



Mel Steinberg
Smith College

Mel Steinberg conducted the first training for Comprehensive Conceptual Curriculum Project (C3P) developers in the use of the project he designed and spearheaded called CASTLE. CASTLE is a powerful curriculum that helps students and teachers understand electricity in a concrete way. Over the years, CASTLE became a cornerstone of the training for the AAPT/PTRA program, as well as the C3P workshops. It is one of the most requested AAPT/PTRA teacher workshops. Mel made an overwhelming difference in physics education. (This award will be presented posthumously.)

AIP's Science Writing Award in the Children's Category – SNEEZE!

Alexandra Siy

Dennis Kunkel

Alexandra Siy and **Dennis Kunkel** have won the 2008 AIP Science Writing Award in the Children's category for their book *SNEEZE!* (Charlesbridge, 2007). Siy is a photographer and children's book author in upstate New York and Kunkel is a scientist in Hawaii who specializes in imaging the invisible microscopic world. Combining Siy's photographs and prose with Kunkel's electron micrographs of pollen, mold, dander, mites, and other invisible irritants, *SNEEZE!* is about nine kids discovering nine different reasons for sneezing.

AIP's Andrew W. Gemant Award – John S. Rigden

Monday, July 27, 7:30–8:30 p.m.
Mendelssohn Theater

John Rigden
Washington University of
St. Louis

John S. Rigden is an internationally renowned American physicist. His areas of expertise are molecular physics and the history of science. He is currently the co-editor of the scholarly journal *Physics in Perspective*, published by Birkhäuser Publishing in Basel, Switzerland. Rigden was editor of the *American Journal of Physics* from 1975 to 1985. In 1987, he joined the American Institute of Physics, where he served as Director of Physics Programs. In 1992, he was appointed Director of Development of the National Science Standards Project at the National Academy of Sciences. In 1995, he was elected chairman of the History of Physics Forum of the American Physical Society. He has also served on committees for the AAPT, the American Physical Society, the American Association for the Advancement of Science, and the National Academy of Sciences.

K.C. Cole
USC Annenberg
School of Journalism

Plenary: Something Incredibly Wonderful Happens: Frank Oppenheimer and the World He Made Up

Wednesday, July 29, 9–10 a.m.
Mendelssohn Theater

K.C. Cole is a professor at the University of Southern California's Annenberg School of Journalism, and the author of eight nonfiction books, including *The Universe and the Teacup: The Mathematics of Truth and Beauty*. She covered math, physics, cosmology and psychology at *The Los Angeles Times* for 10 years, often exploring connections between science, art, and society, and wrote the column "Mind Over Matter." Cole has taught at UCLA, Wesleyan, and Yale Universities, and has been an editor, writer, and columnist at *Discover Magazine*. Her work was featured in *The Best American Science Writing 2004 and 2005*, and *The Best American Science and Nature Writing 2002*. She also does science commentaries for public radio's Marketplace, and is a regular year-end commentator for NPR Science Friday. She founded and hosts a regular series of events on art, science, and politics, at Santa Monica Art Studios known as Categorically Not! Her most recent book is *Something Incredibly Wonderful Happens: Frank Oppenheimer and the World He Made Up*, to be published this summer by Houghton Mifflin Harcourt.

John Goree
University of Iowa

Symposium on Plasma Physics

Monday, July 27, 10:30 a.m.–12 p.m.
Mendelssohn Theater

The Electrical Charge and Motion of Objects Inserted into a Plasma

John Goree has been a faculty member at The University of Iowa's Department of Physics and Astronomy since 1985. As a high school junior, he placed second in physics at the International Science and Engineering Fair, and he now enjoys judging high school projects at science fairs. He was an undergraduate at California Institute of Technology, where he received the B.S. in Applied Physics in 1980. He received the Ph.D. in Plasma Physics at Princeton University in 1985. He has spent two years while on sabbatical at the Max Planck Institute in Garching, Germany, where he helped with the design of an experiment that now flies on the International Space Station.

Cary Forest
University of Wisconsin

Turbulent Liquid Metal Dynamo Experiments

Cary Forest is a professor of physics at the University of Wisconsin. His research focuses on understanding how electrical currents are generated in plasmas and other magnetohydrodynamic (MHD) systems. His thesis work at Princeton demonstrated tokamak formation by pressure driven currents alone (solenoid-free startup) for which he was awarded the DPP's Outstanding Doctoral Thesis Award. He then moved to General Atomics in 1992 where he worked as a scientist on the DIII-D tokamak, focusing on measuring the non-inductive currents driven by rf heating and neutral beam injection. He invented a technique for determining the internal inductive electric field inside the tokamak plasma which has become widely used for current drive analysis on most large tokamaks. While at GA, Cary was deeply involved in a number of foreign collaborations including several multi-month visits to the Kurchatov Institute in Moscow, where he worked on the T-10 tokamak, and to Cadarache, France (the site of the future ITER tokamak), where he worked on Tore Supra. In 1997, he moved to the University of Wisconsin, where he began a program in liquid metal MHD experiments designed to investigate how planetary and solar dynamos function.

committees

Saturday, July 25, Committee Meeting

Awards Committee	MI League Koessler	12–3 p.m.

Sunday, July 26, Committee Meetings

Publications Committee	MI League Henderson	7:30–10:30 a.m.
Meetings Committee	MI League Room D	7:30–10:30 a.m.
Nominating Committee I	MI League Room D	3:30–5:30 p.m.
Programs Committee I	MI League Henderson	4–5:30 p.m.
Committee on Governance Structure	MI League Koessler	4–5:30 p.m.
Section Officers Exchange	MI League Henderson	5:30–6:30 p.m.
Graduate Education in Physics Committee	CC Little 1509	5:30–7 p.m.
Women in Physics Committee	CC Little 1507	5:30–7 p.m.
Space Science and Astronomy Education	CC Little 1512	5:30–7 p.m.
Professional Concerns Committee	CC Little 1518	5:30–7 p.m.
Science Education for the Public Committee	CC Little 1505	5:30–7 p.m.
Section Representatives	MI League Henderson	6:30–8 p.m.

Monday, July 27, Committee Meetings

Apparatus Committee	CC Little 1509	7–8:30 a.m.
Physics in High School Committee	CC Little 1507	7–8:30 a.m.
International Physics Education Committee	CC Little 1512	7–8:30 a.m.
Governance Review Committee (GRC)	MI League Room 2	7–8:30 a.m.
Bauder Fund Committee	MI League Room 2	12–1:30 p.m.
Educational Technologies Committee	CC Little 1509	12–1:30 p.m.
SI Units and Metric Education Committee	Dana 1006	12–1:30 p.m.
Teacher Preparation Committee	CC Little 1507	12–1:30 p.m.
PIRA Business Meeting	USB 1230	6–7:30 p.m.

Tuesday, July 28, Committee Meetings

History and Philosophy Committee	CC Little 1509	7–8:30 a.m.
Physics in Pre-High School Education	CC Little 1512	7–8:30 a.m.
Physics in Two-Year Colleges Committee	CC Little 1518	7–8:30 a.m.
Research in Physics Education Committee	MI League Room D	7–8:30 a.m.
Interests of Senior Physicists Committee	Dana 1064	11:30 a.m.–1 p.m.
Role of Laboratory in H.S. Physics	MI League Henderson	11:30 a.m.–1 p.m.
Minorities in Physics Committee	CC Little 1509	11:30 a.m.–1 p.m.
Membership and Benefits Committee	MI League Room D	11:30 a.m.–1 p.m.
Laboratories Committee	CC Little 1507	11:30 a.m.–1 p.m.
Undergraduate Education Committee	MI League Koessler	11:30 a.m.–1 p.m.

Wednesday, July 29, Committee Meetings

Programs Committee II	MI League Henderson	7–9 a.m.
Investment Advisory Committee	MI League Room D	7:30–9 a.m.
Physics Bowl Advisory Committee	MI League Room 2	7:30–9 a.m.
Nominating Committee II	MI League Koessler	7:30–9 a.m.
PERTG Committee	MI League Room D	12–12:45 p.m.

(The time and place for the meetings of the Audit, Finance, and PERLOC committees will be arranged by the chairs of those committees.)

exhibitor information

Stop by the Exhibit Hall, located in the Michigan League, second floor, to see the exhibitors who have come to the AAPT meeting. Hours for the show are: Sunday, 8–10 p.m., and Monday–Tuesday, 10 a.m.–6 p.m.

Booth #40

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Booths #34 ,35, 36

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

AAPT Shared Book (booth 17)

Browse through featured titles from many publishers. The Great Book Giveaway will be held Wednesday at 8 a.m. when the books are raffled off. Pick up your raffle ticket at the AAPT booth before Tuesday at 5 p.m.

Booth #50

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

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Booth #70, 71

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Booth #55

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Klinger Educational will be exhibiting a functioning Analytical X-ray machine, capable of using five different X-ray tubes with anodes of Mo, Cu, Fe, W, Ag. When the built-in Goniometer is used with the Energy Detector, we will be performing experiments in X-ray fluorescence, X-ray energy spectroscopy and many others. For the first time in North America, Klinger/Leybold's newest development, Tomography module, will be demonstrated. This unit works with the X-ray machine, recording while a computer generates a 3D-object.

Booth #20, 21

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Booth #10, 11

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The Physics Teacher Education Coalition has the goal of improving the education of future physics teachers. We will provide information on membership, conferences, and resources for physics teacher education.

Booth #25

Physics2000.com

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Booth #52

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Booth #30, 31

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commercial workshops

CW01: Bringing the Universe into Your Classroom

Sponsor: CENCO Physics
Date: Monday, July 27
Time: 9–10 a.m.
Room: CC Little 1507

Leader: Bob Reiland

Since the early 1990s, major new technology developments have initiated a revolution in our understanding of the universe and its origins. In recent years new imaging techniques have made it possible to map concentrations of the material known as dark matter, and a new substance, known as dark energy has been discovered. For the most part these new developments are more and more present in state standards. Many of them are relatively easy to understand and also of high interest to students. Join two experienced CENCO teachers (both also members of the Contemporary Physics Education Project – CPEP) in exploring the teaching chart, The History and Fate of the Universe, as a vehicle to bring the understanding of dark energy and matter into your classroom. In addition, participants will have the opportunity to engage in several classroom tested inquiry-based activities involving the expansion of the universe. All participants will receive a copy of the CPEP chart and a selection of activity materials.

CW02: Get a Bull's Eye with Cenco's Projectile Motion Ramp

Sponsor: CENCO Physics
Date: Monday, July 27
Time: 9–10 a.m.
Room: USB 1250

Leader: Paul Robinson

Roll a steel marble down a ramp mounted on a lab table, measure its velocity at the bottom, and then have students predict the landing point on the floor—sounds simple enough. Versions of this lab have been performed for years with make-shift ramps, inferior timing systems, with no or inconsistent release mechanisms for the ball. CENCO has teamed up with Paul Robinson. Together they have engineered a large-scale ramp that gives accurate, reproducible results. This simple but elegant apparatus is as affordable as it is easy-to-use and can be set up in minutes. Teaching tips and suggested curriculum applications will be provided.

CW03: Vernier Software: New Data Collection Tools for Physics

Sponsor: Vernier Software & Technology
Date: Monday, July 27
Time: 9–10 a.m.
Room: CC Little 1509

Leaders: David Vernier, John Gastineau

Attend this hands-on workshop to learn about new data collection tools from Vernier Software & Technology, or if you need an overview of data collection, we'll be happy to show you the basics. Drop in anytime during the workshop.

- Explore the Audio Function Generator on Vernier LabQuest. Use it to drive the internal or external speakers.
- Use our new Power Amplifier to study electrical circuits or to investigate resonance.
- Experiment with our new Optics Expansion Kit.
- Use the Vernier Spectrometer to collect emission spectra of LEDs and other lamps.
- Use our new Bumper and Launcher kit with Vernier Dynamics System.
- Try out some Vernier products for engineering or physics projects: The Vernier NXT Adapter allows our sensor 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.

CW04: Kinetic Books Workshop

Sponsor: Kinetic Books
Date: Monday, July 27
Time: 9–10 a.m.
Room: Dennison 110

Leader: Lake Bancroft

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.

CW05: Advanced Physics Lab

Sponsor: CENCO Physics
Date: Monday, July 27
Time: 12–2 p.m.
Room: Randall 1233

This participatory workshop for college and university physics faculty provides an overview of significant advanced physics labs. These experiments effectively illustrate the groundbreaking concepts that helped to revolutionize physics in the early 20th century and participants will be able to evaluate the experiments firsthand. Participants will rotate through stations to receive valuable hands-on experience and will be given the opportunity to ask questions about the labs being presented. The topics presented will include the behavior of electrons and key concepts in thermodynamics. Experiments include both quantitative and qualitative investigations as well as experiment plans. The laboratory equipment used will include 3B Scientific's Teltron tube series and Critical Point Apparatus as well as CENCO's e/m Apparatus and Hall effect experiment.

CW06: Physics 2000 Workshop

Sponsor: Physics2000.com
Date: Monday, July 27
Time: 12–2 p.m.
Room: USB 1250

Leader: Elisha Huggins

For nearly a century we have lived with an introductory physics curriculum that divides physics into classical and modern parts, and teaches only the classical part to the majority of students. The Physics2000 workshop demonstrates how to easily overcome this divide by starting with special relativity in the first week, and fitting in 20th century topics as you go along. As an example, we will discuss introducing magnetism from Coulomb's law and the Lorentz contraction, and teach the time-energy form of the uncertainty principle using the pulse Fourier Transform capability of MacScope II.

CW07: Strangeness and Charm in Your Classroom

Sponsor: CENCO Physics
Date: Tuesday, July 28
Time: 11:30 a.m.– 1 p.m.
Room: USB 1250

Leader: Bob Reiland

Quarks, leptons, and mesons have become standard topics in many high school and introductory college physics texts in the past decade. Many veteran physics teachers however are challenged to teach this material. Join two experienced teachers (both members of the Contemporary Physics Education project—CPEP) in exploring the basics and most recent discoveries in the field of particle physics. Using the CPEP developed teaching chart, The Standard Model of Fundamental Particles and Interactions, participants will explore the fundamental structure of baryons and mesons, the current understanding of the "neutrino mass" problem, and the status of the search for the elusive Higgs boson. In addition to interactive discussion with the workshop leaders, participants will explore Rutherford scattering and fundamental particle detection by performing classroom tested, inquiry-based activities. All participants will receive a copy of the CPEP chart, and several sets of apparatus for the activities will be given away.

CW08: And You Thought It Was About Homework: The Way You Imagined Teaching Could Be

Sponsor: WebAssign
Date: Monday, July 27
Time: 12–2 p.m.
Room: Dennison 120

Leader: John Risley

Help your students learn with WebAssign. Find out what's new. WebAssign, the premier online homework, quizzing, and testing system, continues to have all of the features you want and includes content from all major publishers. Access questions from all major physics and astronomy textbooks, or write your own. Check out our latest offerings with 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 assignments knowing how difficult each question is and how many students have tried it before. Prepare your students for labs and collect their lab data, analysis, and reports—all using WebAssign. Streamline your work flow with WebAssign. It's easy to use, reliable, and helps you stay connected, your way. Quickly access student responses, view item analysis for each question, communicate using class forums, Ask Your Teacher, and announcements, give students access to all of their course grades with complete class statistics, propagate common assignments to multiple sections, give secure quizzes and tests. Find out how to integrate WebAssign with Blackboard, Shibboleth, D2L, and other registration systems. Over 1 million students are using WebAssign. *Find out why.*

SPIN-UP

Strategic Programs for Innovations in Undergraduate Physics (SPIN-UP) Regional Workshops

The Goal of the SPIN-UP Regional Workshops is to enable physics departments in a wide variety of institutions to build the departmental infrastructure that will produce long-term improvements in undergraduate physics programs and to enhance both the number of students studying physics and the quality of student learning.

– ***Marquette University***, Milwaukee, WI: June 18-20, 2009.
Presentations are online at www.aapt.org/ Projects/spinup-regional.cfm

– ***Cal Poly, San Luis Obispo,*** CA: June 25-27, 2010

– ***North Carolina State University,*** Raleigh, NC: September 11-13, 2009

– ***Rutgers University,*** New Brunswick, NJ
(check www.aapt.org/Projects/spinup-regional.cfm for the dates)
The Rutgers workshop will be targeted specifically toward departments that grant the Ph.D. in physics. Others address all departments including those granting a Ph.D.

For more information contact Ruth Howes at rhowes@bsu.edu

AAPT PHYSICS EDUCATION APS physics AMERICAN INSTITUTE OF PHYSICS NSF

Meeting at a Glance

Meeting at a Glance includes sessions, workshops, committee meetings and other events, including snack breaks, plenary sessions, and receptions. All rooms will be at the University of Michigan.

KEY: ML–Michigan League (Union) **USB**–Undergraduate Science Building

FRIDAY, July 24

8 a.m–5 p.m.		PhysTEC Meeting	CC Little 1505
6–8 p.m.		***PRE-REGISTRATION PICK-UP***	ML Concourse

SATURDAY, July 25

7 a.m.–4:30 p.m.		***REGISTRATION***	ML Concourse
8 a.m.–12 p.m.	W07	Falsification Labs	Randall 1224
8 a.m.–12 p.m.	W08	New Methodology for Using Clickers in Physics Lectures	Randall 1261
8 a.m–5 p.m.		PhysTEC Meeting	CC Little 1505
8 a.m–5 p.m.		TYC Meeting	CC Little 1512
8 a.m.–5 p.m.	W01	Workshop–Cyclotron Laboratory Tour	Michigan State Univ.
8 a.m.–5 p.m.	W02	PIRA Lecture Demonstrations I	Dennison 170
8 a.m.–5 p.m.	W03	Learning Physics While Practicing Science	USB 1250
8 a.m.–5 p.m.	W04	Teaching Physics for the First Time	Randall 1209
8 a.m.–5 p.m.	W05	Piaget Beyond "Piaget"	Dennison 120
8 a.m.–5 p.m.	W06	Using Research-Based Curricula and Tools in Intro. Physics Course	Randall 1221
12–3 p.m.		Awards Committee Meeting	ML Koessler
1–2 p.m.	T02	Challenging Physics Problems for Broad Audiences	CC Little 1512
1–4 p.m.	T01	Critical Thinking in Introductory Astronomy	USB 1230
1–5 p.m.	W11	NTIPERS: Research-Based Conceptual Reasoning Tasks	Chemistry 1650
1–5 p.m.	W12	V-Python: 3-D Programming for Ordinary Mortals	Randall 1224
1–5 p.m.	W13	Haunted Physics Laboratories	Randall 1233, 1412, 1416
1–5 p.m.	W14	Potpourri of Simulations	Randall 1261
12–10 p.m.		Physics Photo Contest Viewing/Voting	ML Concourse
5–10 p.m.		AAPT Executive Board Meeting	ML Koessler/Room D

SUNDAY, July 26

7 a.m.–4 p.m.		***REGISTRATION***	ML Concourse
7:30–10:30 a.m.		Publications Committee Meeting	ML Henderson
7:30–10:30 a.m.		Meetings Committee Meeting	ML Room D
8 a.m.–12 p.m.	W20	Learning the "Game" of Science: Nature and Philosophy of Science	Dennison 130
8 a.m.–12 p.m.	W21	Writing Better Tests: Mining the Data	CC Little 1512
8 a.m.–12 p.m.	W22	Preparing Pre-College Teachers to Teach Physics by Inquiry	Chemistry 1650
8 a.m.–12 p.m.	W23	The Physics of Supernovae	USB 1250
8 a.m.–12 p.m.	W24	Teaching Astronomy Through Active Learning	Randall 1412
8 a.m.–5 p.m.		Henry Ford Museum and Greenfield Village Tour (ticket required)	Offsite
8 a.m.–5 p.m.		TYC Resource Room Setup, including posters	ML Room 4
8 a.m.–5 p.m.		PIRA Resource Room Setup	ML Vandenberg
8 a.m.–5 p.m.		TYC Meeting	CC Little 1512
8 a.m.–5 p.m.	W15	Using RTOP to Improve Physics and Physical Science Teaching	Dennison 120
8 a.m.–5 p.m.	W16	Road Show Apparatus: Design, Construction, and Application	Dennison 182
8 a.m.–5 p.m.	W17	Research-Based Alternatives to Problem Solving in General	Dennison 110
8 a.m.–5 p.m.	W18	Taste of Technology (counts as two workshops)	Randall 1221/1224
8 a.m.–5 p.m.	W19	PIRA Lecture Demonstrations II	Dennison 170
8 a.m.–10 p.m.		Physics Photo Contest Viewing/Voting	ML Concourse
10:30 a.m.–3:30 p.m.		AAPT Executive Board Meeting	ML Koessler/Room D
1–5 p.m.	W25	Physics and Toys I: Force, Motion, Light, and Sound	CC Little 1505
1–5 p.m.	W26	Energy in the 21st Century	Randall 1261
1–5 p.m.	W27	Promoting Active Inquiry-Based Learning with Computers	Randall 1209
1–5 p.m.	W28	What Physics Teachers Should Know About Cognitive Research	Dennison 268
1–5 p.m.	W29	Tutorials in Introductory Physics	Chemistry 1650

1–5 p.m.	W30	Designing Research Studies Around PhET's Simulations	Randall 1412
1–5 p.m.	W31	Teaching and Demos in Nuclear Physics	Randall 1233
1–5 p.m.	W34	Designing a Diagnostic Learning Environment	USB 1250
1–5 p.m.	W35	Taking Oral Histories: Preserving the Stories of Our Disciplines	USB 1230
1–5 p.m.	W36	The Best Intermediate and Advanced Lab You Will Ever See	Randall 4268
3:30–5:30 p.m.		Nominating Committee Meeting I	ML Room D
4–5:30 p.m.		Programs Committee Meeting I	ML Henderson
4–5:30 p.m.		Committee on Governance Structure Meeting	ML Room 2
5:30–6:30 p.m.	SUN	SPS Poster Reception	ML Koessler
5:30–6:30 p.m.		Section Officers Exchange	ML Henderson
5:30–7 p.m.		Graduate Education in Physics Committee Meeting	CC Little 1509
5:30–7 p.m.		Women in Physics Committee Meeting	CC Little 1507
5:30–7 p.m.		Space Science and Astronomy Education Committee Meeting	CC Little 1512
5:30–7 p.m.		Professional Concerns Committee Meeting	CC Little 1518
5:30–7 p.m.		Science Education for the Public Committee Meeting	CC Little 1505
6–8 p.m.		High School Share-a-thon	West Hall 340
6:30–8 p.m.		Section Representatives Meeting	ML Henderson
7:30–9:30 p.m.		***REGISTRATION***	ML Concourse
8–10 p.m.		***Exhibit Hall Opens & Welcome Reception***	ML Second Floor

MONDAY, July 27

7–8:30 a.m.		TYC Breakfast – (ticket required)	ML Henderson
7–8:30 a.m.		Governance Review Committee (GRC)	ML Room 2
7–8:30 a.m.		First Timers' Gathering	ML Koessler
7–8:30 a.m.		Apparatus Committee Meeting	CC Little 1509
7–8:30 a.m.		Physics in High School Committee Meeting	CC Little 1507
7–8:30 a.m.		International Physics Education Committee Meeting	CC Little 1512
7–8:30 a.m.	AAA	Crackerbarrel for Area Committee Chairs	CC Little 1518
7 a.m.–5 p.m.		***REGISTRATION***	ML Concourse
8 a.m.–5 p.m.		TYC Resource Room and Posters	ML Room 4
8 a.m.–5 p.m.		PIRA Resource Room and Apparatus Competition	ML Vandenberg
8 a.m.–10 p.m.		Physics Photo Contest Viewing/Voting	ML Concourse
8:30–9:30 a.m.	AJ	A Physicist Scattering on Hollywood	Dana 1040
8:30–10:30 a.m.	AA	Panel: Discussion of TYC Issues	CC Little 1528
8:30–10:30 a.m.	AB	Panel: What Graduate Schools Expect from Undergraduates	Chemistry 1200
8:30–10:30 a.m.	AC	Giving More Than One Test: Physics Students' Understanding	Chemistry 1210
9–10 a.m.	AE	High-Performance Computing on the Desktop	Chemistry 1400
8:30–10:30 a.m.	AH	Innovations in Introductory Laboratories	Dennison 170
8:30–10:50 a.m.	AD	International Programs and Cooperation	Chemistry 1300
8:30 a.m.–10 p.m.	PST1	Poster Session I	Dana Hall Atrium, 1024, 1028, 1046
9–10 a.m.	CW01	CENCO Free Workshop – Bringing Universe into Your Classroom	CC Little 1507
9–10 a.m.	CW02	CENCO Free Workshop – Cenco's Projectile Motion Ramp	USB 1250
9–10 a.m.	CW03	Vernier Free Workshop – New Data Collection Tools	CC Little 1509
9–10 a.m.	CW04	Kinetics Books Free Commercial Workshop	Dennison 110
9:30–10:30 a.m.	AF	Teaching Physics in Urban Schools	Chemistry 1640
9:30–10:30 a.m.	AG	PER Tools: Techniques and Broad Implications	Dana 1040
9:30–10:30 a.m.	AI	Astronomy at the University of Michigan	Dennsion 182
9:30–10:30 a.m.		Spouses' Gathering	ML Henderson
10 a.m.–6 p.m.		***EXHIBIT HALL*** (coffee and muffins, 10 a.m.)	ML Second Floor
10:30 a.m.–12 p.m.	P1	Symposium on Plasma Physics	Mendelssohn Theater
12–1:30 p.m.		Past Officers' Luncheon – closed	ML Koessler
12–1:30 p.m.		Young Physicists' Meet and Greet	ML Henderson
12–1:30 p.m.		Bauder Fund Committee Meeting	ML Room 2
12–1:30 p.m.		Educational Technologies Committee Meeting	CC Little 1509
12-1:30 p.m.		Teacher Preparation Committee Meeting	CC Little 1507
12–1:30 p.m.		SI Units and Metric Education Committee	Dana 1006
12–1:30 p.m.	BAA	Crackerbarrel: Physics and Society Education	CC Little 1512
12–1:30 p.m.	BBB	Crackerbarrel: Web Resources for Teaching Astronomy	CC Little 1505
12–1:30 p.m.	BBC	Crackerbarrel: Professional Concerns of PER Faculty	CC Little 1518
12–2 p.m.	CW05	CENCO Free Workshop – Advanced Physics Lab	Randall 1233

12-2 p.m.	CW06	Physics2000.com Free Commercial Workshop	USB 1250
12–2 p.m.	CW08	WebAssign Free Commercial Workshop	Dennison 120
12:20–1:30 p.m.		"400 Years of the Telescope" PBS film viewing	Dennison 182
1:30–3:30 p.m.	BA	Panel: Reforming the Intro. Physics Course for Life Science Majors	CC Little 1528
1:30–3:30 p.m.	BB	KSTF Teaching Fellowships	Chemistry 1200
1:30–3:30 p.m.	BC	Issues in Student Problem Solving	Chemistry 1210
1:30–3:30 p.m.	BD	Getting Published	Chemistry 1300
1:30–3:30 p.m.	BE	Data Mining to Study Learning	Chemistry 1400
1:30–3:30 p.m.	BF	PIRA Session: Demos and Misconceptions	Chemistry 1640
1:30–3:30 p.m.	BG	Energy and Environment	Dana 1040
1:30–3:30 p.m.	BH	Cutting-Edge Research at Michigan State University	Dennison 170
1:30–3:30 p.m.	BI	How to Prepare Undergraduates for Graduate School	Dennison 182
3:30–4:30 p.m.	P2	Plenary: Millikan Medal – Arthur Eisenkraft	Mendelssohn Theater
4:30–6 p.m.	CA	Distance Learning	Chemistry 1200
4:30–6 p.m.	CB	Research Regarding Student Interactions and Collaborations	Chemistry 1210
4:30–6 p.m.	CC	Particle Physics in High Schools	Chemistry 1300
4:30–6 p.m.	CD	Recruiting and Retaining Women in Physics	Chemistry 1400
4:30–6 p.m.	CE	Teaching Physics Around the World – Part I	Chemistry 1640
4:30–6 p.m.	CF	Advice for the New Physics Teacher	Dana 1040
4:30–6 p.m.	CG	Carnival Knowledge	Dennison 170
4:30–6 p.m.	CH	Innovations in Teaching Astronomy	Dennison 182
4:30–6 p.m.	CI	Physics Bazaar – Posters	CC Little 1528
5–6 p.m.		Exhibit Hall (Happy Hour, Mojito Punch)	ML Second Floor
6–7 p.m.		PIRA Business Meeting	USB 1230
6–7:30 p.m.		Awards Dinner – (ticket required)	ML Koessler
7:30–8:30 p.m.	P3	AIP Gemant Award – John Rigden	Mendelssohn Theater
8:30–9:15 p.m.	PST1	Odd-numbered posters – Authors present (snacks)	Dana Hall
9:15–10 p.m.	PST1	Even-numbered posters – Authors present (snacks)	Dana Hall

TUESDAY, July 28

7–8:30 a.m.		Exhibitors' Breakfast	ML Henderson
7–8:30 a.m.		Retirees' Breakfast – (ticket required)	ML Koessler
7–8:30 a.m.		History and Philosophy Committee Meeting	CC Little 1509
7–8:30 a.m.		Physics in Two-Year Colleges Committee Meeting	CC Little 1518
7–8:30 a.m.		Physics in Pre-High School Education Committee Meeting	CC Little 1512
7–8:30 a.m.		Research in Physics Education Committee Meeting	ML Room D
7–8:30 a.m.	DDD	Crackerbarrel: National Task Force on Physics Teacher Preparation	CC Little 1505
7 a.m.–4:30 p.m.		***REGISTRATION***	ML Concourse
8 a.m.–12 p.m.		Physics Photo Contest Viewing/Voting	ML Concourse
8 a.m.–5 p.m.		TYC Resource Room and Posters	ML Room 4
8 a.m.–5 p.m.		PIRA Resource Room and Apparatus Competition	ML Vandenberg
8:30–9:30 a.m.	DG1	New Demonstrations in E and M	Dennison 170
8:30–10:30 a.m.	DA	Pre-College Physics Potpourri	Chemistry 1200
8:30–10:30 a.m.	DB	Student Conceptual Difficulties: Introductory and Upper-Level	Chemistry 1210
8:30–10:30 a.m.	DC	What to Teach After Newtonian Mechanics	Chemistry 1300
8:30–10:30 a.m.	DD	Effectiveness of Educational Technology in Instruction	Chemistry 1400
8:30–10:30 a.m.	DE	Panel: Establishing and Improving Teacher Preparation Programs	Chemistry 1640
8:30–10:30 a.m.	DF	Introductory College-Level Courses	Dana 1040
8:30–10:30 a.m.	DH	PER-Based Materials and Research Findings	Dennison 182
8:30 a.m.–10 p.m.	PST2	Poster Session II	Dana Hall Atrium, 1024, 1028, 1046
9:30–10:30 a.m.	DG2	Discrepant Events	Dennison 170
10 a.m.–6 p.m.		***EXHIBIT HALL*** (Coffee and scones, 10 a.m.)	ML Second Floor
10:30–11:30 a.m.	P4	Klopsteg Award – Lee Smolin	Mendelssohn Theater
11:30 a.m.–1 p.m.	CW07	CENCO Free Workshop–Strangeness and Charm in Classroom	USB 1250
11:30 a.m.–1 p.m.		Minorities in Physics Committee Meeting	CC Little 1509
11:30 a.m.–1 p.m.		Interests of Senior Physicists Committee Meeting	Dana 1064
11:30 a.m.–1 p.m.		Membership and Benefits Committee Meeting	ML Room D
11:30 a.m.–1 p.m.		Laboratories Committee Meeting	CC Little 1507
11:30 a.m.–1 p.m.		Undergraduate Education Committee Meeting	ML Koessler
11:30 a.m.–1 p.m.		Role of the Laboratory in H.S. Physics Meeting	ML Henderson

11:30 a.m.–1 p.m.	EEE	Crackerbarrel: Professional Concerns of PER Solo Faculty	CC Little 1512
11:30 a.m.–1 p.m.	EEF	Crackerbarrel: International Issues in the AAPT	CC Little 1505
11:30 a.m.–1 p.m.	EEG	Crackerbarrel: Professional Concerns of Graduate Students	CC Little 1518
11:50 a.m.–1 p.m.		"400 Years of the Telescope" PBS film viewing	Dennison 182
1–2:30 p.m.	EA	New Faculty Workshop for TYC Faculty	CC Little 1528
1–2:30 p.m.	EB	Presenting Cutting-Edge Research for Outreach and Teaching	Chemistry 1200
1–2:30 p.m.	EC	The Art and Science of Physics Teaching	Chemistry 1210
1–2:30 p.m.	ED	Teachers in Residence: Adding Reality to Physics Teacher Prep.	Chemistry 1300
1–2:30 p.m.	EE	Wii Remote for Physics Learning	Chemistry 1400
1–2:30 p.m.	EF	Forgotten Women in Science	Chemistry 1640
1–2:30 p.m.	EG	Biography in Physics	Dana 1040
1–2:30 p.m.	EH	Enabling Us All: The Broad Physics Legacy of H. Richard Crane	Dennison 170
1–2:30 p.m.	EI	Highlights of the International Year of Astronomy	Dennison 182
2:30–4:15 p.m.	P5	AAPT Awards – DSC and Excellence in Teaching	Mendelssohn Theater
4:15–6 p.m.	FA	Panel: Research-Based Studies on Writing to Learn	CC Little 1528
4:15–6 p.m.	FB	Frontiers in Variable Star Astronomy	Chemistry 1200
4:15–6 p.m.	FC	Students' Reasoning, Understanding, and Mental Models	Chemistry 1210
4:15–6 p.m.	FD	Modeling Instruction in Physics	Chemistry 1300
4:15–6 p.m.	FE	Improving the Student Teaching Experience	Chemistry 1400
4:15–6 p.m.	FF	Diversity Issues	Chemistry 1640
4:15–6 p.m.	FG	Upper-Level Undergraduate Physics	Dana 1040
4:15–6 p.m.	FH	Physics and Society Education	Dennison 170
4:15–6 p.m.	FI	Interactive Lecture Demonstrations: Physics Suite Materials	Dennison 182
4:15–6 p.m.	FJ	Make and Take for Demonstrations	Randall 1412
5–6 p.m.		Exhibit Hall (Happy Hour, Sangria Punch)	ML Second Floor
6–7:30 p.m.		Summer Picnic – (ticket required)	Rackham Graduate Center
7–7:30 p.m.		Carillon Bell Tower Concert	
7:30–8:30 p.m.		Demo Show	Power Center
8:30–9:15 p.m.	PST2	Odd-numbered posters – Authors present (snacks)	Dana Hall
9:15–10 p.m.	PST2	Even-numbered posters – Authors present (snacks)	Dana Hall

WEDNESDAY, July 29

7–9 a.m.		Programs Committee Meeting II	ML Henderson
7:30–9 a.m.		Investment Advisory Committee Meeting	ML Room D
7:30–9 a.m.		Physics Bowl Advisory Committee Meeting	ML Room 2
7:30–9 a.m.		Nominating Committee Meeting II	ML Koessler
8–9 a.m.		GREAT BOOK GIVEAWAY	ML Concourse
8 a.m.–3 p.m.		***REGISTRATION***	ML Concourse
8 a.m.–5 p.m.		TYC Resource Room and Posters	ML Room 4
8 a.m.–5 p.m.		PIRA Resource Room and Apparatus Competition	ML Vandenberg
9–10 a.m.	P6	Plenary: Frank Oppenheimer and the World He Made Up	Mendelssohn Theater
10 a.m.–12 p.m.	GA	Panel: Status of Instructional Resource Specialists	Chemistry 1200
10 a.m.–12 p.m.	GB	Getting Started in Physics Education Research	Chemistry 1210
10 a.m.–12 p.m.	GC	Panel: The Changing Community of Physics: Promoting Diversity	Chemistry 1300
10 a.m.–12 p.m.	GD	Physics Education Research Around the World	Chemistry 1400
10 a.m.–12 p.m.	GE	Panel: Tutorials in Intermediate Mechanics	Chemistry 1640
10 a.m.–12 p.m.	GF	In-service and Pre-service Teacher Preparation	Dana 1040
10 a.m.–12 p.m.	GG	Upper-Division Laboratories: Ideas, Equipment, Techniques Part I	Dennison 170
10 a.m.–12 p.m.	GH	Cutting-Edge Research at the University of Michigan	Dennison 182
12–12:45 p.m.		PERTG Committee Meeting	ML Room D
12:45–2:45 p.m.	HA	Panel: High School Teachers at CERN	Chemistry 1200
12:45–2:45 p.m.	HB	Upper-Division Laboratories: Ideas, Equipment, Techniques Part II	Chemistry 1210
12:45–2:45 p.m.	HC	Computer Modeling in the Introductory Course	Chemistry 1300
12:45–2:45 p.m.	HD	Best Practices for Teaching with Technology	Chemistry 1400
12:45–2:45 p.m.	HE	Teaching Physics Around the World: Part II	Chemistry 1640
12:45–2:45 p.m.	HF	Innovations in the TYC Curriculum	Dana 1040
12:45–2:45 p.m.	HH	Teacher Preparation: Research on Teacher Quality Instruments	Dennison 182
12:45–2:45 p.m.	HI	Post-Deadline Papers	Dennison 170
3–7 p.m.		Detroit City Tour (ticket required)	Offsite
3:15–7:15 p.m.		AAPT Executive Board Meeting	ML Koessler/Room D
3:30–5:30 p.m.	HG	PERC Bridging Session	Dennison 170
6–10 p.m.		PERC Banquet/Poster Session – (ticket required)	ML Ballroom

THURSDAY, July 30

8:30 a.m.–5:30 p.m.		PER Conference	

Monday, July 27, 2009 – Session Schedule

	CC Little Bldg. 1528	CC Little Bldg. 1518	Chemistry 1200	Chemistry 1210	Chemistry 1300	Chemistry 1400	Chemistry 1640	Dana 1040	Dennison 170	Dennison 182	CC Little Bldg. 1512	CC Little Bldg. 1505	Mendel-ssohn Theater	Dana Hall Atrium
7:00 a.m.		**AAA** *Cracker-barrel:* Area Committee Chairs												
8:00 a.m.														
8:30 a.m.	**AA** *Panel:* Discussion of TYC Issues		**AB** *Panel:* What Graduate Schools Expect from Undergrad-uates	**AC** Giving More Than One Test: Physics Students' Understand-ing & Reas-oning	**AD** Interna-tional Programs and Cooperation	**AE** High-Performance Computing on the Desktop		**AJ** A Physicist Scattering on Hollywood	**AH** Innovations in Introductory Labs					**Poster Session I**
9:00 a.m.							**AF** Teaching in Urban Schools	**AG** PER Tools		**AI** Astronomy at Univ. of Michigan				
10:00 a.m.														
10:30 a.m.													***Plenary*:** APS/DPP Symposium on Plasma Physics	
11:00 a.m.														
12:00 p.m.		**BBC** *Crkrbrl:* Prof. Concerns of PER Faculty									**BAA** *Crkrbrl:* Physics and Society Education	**BBB** *Crkrbrl:* Web Resources for Teaching Astronomy		
12:30 p.m.														
1:30 p.m.	**BA** *Panel:* Intro. Phys. Course for Life Sciences		**BB** KSTF Teaching Fellowships	**BC** Issues in Student Problem Solving	**BD** Getting Published	**BE** Data Mining to Study Learning	**BF** PIRA Session: Demos and Misconcep-tions	**BG** Energy and Environment	**BH** Cutting-Edge Research at Mich. State	**BI** Preparing Undergrads for Grad School				
3:00 p.m.														
3:30 p.m.													**Millikan Medal**	
4:30 p.m.	**CI** *Posters:* Physics Bazaar		**CA** Distance Learning	**CB** Research on Student Interactions	**CC** Particle Physics in High Schools	**CD** Recruiting, Retaining Women in Physics	**CE** Teaching Physics Around the World Part I	**CF** Advice for the New Physics Teacher	**CG** Carnival Knowledge	**CH** Innovations in Teaching Astronomy				
5:00 p.m.														
6:00 p.m.														
7:30 p.m.													**AIP Gemant Award**	
8:30 p.m.														**Poster Session I–snacks**
10:00 p.m.														

Tuesday, July 28, 2009 – Session Schedule

	CC Little Bldg. 1528	CC Little Bldg. 1518	Chemistry 1200	Chemistry 1210	Chemistry 1300	Chemistry 1400	Chemistry 1640	Dana 1040	Dennison 170	Dennison 182	CC Little Bldg. 1512	CC Little Bldg. 1505	Mendel-ssohn Theater	Dana Atrium	Randall Lab 1412
7:00 a.m.												**DDD** *Crkbrl:* Nati. Task Force on Teacher Preparation			
8:00 a.m.															
8:30 a.m.			**DA** Pre-College Physics Potpourri	**DB** Student Conceptual Difficulties	**DC** What to Teach After Newtonian Mechanics	**DD** Effectiveness of Educa-tional Technology in Instruc-tion	**DE** *Panel:* Establishing & Improving Teacher Preparation Programs	**DF** Introductory College-Level Courses	**DG1** New Demos in E & M **DG2** Discrepant Events	**DH** PER-Based Materials and Research Findings				**Poster Session II**	
9:00 a.m.															
10:00 a.m.															
10:30 a.m.													**Klopsteg Award**		
11:30 a.m.		**EEG** *Crkbrl:* Prof. Concerns of Grad. Students									**EEE** *Crkbrl:* Prof. Concerns of PER Solo Faculty	**EEF** *Crkbrl:* Internation-al Issues in AAPT			
12:00 p.m.															
1:00 p.m.	**EA** New Faculty Workshop for TYC Faculty		**EB** Cutting-Edge Reasearch for Teaching	**EC** The Art and Science of Physics Teaching	**ED** Teachers in Residence	**EE** Wii Remote for Physics Learning	**EF** Forgotten Women in Science	**EG** Biography in Physics	**EH** Broad Physics Legacy of H. Richard Crane	**EI** International Year of Astronomy Highlights					
1:30 p.m.															
2:30 p.m.													**AAPT Awards Ceremony**		
3:30 p.m.															
4:15 p.m.	**FA** *Panel:* Writing to Learn Re-search Studies		**FB** Frontiers in Variable Star Astronomy	**FC** Students' Reasoning, Under-standing	**FD** Modeling Instruction in Physics	**FE** Improving the Student Teaching Experience	**FF** Diversity Issues	**FG** Upper-Level Undergrad. Physics	**FH** Physics and Society Education	**FI** Interactive Lecture Demos					**FJ** Make and Take for Demon-strations
5:00 p.m.															
6:00 p.m.															
7:30 p.m.															
8:30 p.m.														**Poster Session II - w/ snacks**	
10:00 p.m.															

Wednesday, July 29, 2009 – Session Schedule

	Chemistry 1200	Chemistry 1210	Chemistry 1300	Chemistry 1400	Chemistry 1640	Dana 1040	Dennison 170	Dennison 182	Mendel-ssohn Theater
9:00 a.m.									***Plenary:*** **Frank Oppen-heimer and the World He Made Up**
9:30 a.m.									
10:00 a.m.	**GA** ***Panel:*** **Status of Instructional Resource Specialists**	**GB** **Getting Started in Physics Education Research**	**GC** ***Panel:*** **The Changing Community of Physics: Re-sources and Programs that Promote Inclusion and Diversity**	**GD** **Physics Education Research Around the World**	**GE** ***Panel:*** **Tutorials in Intermediate Mechanics**	**GF** **In-Service and Pre-Service Teacher Preparation**	**GG** **Upper-Division Laboratories: Ideas, Equipment and Techniques, Part I**	**GH** **Cutting-Edge Research at the University of Michigan**	
10:30 a.m.									
11:00 a.m.									
11:30 a.m.									
12:00 p.m.									
12:45 p.m.	**HA** ***Panel:*** **High School Teachers at CERN**	**HB** **Upper-Division Laboratories: Ideas, Equipment, and Techniques, Part II**	**HC** **Computer Modeling in the Introductory Course**	**HD** **Best Practices for Teaching with Technology**	**HE** **Teaching Physics Around the World Part II**	**HF** **Innovations in the TYC Curriculum**	**HI** **Post-Deadline Papers**	**HH** **Teacher Preparation: Research on Teacher Quality Instruments**	
1:30 p.m.									
2:00 p.m.									
2:30 p.m.									
2:45 p.m.									
3:30 p.m.							**HG** **PERC Bridging Session**		
4:30 p.m.									
5:30 p.m.									

Saturday, July 25 Workshops

T01: Critical Thinking in Introductory Astronomy

Sponsor: Committee on Space Science and Astronomy
Time: 1–4 p.m. Saturday
Member Price: $30 **Non-Member Price:** $55
Location: Undergraduate Science Building (USB) 1230

Joe Heafner, Catawba Valley Community College, Conover, NC; heafnerj@sticksandshadows.com

This tutorial will present a series of interactive inquiry activities designed to promote critical thinking in introductory astronomy. Participants will receive copies of current activities and will experience them as students do. These activities are part of a project called Learning Critical Thinking in Astronomy, and represent the contents of a textbook that will be the eventual outcome of this project.

T02: Challenging Physics Problems for Broad Audiences

Sponsor: Committee on Science Education for the Public
Time: 1–2 p.m. Saturday
Member Price: $30 **Non-Member Price:** $55
Location: CC Little 1512

Grimvall Goran, KTH Theoretical Physics, AlbaNova, Stockholm, Sweden; grimvall@kth.se

In the daily or weekly press there are numerous Suduko, recreational mathematics, and logical problems, but almost never problems relating to physics and engineering. The presenter has published a weekly problem since 1979 in a Swedish news journal for engineers with a very wide spectrum of readers (300,000 weekly). Since 2006 a simpler problem appears in a weekly news and advertisement journal for farmers. These types of columns are rather short, differ from traditional school science tasks, and convey interesting information even if the reader does not attempt to solve the problem. Participants in the tutorial will get ideas on how to do something similar, e.g., for local or regional press, science-club newsletters and school competitions. There will be problem ideas to take home and use, either as they are or after giving them a new twist.

W01: Cyclotron Tour and Workshop – Michigan State University

Sponsors: Committee on Science Education for the Public, Committee on Graduate Education in Physics
Time: 8 a.m.–5 p.m. Saturday
Member Price: $45* **Non-Member Price:** $70*
Location: Michigan State University

Zach Constan, Michigan State University, East Lansing, MI; constan@nscl.msu.edu

Michael Thoennessen

Explore National Superconducting Cyclotron Laboratory, a world-class rare-isotope facility on the campus of Michigan State University. The day will include a behind-the-scenes tour, lectures by faculty, demonstrations, and hands-on experiments using the lab's detectors.

*This workshop fee includes lunch and demonstration materials.

W02: PIRA Lecture Demonstrations 1

Sponsor: Committee on Apparatus
Time: 8 a.m.–5 p.m. Saturday
Member Price: $80 **Non-Member Price:** $105
Location: Dennison 170

Dale Stille, University of Iowa, Iowa City, IA; dale-stille@uiowa.edu

Sam Sampere

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

W03: Learning Physics While Practicing Science

Sponsor: Committee on Physics in Undergraduate Education
Time: 8 a.m.–5 p.m. Saturday
Member Price: $70 **Non-Member Price:** $95
Location: Undergraduate Science Building (USB) 1250

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

Alan Van Heuvelen

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

W04: Teaching Physics for the First Time

Sponsor: Committee on Physics in High Schools
Time: 8 a.m.–5 p.m. Saturday
Member Price: $90 **Non-Member Price:** $120
Location: Randall 1209

Jan Mader, Great Falls, MT; jan_mader@gfps.k12.mt.us

Mary Winn

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.*

W05: Piaget, Beyond "Piaget"

Sponsors: Committee on Teacher Preparation, Committee on Research in Physics Education
Time: 8 a.m.–5 p.m. Saturday
Member Price: $55 **Non-Member Price:** $80
Location: Dennison 120

Dewey Dykstra, Boise State University, Boise, ID; ddykstra@boisestate.edu

In the late 1970s the first AAPT workshop introduced applications of Piaget's ideas to physics teaching. For most, Piaget's organization of his data into stages of reasoning explained student difficulties with physics materials. Satisfied, many did not look further. This workshop will draw the participant beyond stages directly into Piaget's theory of cognitive development, how and why people develop in their understanding of the world. The participants will learn about Piaget's cognitive equilibration theory, which challenges the traditional view of teaching. In the spirit of his experimental method, participants will examine classroom evidence of student understanding of physical phenomena. Instructional practices consistent with the theory and evidence of their spectacular effect will be considered. A take-home supplement to the extensive workshop manual will include activities on stages of reasoning as identified by Piaget and co-workers. This supplement is based on the original AAPT workshop.

W06: Using Research-Based Curricula and Tools to Revitalize Your Introductory Course

Sponsors: Committee on Research in Physics Education, Committee on Educational Technologies
Time: 8 a.m.–5 p.m. Saturday
Member Price: $65 **Non-Member Price:** $90
Location: Randall 1221

David Sokoloff, University of Oregon, Eugene, OR. sokoloff@uoregon.edu

Ronald Thornton, Priscilla Laws

This hands-on workshop is designed for those who want to present active learning and computer tools in their introductory courses. We will acquaint attendees with 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. 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 NSF.

W07: Falsification Labs

Sponsor: Committee on Laboratories
Time: 8 a.m.–12 p.m. Saturday
Member Price: $35 **Non-Member Price:** $60
Location: Randall 1224

Eric Ayars, California State University–Chico, Chico, CA; ayars@mailaps.org

Tim Erickson

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 that 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.

W08: A New Methodology for Using Clickers in Physics Lectures

Sponsors: Committee on Research in Physics Education, Committee on Professional Concerns
Time: 8 a.m.–12 p.m. Saturday
Member Price: $40 **Non-Member Price:** $65
Location: Randall 1261

Neville Reay, The Ohio State University, Columbus, OH; reay@mps.ohio-state.edu

Lei Bao, Lin Ding, and Albert Lee

Participants in this workshop will experience a new question-sequence clicker methodology that helps students both to enjoy lectures and experience significant learning gains. Participants will use clickers to observe a variety of presentation techniques and suggest some of their own. They will learn how to create and validate sequences and evaluate learning gains. Collaborating in teams, participants will create and present their own two-question sequences. Presenters from the Ohio State University Physics Education Research Group are an experienced clicker team funded in part by the NSF. They have created, validated, used, and evaluated for learning gains clicker question sequences covering all major concepts for three quarters of introductory physics. Participants will be given disks containing these sequences, a brief "how to" manual, and associated published papers.

W11: NTIPERS: Research-Based Conceptual Reasoning Tasks for Introductory Mechanics

Sponsors: Committee on Research in Physics Education, Committee on Physics in Two-Year Colleges
Time: 1–5 p.m. Saturday
Member Price: $30 **Non-Member Price:** $55
Location: Chemistry 1650

David Maloney, IPFW, Ft. Wayne, IN; maloney@ipfw.edu

Curtis Hieggelke, Steve Kanim

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

W12: VPython: 3-D Programming for Ordinary Mortals

Sponsors: Committee on Physics in Undergraduate Education, Committee on Educational Technologies
Time: 1–5 p.m. Saturday
Member Price: $35 **Non-Member Price:** $60
Location: Randall 1224

Bruce Sherwood, NCSU Physics, Raleigh, NC; Bruce_Sherwood@ncsu.edu

Ruth Chabay

VPython is a programming environment that enables even novices to write programs that produce navigable real-time 3D animations. The new version 4.0 supports transparency and material displays such as wood or marble on all platforms, and for the first time runs as a native application on the Mac. Students in our introductory physics courses use VPython to write programs to model physical systems and to visualize electric and magnetic fields (http://www4.ncsu.edu/~rwchabay/mi). One to two hours of carefully crafted instruction is sufficient to bring novice students to the point of being able to do serious computer modeling. VPython is based on the Python programming language (http://python.org) which has a large user community. Like Python, VPython is open source freeware available for Windows, Linux, and Macintosh (http://vpython.org). Workshop participants will learn to write 3D programs and can sample existing physics applications.

workshops–Sunday

W13: Haunted Physics Laboratories

Sponsor: Committee on Science Education for the Public
Time: 1–5 p.m. Saturday
Member Price: $65 **Non-Member Price:** $90
Location: Randall 1233, 1412, 1416

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

Nearly everyone enjoys Halloween. Combine this with physics, considered to be scary by most of the public, and you have a spooktacular Haunted Physics Lab to attract students to your department or community event. Children and adults will learn physics and be confronted by their misconceptions as they interact with displays and apparatus that illustrate phenomena from many areas of physics. Learn how to put on a Haunted Physics Lab at your school or elsewhere in the community while using mostly standard laboratory and demonstration equipment from your stockroom. Participants will receive a resource CD and lots of goodies to create their own Haunted Physics Lab back home. See a description and pictures of some displays at http://www.aa.psu.edu/lionscience/haunted-lab.html.

W14: Potpourri of Simulations

Sponsors: Committee on Educational Technologies, Committee on Physics in Two-Year Colleges
Time: 1–5 p.m. Saturday
Member Price: $70 **Non-Member Price:** $95
Location: Randall 1261

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

A wide variety of simulations have become available, including both free and commercially available packages. In this workshop, simulations will be viewed from a consumer's, i.e. physics teacher's, point of view. Participants will explore several different simulation packages including PhET, Physlets, and TEAL, and advantages and disadvantages for using them will be examined. Sample uses of the simulations in the classroom including assessment, demonstration, and lab activities will be explored, and participants will develop curriculum pieces that employ simulations.

Sunday, July 26 Workshops

W15: Using RTOP to Improve Physics and Physical Science Teaching

Sponsors: Committee on Teacher Preparation, Committee on Physics in Pre-High School Education
Time: 8 a.m.–5 p.m. Sunday
Member Price: $70 **Non-Member Price:** $95
Location: Dennison 120

Kathleen Falconer, Buffalo State College, Buffalo, NY; 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.

W16: Road Show Apparatus: Design, Construction, and Application

Sponsors: Committee on Science Education for the Public, Committee on Apparatus
Time: 8 a.m.–5 p.m. Sunday
Member Price: $95 **Non-Member Price:** $120
Location: Dennison 182

David Sturm, University of Maine, Orono, ME; sturmde@maine.edu

Brian Jones

How do you organize the apparatus for Physics On The Road? Structured similarly to the 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 of apparatus. For each, we'll cover design and construction, and application of existing demonstrations found in most departments. Workshop leaders will also discuss how to organize your collection for travel and storage using the PIRA Demonstration Classification System. Some travel-friendly apparatus will be made in the workshop. And of course, we'll network, and we'll share and develop plenty of new ideas for cool road show gear. Your own "top road show demo" list can be sent now to sturmde@maine.edu and we'll share this survey's results for the first time in the workshop.

W17: Research-Based Alternatives to Problem Solving in General Physics

Sponsors: Committee on Research in Physics Education, Committee on Physics in Two-Year Colleges
Time: 8 a.m.–5 p.m. Sunday
Member Price: $55 **Non-Member Price:** $80
Location: Dennison 110

Kathleen Harper, Denison University, Granville, OH; harperk@denison.edu

Thomas Foster, David Maloney

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

W18: Taste of Technology

Sponsor: Committee on Educational Technologies
Time: 8 a.m.–5 p.m. Sunday
Member Price: $65 **Non-Member Price:** $90
Location: Randall 1221/1224

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

Michelle Strand

Want to learn about state-of-the-art educational technologies? Not sure where to start? Worried about getting in over your head in a full-day workshop? If so, come join us for a Taste of Technology. This full-day workshop will consist of 8 two-hour mini-workshops chosen from the most-successful and well-attended Committee on Educational Technologies sponsored workshops of the recent past. Participants will sample, or "taste," four out of the 8 workshops during the course of the day. These mini-workshops include: Blogs, Wikis and Forums, comPADRE, Easy Java Simulations, Real Time Data Acquisition Tools, TELS, Tracker Video Analysis, VPython, and WebTOP. The workshop will be run in two rooms, allowing participants to choose among two mini-workshops at a time. A schedule of the mini-workshops along with a brief abstract for each will be sent to participants about two weeks before the meeting. At the end of the day, participants will receive materials (handouts, CDs, books) from all 8 mini-workshops. More information and abstracts for each mini-workshop are available at http://webphysics.davidson.edu/mjb/taste_09.html.

W19: PIRA Lecture Demonstrations 2

Sponsor: Committee on Apparatus
Time: 8 a.m.–5 p.m. Sunday
Member Price: $80 **Non-Member Price:** $105
Location: Dennison 170

Dale Stille, University of Iowa. Iowa City, IA; dale-stille@uiowa.edu

Sam Sampere

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

W20: Learning the "Game" of Science: Introducing Students to the Nature and Philosophy of Science

Sponsor: Committee on History & Philosophy of Physics
Time: 8 a.m.–12 p.m. Sunday
Member Price: $30 **Non-Member Price:** $55
Location: Dennison 130

David Maloney, IPFW, Fort Wayne, IN; 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.

W21: Writing Better Tests: Mining the Data

Sponsor: Committee on Physics in High Schools
Time: 8 a.m.–12 p.m. Sunday
Member Price: $40 **Non-Member Price:** $65
Location: CC Little 1512

Nathan Unterman, Glenbrook North High School, Northbrook, IL; 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.

W22: Preparing Pre-College Teachers to Teach Physics by Inquiry

Sponsors: Committee on Research in Physics Education, Committee on Physics in High Schools
Time: 8 a.m.–12 p.m. Sunday
Member Price: $55 **Non-Member Price:** $80
Location: Chemistry 1650

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

This workshop focuses on how college and university physics faculty can contribute to the professional development of pre-college (K-12) teachers. Participants will have an opportunity to gain hands-on experience with Physics by Inquiry, instructional materials designed to provide teachers with the background needed to teach physics and physical science as a process of inquiry. Excerpts from a video produced by WGBH will be used to illustrate interactions between teachers and instructors during a course based on these instructional materials. Participants will also gain an understanding of how physics education research has guided the design of the curriculum. In addition, there will be a discussion of various intellectual and practical issues. Volumes I and II will be provided to participants.

W23: The Physics of Supernovae

Sponsor: Committee on Space Science and Astronomy
Time: 8 a.m.–12 p.m. Sunday
Member Price: $35 **Non-Member Price:** $60
Location: Undergraduate Science Building (USB) 1250

Doug Lombardi. North Las Vegas, NV; dalombardi@interact.ccsd.net

Donna Young, Pamela Perry

Space and ground-based telescopes use computer-aided data collection and processing. The Chandra X-Ray Observatory downloads millions of pieces of information to Earth. To control, process, and analyze this flood of data, scientists rely on computers, not only to do calculations, but also to change numbers into pictures. Participants will learn how to access and use image analysis software that turns their computer into a virtual Linux machine. They will access the archived Chandra X-ray data, and use the DS9 software to investigate supernovae and galaxies using analysis tools such as radial profiles, light curves, energy spectra plots, and histograms.

W24: Teaching Astronomy Through Active Learning

Sponsor: Committee on Space Science and Astronomy
Time: 8 a.m.–12 p.m. Sunday
Member Price: $65 **Non-Member Price:** $90
Location: Randall 1412

Michael LoPresto, Henry Ford Community College, Dearborn, MI; lopresto@hfcc.edu

Center for Astronomy Education (CAE) http://astronomy101.jpl.nasa.gov/

The overarching goal of this workshop is for participants to become familiar with learner-centered teaching and assessment materials, as well as how to implement them in their college astronomy courses. To accomplish this goal, participants will learn how to create productive learning environments by 1) reviewing research on the nature of teaching and learning, and by 2) spending the bulk of our workshop time engaged with learner-centered instructional strategies such as: interactive lectures, Think-Pair-Share, engaging demonstrations, collaborative groups, Lecture-Tutorials, and Ranking Tasks. The workshop will culminate with participants learning how to put these teaching strategies together into effective learning sequences for the learner-centered classroom.

W25: Physics and Toys I: Force, Motion, Light, and Sound

Sponsors: Committee on Science Education for the Public, Committee on Physics in Pre-High School Education

Time: 1–5 p.m. Sunday

Member Price: $40 **Non-Member Price:** $65

Location: CC Little 1505

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

W26: Energy in the 21st Century

Sponsors: Committee on Science Education for the Public, Committee on Physics in Two-Year Colleges

Time: 1–5 p.m. Sunday

Member Price: $35 **Non-Member Price:** $60

Location: Randall 1261

Gregory Mulder, Linn-Benton Community College Albany, OR; mulderg@linnbenton.edu

Pat Keefe, 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 group projects that involve designing energy systems. The first looks at the human race's global energy budget; the next exercise looks at the United States' usage of energy; the final exercise has you consider your own energy budget at home. All of these modeling exercises look at past energy consumption patterns and develop a plan for energy usage into 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.

W27: Promoting Active Inquiry-Based Learning with Computers in High Schools

Sponsor: Committee on Physics in High Schools

Time: 1–5 p.m. Sunday

Member Price: $40 **Non-Member Price:** $65

Location: Randall 1209

Maxine Willis, Dickinson College, Carlisle, PA; willism@dickinson.edu

Priscilla Laws, Marty Bamberger

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.

W28: What Every Physics Teacher Should Know About Cognitive Research

Sponsors: Committee on Research in Physics Education, Committee on Professional Concerns

Time: 1–5 p.m. Sunday

Member Price: $30 **Non-Member Price:** $55

Location: Dennison 268

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

In the past few decades, cognitive research has made major 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. This workshop will be useful for all physics teachers. Those involved in physics education research are particularly encouraged to attend.

W29: Tutorials in Introductory Physics

Sponsors: Committee on Research in Physics Education, Committee on International Physics Education
Time: 1–5 p.m. Sunday
Member Price: $55 **Non-Member Price:** $80
Location: Chemistry 1650

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

Tutorials in Introductory Physics is a set of instructional materials intended to supplement the lecture, textbook, and laboratory of a standard calculus-based or algebra-based introductory course. The tutorials are designed to address specific conceptual and reasoning difficulties that have been identified through research. In addition to providing hands-on experience with the curriculum, the workshop will include discussions of instructional strategies and results from assessments of student learning. Important aspects related to implementation of the tutorials will be covered, including preparation of graduate teaching assistants, undergraduate peer instructors, and post-docs. Copies of T*utorials in Introductory Physics* will be provided to participants.

W30: Teacher and Researcher: Designing Research Studies Around PhET's Interactive Simulations

Sponsors: Committee on Research in Physics Education, Committee on Educational Technologies
Time: 1–5 p.m. Sunday
Member Price: $35 **Non-Member Price:** $60
Location: Randall 1412

Kathy Perkins, University of Colorado Boulder, Boulder, CO; katherine.perkins@colorado.edu

Wendy Adams

Learn about ideas for combining the teaching and research aspects of your job. Most faculty are not trained to be education researchers; however, they are in a position to do high-quality studies while teaching. The suite of 80 research-based simulations developed by the Physics Education Technology (PhET) Project (http://phet.colorado.edu) create animated, interactive, game-like environments that are designed to engage students in active thinking, encourage experimentation, and help develop visual and conceptual models of physical phenomena, emphasizing their connections to everyday life. How does learning with simulations compare to learning with other resources? What types of simulation use are most effective? What are the impacts on learning, enjoyment, nature of student engagement, and preparation for future learning? These simulations provide a rich resource for investigating these questions. In this workshop, participants will identify several research questions and design research studies that they could carry out within the context of their own teaching.

W31: Teaching and Demos in Nuclear Physics

Sponsors: Committee on Science Education for the Public, Committee on Physics in High Schools
Time: 1–5 p.m. Sunday
Member Price: $35 **Non-Member Price:** $60
Location: Randall 1233

Zach Constan, Michigan State University, East Lansing, MI; constan@nscl.msu.edu

Michael Thoennessen

This workshop is a hands-on introduction to tools for teaching nuclear science, including classroom resources and opportunities outside the school. All are outreach programs of the National Superconducting Cyclotron Laboratory at Michigan State University. Cost includes take-home demo materials.

W34: Designing a Diagnostic Learning Environment in Pre-College Classrooms

Sponsors: Committee on Teacher Preparation, Committee on Research in Physics Education
Time: 1–5 p.m. Sunday
Member Price: $35 **Non-Member Price:** $60
Location: Undergraduate Science Building (USB) 1250

Stamatis Vokos, Seattle Pacific University, Seattle, WA; vokos@spu.edu

Eleanor Close, Lane Seeley

While many teachers engage in frequent assessment, typically this means that they identify whether the student has the "right" idea, and if not, the instruction presents more of the right idea. A diagnostic learning environment is one in which assessments are used for formative purposes, i.e., to identify the fine structure of students' understanding and reasoning, and to help the teacher decide which aspects of student thinking might be troublesome so that she/he may address specific student ideas with targeted instruction. To employ formative assessment effectively, teachers need deep subject matter knowledge coupled with robust pedagogical content knowledge. Participants of this workshop will experience a diagnostic learning environment and learn about issues that arise in setting up courses or even teacher professional preparation programs that are focused on formative assessment. In addition, participants will learn about the Diagnoser Project's free instructional tools to help diagnose pre-college student thinking and guide instructional decisions. Participants are invited to bring their own laptop.

W35: Taking Oral Histories: Preserving the Stories of Our Disciplines and Lives

Sponsors: Committee on Women in Physics, Committee on History & Philosophy of Physics

CANCELED

Time: 1–5 p.m. Sunday
Member Price: $40 **Non-Member Price:** $65
Location: Undergraduate Science Building (USB) 1230

Raymond Nelson, United States Military Academy, West Point, NY; raymond.nelson@usma.edu

This workshop is focused on techniques for taking oral histories. Its purpose is to help those interested in preserving the personal stories of women who may be considered pioneers in physics and physics education. The techniques presented, however, will be generally applicable to any project where significant contemporaneous accounts of historical events are being preserved through audio or video recordings of subject interviews.

W36: The Best Intermediate and Advanced Lab You Will Ever See

Sponsor: Committee on Apparatus
Time: 1–5 p.m. Sunday
Member Price: $40 **Non-Member Price:** $65
Location: Randall 4268

Ramon Torres-Isea, University of Michigan, Ann Arbor, MI; rtorres@umich.edu

Mary Ann Klaussen, Van Bristrow

The 2009 AAPT Summer Meeting offers a unique opportunity for individuals who are interested in or working with intermediate and advanced physics laboratories. This is due to the "2009 Topical Conference – Advanced Laboratories" meeting which is taking place at Michigan immediately prior to the start of the AAPT meeting. This means that in addition to the excellent laboratory experiments that Michigan already has, other colleges from across the United States will be bringing and setting up their best experiments also. In other words, for one time only, the "best of the best" will be together in the same room. A photon counting experiment from Brown University, advanced optics experiments from Eastern Michigan University, and unique laboratories in electronics from the University of Michigan–Dearborn are just some of the experiments slated to appear. This workshop will be in the form of a walking tour with explanations and technical details on each experiment being provided.

SUNDAY, July 26

Registration 7 a.m.–4 p.m. and 7:30–9:30 p.m.
Michigan League Concourse

High School Share-a-Thon 6–8 p.m
West Hall 340

Exhibit Hall Opens/ Welcome Reception 8–10 p.m
Michigan League 2nd floor

Session SUN: Undergraduate Student Research and Outreach (Posters)

Location: Michigan League, Koessler
Sponsor: Committee on Physics in Undergraduate Education
Date: Sunday, July 26
Time: 5:30–6:30 p.m.

Presider: Gary White

Undergraduates present resarch from a wide variety of physics related areas. Posters detailing science outreach events are also welcome.

SUN01: 6–8 p.m. Exploring Student Knowledge of Voltage, Resistance, and Current

Rebecca L Crema, Grove City College, 180 Mill Rd., PO Box 314, Port Republic, NJ 08241; cremarl1@gcc.edu*

I am researching students' understanding of electric circuits in an introductory, nonscience-major physics class at Grove City College. Differentiating between and understanding current, voltage, and resistance is quite difficult and confusing for many students. I have been researching the common misconceptions held by students before, during, and after their class and lab involvement with circuits. Students in the class I studied spend three lab sessions working with circuits. I videotaped students using the original laboratory materials, interviewed students about their understanding of circuit concepts after each lab activity, and analyzed diagnostic test data to identify specific problem areas. I have helped re-write the laboratory materials to improve student learning. This presentation will present the difficulties students were encountering, describe how we modified the lab materials to better address those difficulties, and summarize the changes in diagnostic data we saw after introducing the modified materials.
*Sponsor: DJ Wagner

SUN02: 6-8 p.m. Applying Physics in an Artist's World

Kristal Feldt, University of Kansas, Lawrence, KS 66044; kfeldt@ku.edu

Based on my own experiences in connecting the worlds of physics and art, I believe that the two fields share more in common than people in either field expect. In my poster, I will discuss how a designer must consider certain details of physics to create her own works of art and provide recommendations on how to capture the interest of artistically minded students. I will also provide resources on artists that draw inspiration from physics, books on the topic of physics and art, and simple ways to introduce artistic creativity to one's life.

SUN03: 6–8 p.m. Astronomy Labs Using Software and Video Analysis

Kathleen M. Geise, University of Denver, Denver, CO 80208; kgeise@du.edu

Steven Iona, Peter Hallam, University of Denver

Using a readily available commercial astronomy software package, we have generated movies that students import into data collection software for video analysis. These, along with other activities, have become part of the laboratory experiences in our undergraduate, nonmajor physics and astronomy course. The topics covered in the labs include: using Io's orbit of Jupiter to explore Kepler's laws; calculating the eccentricity and retrograde motion of Mars; observing the Earth's precession; and exploring observational astronomy topics such as constellation identification, using coordinate systems, and determining relationships using the magnitude scale. Students also explore the effect of light pollution.

SUN04: 6–8 p.m. Effects on Problem Solving Skills Due to Particular Styles of Questions

Zachary S. Goldman, Denison University, Department of Physics and Astronomy, Granville, OH 43023; goldma_z@denison.edu*

Chenggeng Zeng, Kathleen A. Harper, Denison University

There is a perception among many beginning physics students that "solving" physics problems is simply a matter of deciding how to manipulate the quantities given in the question to compute "the" answer. We attempt to help students develop a more sophisticated set of problem-solving skills and a deeper understanding of the underlying physical principles by providing homework/collaborative work questions that include a greater or lesser amount of information than is needed to adequately respond to the question. We also pose questions that are based on situations where the suggested outcome is impossible (that is, there is no valid solution to the problem) and situations where there are several outcomes that fit the requirements of the problem (several valid solutions). We study the effect that these questions have on the problem solving ability of introductory physics students.
*Sponsored by Kathleen A. Harper.
This work is sponsored by NSF grant DUE-0633677

SUN05: 6–8 p.m. Classification of Physical Models

Christopher A. Merck, Stevens Institute of Technology, Hoboken, NJ 07030; cmerck@stevens.edu

Rajen Dutta, Brandon Langley

A classification system for models used in physics is developed. Models are defined using set-theoretic structures. Morphisms between structures formalize the concepts of symmetry within a model, equivalence of two models, and generalization relationships. The classification is then developed based on the cardinality and complexity of the models' various components including time, field, and predictive properties. Also explored is the problem of observation of and within models. Some examples are provided, including finite models, the many body system, Navier-Stokes fluid flow, quantum puppeteering, cellular automata, and feedback loops.

SUN06: 6–8 p.m. Identifying Student Difficulties with Pressure in a Fluid

Adam J. Moyer, Grove City College, Kittanning, PA 16201; moyeraj1@gcc.edu

My study is part of an effort to develop an FCI-style diagnostic test covering fluids. I have been studying the responses to a question modified from materials by McDermott.[1]. This question, which asks students to rank pressures in an N-shaped tube and explain their reasoning, has been administered to hundreds of students in three different introductory courses at Grove City College. As expected, the data seems to provide an endless range of answers. Explanations given by students are crucial to consider, since students will choose the same rankings for very different reasons. I have sorted the responses into categories relating to similar interpretations of the question. I will use the commonly occurring difficulties to develop a series of multiple-choice questions probing the various facets of student understanding of pressure. By analyzing the data from the resulting questions, instructors will be able to tailor instruction to address the the identified difficulties.

1. McDermott, et. al., *Instructor's Guide for Tutorials in Introductory Physics* (Pearson Education, Upper Saddle River, NJ) 2003.

SUN07: 6–8 p.m Problem-Solving Skills in College Introductory Physics

Chengeng Zeng, Department of Physics and Astronomy, Denison University, Granville, OH 430023; zeng_g@denison.edu*

Zachary Simon Goldman, Kathleen A. Harper, Denison University

In the practice of teaching college introductory physics classes, students exhibit different types of learning patterns with different degrees of understanding. The spectrum of this diversity can be best exemplified by the mistakes they made on the problems specially designed for assessment purpose. This study designed a set of problems covering the major topics in introductory physics and aimed to analyze the students' thinking processes and problem-solving skills. In the poster, several such thought-provoking problems are given and their variations are shown to help provide insight into how students take in information and build the mathematical models based on the physical situations. The problems are also meant to diversify the current problem-designing scheme that is predominantly imbued with "one valid answer; no more or no less information provided" philosophy. Teachers may find them intriguing to read and will hopefully harvest some inspiration and ideas from our samples.

* Sponsored by Kathleen A. Harper

This work is sponsored by NSF grant DUE-0633677.

SUN08: 6–8 p.m. Reaching Out to the Public: UM Society of Physics Students

Jessica A. Zinger, University of Michigan Society of Physics Students, 905 Sybil St., Ann Arbor, MI 48104; jazinger@umich.edu

Public outreach is one of the main activities that the University of Michigan Society of Physics Students (SPS) engages in. This poster will showcase photos from Physicspalooza, an event we put on at the Ann Arbor Hand's On Museum each year in April. Physicspalooza is an opportunity for SPS to bring physics to the public in an accessible, fun way. A major challenge we face in this endeavor is the wide range of ages and background knowledge found in a typical cross section of museum-goers. This poster will contain information about how we approach this issue as well as general information about our outreach activities.

SUN09: 6–8 p.m. Physics Quest

Leslie Watkins, North Carolina State University and The Society of Physics Students, One Physics Ellipse, College Park, MD, 20740 watkins@aps.org; lgwatkin@ncsu.edu

PhysicsQuest is a competition for middle school students. Registered classrooms receive a free kit that includes an activity book with four physics lab activities and all the materials needed to complete these activities. Each lab that the students complete provides a clue to solve a mystery detailed in the activity book. In addition to the PhysicsQuest kit, there are three extension activities for each main activity listed online. These activities provide opportunities for additional exploration of the concepts outlined in the main lab activities. My role as an APS intern this summer has been to develop the extension activities for the 2009 PhysicsQuest kit, which will be laser themed in honor of the 50th anniversary of the invention of the laser.

SUN10: 6–8 p.m. Through Time with Galileo: The 2009 SPS Outreach Catalyst Kit

Mary Mills, The College of Wooster and the Society of Physics Students, One Physics Ellipse, College Park, MD, 20740; mmills@aip.org, mmills10@wooster.edu

This is the eighth year for the Society of Physics Students Outreach Catalyst Kit (SOCK) Program. With 2009 being the International Year of Astronomy, this year's topic is Galileo and it celebrates not only his discoveries in astronomy but also some of his other physics experiments. The SOCK will feature lessons on building a refracting telescope, racing household items down an inclined plane, and fun with moon craters. Other demonstrations include day and night observations with a Galileoscope, instructions to build a water clock, and many other topics. If your chapter is interested in getting a SOCK, please contact me directly or the SPS National Office.

SUN11: 6–8 p.m. Documenting the International Year of Astronomy

Scott Stacy, Texas Christian University and The Society of Physics Students, One Physics Ellipse, College Park, MD, 20740; sstacy@aip.org, S.A.Stacy@tcu.edu

The year 2009 will commemorate the achievements of astronomy from the past 400 years. Dubbed the International Year of Astronomy (IYA), communities around the globe are compiling resources associated with astronomy and the history of astronomy. Over 400 years have passed since Galileo Galilei turned his telescope to the night sky to study objects that lie within the universe. To honor his achievements, Galileoscopes have been developed so that people around the world can make the same observations that Galileo made. In association with comPADRE (Communities for Physics and Astronomy Digital Resources in Education), www.astronomycenter.org is assembling lesson plans, simulations, biographies, tutorials, and demonstrations to educate communities on the progress of astronomy. The resources assembled by astronomy.org over the next year are being archived in comPADRE. The author will examine and catalogue a quantity of the notable entries in this collection which will provide beneficial tools for teachers, students, and organizations to use in understanding the science and history of astronomy.

SUN12: 6–8 p.m. Physics To Go: Online Magazine and Resource Collection

Raina Khatri, Hope College and The Society of Physics Students, One Physics Ellipse, College Park, MD, 20740; khatri@aps.org,raina.khatri@hope.edu

Physics To Go (www.physicstogo.com) is an outreach website, an informal collection of resources intended for readers who want to explore physics on their own. The homepage is also a magazine, updated every two weeks to focus on a different topic in physics by featuring outstanding websites in the Physics To Go collection. My role in this project is to compose new homepages by finding websites and pictures to feature. I catalogue sites in the collection and write descriptions of them for the homepage. This position is one of the outreach/policy internships offered by the Society of Physics Students. Physics To Go is a member of the comPADRE Digital Library, funded by the National Science Foundation, and is maintained by the American Physical Society.

MONDAY, July 27

Registration *Michigan League Concourse*	7 a.m.–5 p.m.
First Timers' Gathering *Michigan League Koessler*	7–8:30 a.m
Poster Session *Dana Hall*	8:30 a.m.–10 p.m. (authors present 8:30 p.m.-10 p.m.)
Symposium on Plasma Physics *Mendelssohn Theater*	10:30 a.m.–12 p.m
Exhibit Show *Michigan League 2nd Floor*	10 a.m.–6 p.m
Millikan Medal *Mendelssohn Theater*	3:30–4:30 p.m

Session AAA: Crackerbarrel for Area Committee Chairs

Location: CC Little 1518
Sponsor: Committee on Professional Concerns
Date: Monday, July 27
Time: 7–8:30 a.m.

Presider: Robert Beck Clark

This crackerbarrel is designed to provide AAPT Area Committee Chairs and Vice Chairs with the opportunity to share ideas and experiences associated with successfully shepherding the work of AAPT Area Committees.

Session AJ: A Physicist Scattering on Hollywood

David Saltzberg

Location: Dana 1040
Date: Monday, July 27
Time: 8:30–9:30 a.m.

Presider: Myron Campbell

AJ01: 8:30–9:30 a.m. A Physicist Scattering on Hollywood

David Saltzberg, University of California-UCLA, Los Angeles, CA 90095-1547; saltzbrg@physics.ucla.edu

For the last two years I have served as the physics consultant for the popular television situation-comedy "The Big Bang Theory" which features physicists as its main characters. I will describe my experiences with the production.

Session AA: Panel – TYC Issues

Location: CC Little 1528
Sponsor: Committee on Physics in Two-Year Colleges
Date: Monday, July 27
Time: 8:30–10:30 a.m.

Presider: Paul Williams

A large number of issues, besides those of the classroom, confront TYC faculty every year. Among these issues are assessment, accreditation, articulation, the role of adjunct faculty, and others. In this session, panelists will give presentations on their experiences in dealing with these issues. There will be a question and answer and discussion session following panelist presentations.

Invited Speakers:

Ron Johns, Austin Community College, Austin, TX 78758; rjohns@austincc.edu

Bill Hogan, Joliet Junior College, Joliet, IL; whogan@jjc.edu

Dennis Gilbert, Lane Community College, Eugene, OR: gilbertd@lanecc.edu

Session AB: Panel – What Graduate Schools Expect from Undergraduates

Location: Chemistry 1200
Sponsors: Committee on Graduate Education in Physics, Committee on Physics in Undergraduate Education
Date: Monday, July 27
Time: 8:30–10:30 a.m.

Presider: Melissa Eblen-Zayas

This panel discussion will focus on how graduate school admissions committees evaluate applicants and what factors predict success in grad school. How do schools evaluate students with different backgrounds—international students, students from liberal arts college, and students from research universities? How much and what type of undergraduate research do graduate schools expect? What role do GRE scores, transcripts, and letters of recommendation have? There will also be plenty of time for questions and discussion.

Invited Speakers:

Cagliyan Kurdak, University of Michigan, Ann Arbor, MI 48109; kurdak@umich.edu

S.D. Mahanti, Michigan State University, East Lansing, MI 48824-2320; mahanti@pa.msu.edu

Session AC: Giving More than One Test: A Closer Look at Physics Students' Understanding and Reasoning

Location: Chemistry 1210
Sponsors: Committee on Teacher Preparation, Committee on Research in Physics Education
Date: Monday, July 27
Time: 8:30–10:30 a.m.

Presider: Dewey L. Dykstra, Jr.

As physics education research develops, correlations between conceptual development and the development of reasoning are of increasing interest. Rather than just describing the nature of students' conceptions at some point in time, we begin to ask question such as: What aspects of reasoning correlate with changes in conceptual understanding observed in students? Are there certain aspects of reasoning that appear to enable or inhibit certain changes in conceptual understanding? How can we make sense of the correlations between reasoning skills and conceptual development? How rapidly does student answering on reasoning or conceptual tests change with time? Answering these questions requires that both student understanding and reasoning be observed simultaneously and that we understand the nature of the instruments we use to gather evidence of understanding and reasoning.

AC01: 8:30–9 a.m. Using Real-Time Data Display to Improve Conceptual Understanding and Spatial Visualization Ability

Invited – Ronald K. Thornton, Tufts University, Center for Science and Math Teaching, Medford, MA 02155; csmt@tufts.edu

Maria Kozhevnikov, Dept. of Psychology, George Mason University

A series of studies[1] show that that students who use real-time data logging software (MBL) or observe its use in the context of mechanics Activity-Based Curricula such as Interactive Lecture Demonstrations, Workshop Physics, and RealTime Physics (indirectly) learn conceptually (as measured by the FMCE) and show significant increases in spatial visualization ability (as measured by the Paper Folding Test and the Mental Rotation Test). A nonscience college course or even a traditional introductory course in physics does not increase students' spatial ability. Science teachers exposed to two-weeks of Activity-Based exercises also significantly increased their spatial visualization ability.

1. *Journal of Science Education and Technology*, Vol. **15**, No. 1, pp 111-132, 2006

AC02: 9–9:30 a.m. What Happens to Student Performance Between the Pre- and Post-Test?

Invited – Andrew F. Heckler, Ohio State University, Columbus, OH 43210; heckler@mps.ohio-state.edu

Eleanor C. Sayre, Ohio State University

In contrast to traditional pre- and post-testing, we administer tests to randomly selected independent groups of students throughout a course in order to examine changes in student understanding on short time scales. Here we report a number of general findings. First, there can be very rapid increases and decreases in performance over a period of several days. Second, much of the data can be characterized by a few common patterns, including no change (most common), rapid peak and decay, temporary interference, and step-up with no decay. Third, the changes often correspond to relevant homework assignments rather than relevant lectures or midterms. Finally, students in the upper half of the class, as measured by final grade, often display different changes in understanding than students in the lower half of the class. These results have been replicated for a number of topics over several classes.

AC03: 9:30–10 a.m. Giving More than One Test: A Way to Improve Instruction

Invited – Paula Heron, University of Washington, Seattle, WA 98195; pheron@phys.washington.edu

Asking questions that require students to interpret and apply fundamental concepts is one of the primary methods by which physics education researchers gain insight into student thinking. Analysis of the responses to such questions can suggest underlying difficulties with the concepts themselves and with the reasoning needed for their application. However, it is well known that subtle changes to the questions can affect how students respond. This general finding serves to remind researchers (and instructors) to interpret student responses with caution, even when informed by a variety of related questions. The variability of student responses can play another role as well. Examples will be used to illustrate how different reasoning patterns observed in response to different questions can guide the development of of effective instructional strategies.

AC04: 10–10:30 a.m. Assessment of Learning and Reasoning

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

Assessment of student knowledge involves many areas including content knowledge, general abilities in reasoning and problem-solving, as well as views and attitudes about knowledge and learning. In the physics education research community, assessment of conceptual understandings and student attitudes have been well studied, while research on student reasoning and its relations to other facets of learning is less developed but is gaining popularity. In this talk, I 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. I will show detailed analysis of students' performances on specific reasoning skills at different age groups and discuss the implications to teaching and education research.

Session AD: International Programs and Cooperation

Location: Chemistry 1300
Sponsors: Committee on International Physics Education, Committee on Physics in High Schools
Date: Monday, July 27
Time: 8:30–10:30 a.m.

Presider: Shane Wood

International collaboration is a well-known and necessary feature of physics research. What about physics education? In this interconnected age, international collaborations make just as much sense in education as they do in research. This session will explore how students and teachers share data, techniques, and ideas in collaborative projects around the world. The question of how to improve and/or expand such collaborations will also be examined.

AD01: 8:30–9 a.m. Physics Education in Chinese Universities

Invited – NianLe Wu, CASTU of Tsinghua University, Tsinghua University, Beijing 100084; nwu@tsinghua.edu.cn*

In China, there are nearly 7 million new students entering college every year. Among them, there are about 20,000 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 nonphysics 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.

* Sponsored by Lei Bao

AD02: 9–9:30 a.m. Developing Self-Learning Ability in a Bilingual College Physics Course

Invited – Ying Yun, Dept. of Physics, Southeast University, Nanjing, 210096; yyun@seu.edu.cn

Hei Zhong, Fang Gu, Hongying Huang, Lingling Meng

When freshman students enter university from high school, they immediately encounter many changes and challenges, especially in the ways of teaching and learning. They are not used to the learning styles in the university, which are more flexible and very different from what they have experienced in high school. It's important for the teachers to help students develop the ability to conduct self-motivated and controlled learning. We have been working on this goal in our physics courses for the past 10 years. In this talk, we introduce the new development in a Bilingual Physics course that uses both Chinese and English to teach physics. We describe the teaching methods designed to foster students' self-learning ability and discuss the results and implications of this new course format.

AD03: 9:30–10 a.m. Science Without Borders

Invited – Helio Takai, Brookhaven National Laboratory, Upton, NY 11973; takai@bnl.gov

Science is a multicultural activity where people of different backgrounds contribute to the ultimate human experience: the exploration of the unknown. The advent of the Internet has made it possible for communities in different countries to interact and collaborate in science and education. Tools such as videoconferencing, wikis, and blogs permit quick interaction among interested parties at a speed that was not available before. International collaboration is key to the success of large science endeavors. In education, international activities are very important for the preparation of a future workforce that is ready for the global market. In this presentation, ideas on how international educational efforts can be successful will be presented, based largely on my own experience.

AD04: 10–10:10 a.m. Masterclasses in Physics – An International Collaboration

Kenneth Cecire, Hampton University, Hampton, VA 23668; cecirek@gmail.com

The Physics Masterclass began in Europe and is managed by the European Particle Physics Outreach Group (EPPOG). The U.S. Masterclass, a project of QuarkNet, continues to develop in unique ways but in collaboration with EPPOG. The Masterclass has also reached students in the Brazil, South Africa, and Japan. The author details the cooperation that makes the Masterclass a truly international movement in physics education.

AD05: 10:10–10:20 a.m. The InterAmerican Conference in Medellin

Gordon J. Aubrecht, Ohio State University at Marion, Marion, OH 43302; aubrecht@mps.ohio-state.edu

Earlier this month, the InterAmerican Council on Physics Education had its triannual meeting at the University of Antiochia in Medellin, Colombia. This is a preliminary report on the meeting.

Session AE: High-Performance Computing on the Desktop

Location: Chemistry 1400
Sponsor: Committee on Educational Technologies
Date: Monday, July 27
Time: 9–10 a.m.

Presider: Wolfgang Christian

High-performance computing is now readily available to physics teachers due to the advent of multi-core desktop computers, high-performance graphics coprocessors, and low-cost clusters. This session explores the impact that these technologies are having on teaching and undergraduate research.

AE01: 8:30–9 a.m. Desktop Supercomputing: The Good, the Bad, and the Ugly

CANCELED

Invited – George K. Thiruvathukal, Loyola University Chicago and CISE Magazine, Chicago, IL 60640; gkt@cs.luc.edu

The age of multicore and novel computing architectures is now firmly upon us. If Intel's projections are right, the supercomputers of yesteryear will be at any physics (or science) student's disposal.

AE02: 9–9:30 a.m. High-Performance Plasma Simulation on Desktop Systems

Invited – Viktor K. Decyk, UCLA, Dept. of Physics and Astronomy, Los Angeles, CA 90095-1547; decyk@physics.ucla.edu

Desktop computers have continued to increase in capability, and simulations that required large parallel computers only a few years ago can now run on a desktop, often without modification. As an example, a plasma particle simulation with 100 million particles, interacting self-consistently via the electromagnetic fields they generate will now run on my dual quad core Macintosh. A production run of 100,000 times steps will finish in about two days. This is an astonishing capability. I will give some examples of student work on these desktop systems. This increase in performance is continuing at a breathtaking pace. NVIDIA Graphics cards have 128 to 240 processors and cost $250-400. We have recently developed particle simulation subroutines for this architecture and have obtained speed-ups of about 20-40 compared to a single processor. I will discuss the lessons learned about how to use this technology.

AE03: 9:30–10 a.m. High-Performance Computing in the Physics Classroom: Results from SC08

Invited – David A. Joiner, Kean University, Union, NJ 07083; djoiner@kean.edu

Incorporating high-performance computing (HPC) into physics education faces challenges in the lack of curriculum support, hardware support, and software support. For each of these challenges, there are an increasing number of solutions for physics teachers. The SC (SuperComputing) conference education program funded a series of "pathways to supercomputing" projects in 2008 to address curriculum across disciplines, including a Physics pathway to address issues of HPC in existing curricula for computational physics. This talk will focus on curricular examples developed for the SC conference in quantum mechanics, statistical mechanics, fluid dynamics, and many-body physics that benefit from the use of HPC, and that are supported by a series of software solutions including the Bootable Cluster CD, GridMathematica, and Easy Java Simulations.

Session AF: Teaching Physics in Urban Schools

Location: Chemistry 1640
Sponsors: Committee on Physics in High Schools, Committee on Teacher Preparation
Date: Monday, July 27
Time: 9:30–10:30 a.m.

Presider: Pat Callahan

This session is focused on challenges and success stories of teaching physics in urban schools. What makes urban science learners different from suburban? What instructional strategies have turned out to be effective/ineffective in urban physics classrooms? Session is open to discussions of political, social, psychological, and pedagogical issues affecting urban physics teaching and learning.

AF01: 9:30–10 a.m. Teaching Physics in Urban Settings: Example of Baltimore City Public Schools

Invited – Katya Denisova, Baltimore City Public Schools, Owings Mills, MD 21117; kdenisova@gmail.com

There has been considerable interest in the last decade in studies of science education in urban settings. Their findings point to inequities chronically prevalent in urban schools, where students are often denied access to fundamental opportunities in areas such as physics. I will discuss this issue using the example of Baltimore City Public Schools through the lens of a classroom teacher and the District Science supervisor. The following components will be addressed: intersection of race and poverty and its influence on urban youth's self-perception of academic ability in physics classes; preparation and retention of urban schools' physics teachers and their attitudes towards teaching and learning of physics; successful and not successful classroom practices and teaching techniques.

AF02: 10–10:30 a.m. Three Physics Classrooms, Three New York City Schools, Three Learning Experiences

Invited – Olga Livanis, NEST+m, 111 Columbia St., New York, NY 10002; olivani@schools.nyc.gov

New York City has many educational settings. My current students bridge the range from those who are under-prepared to the highest achievers. This is the story of my 2008-09 physics class in such a setting: our struggles, experiences, and what they are teaching me.

Session AG: Physics Education Research Tools: Techniques and Broad Implications

Location: Dana 1040
Sponsor: Committee on Research in Physics Education
Date: Monday, July 27
Time: 9:30–10:30 a.m.

Presider: Jeffrey Marx

AG01: 9:30–9:40 a.m. Applying Cluster Analysis to Standardized Tests: Analyzing the FMCE

R. Padraic Springuel, University of Maine, Orono, ME 04469; R.Springuel@umit.maine.edu

Michael C. Wittmann, University of Maine

Questions on the FMCE can be divided up into groups of questions that are related by physical context and representation: Force Sled, Graphs, Newton's third law, etc. Such a division aids teachers and researchers by allowing them to focus their efforts in coming up with a coherent storyline for student responses[1], but misses out on any larger pattern of responses, such as connections in student responses across question groups. Using cluster analysis, we show that larger patterns of responses on the whole test do occur and talk about what these patterns of responses might mean. In this talk, we describe our methods used and show that students group into remarkably few clusters before instruction.

1. T. I. Smith and M. C. Wittmann, "Applying a resources framework to analysis of the force and motion conceptual evaluation," *Phys. Rev. ST Phys. Educ.* Res. **4,** 020101 (2008).

AG02: 9:40–9:50 a.m. Students' Epistemology Assessed by Surveys and their Learning: Are They Consistent?

Umporn Wutchana, Mahidol University, 272 Rama VI Rd., Rajathevi, Bangkok, 08901, Thailand; g4937127@student.mahidol.ac.th

Narumo Emarat, Mahidol University

Eugenia Etkina, Rutgers University

Several studies showed that students who have expert-like epistemology are more likely to achieve high learning gains. In our project we attempted to find out whether students whose epistemology is more expert-like and less expert-like, as judged by the CLASS survey, are different in terms of their approaches to learning physics. All students enrolled in the second semester of an introductory course took the CLASS survey. We used survey results to identify expert-like and non-expert like students to participate in the study. We selected four highest scoring and four lowest scoring students. We then observed those students in laboratories and recitations during the whole semester and interviewed them at the end of the semester. We will report whether we found consistency between the students' epistemology as assessed by paper and pencil survey, their behaviors in labs and recitations, and their self-reports on learning in science classes.

AG03: 9:50–10 a.m. A Standardized Test to Assess Introductory Physics Instructional Methods

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

Aaron Titus, High Point University

The development of a broader, more inclusive assessment to be used in introductory physics courses, not just for the assessment of students' understanding, but in order to evaluate our instructional methods will be discussed. There is a need for an exam that can be used across universities to give faculty information on their students' performance on problems designed to assess not just content knowledge, but skills, such as problem solving, modeling, laboratory skills, and aspects of critical thinking. We discuss the development of such an exam, which will be particularly useful for the evaluation of courses undergoing reform, the introduction of new teaching methods, and other aspects of change, both in traditionally and non-traditionally taught courses.

AG04: 10–10:10 a.m. Interview Room vs. Classroom: How Do the Data Compare?*

Jacquelyn J. Chini, Kansas State University, Manhattan, KS 66506-2601; haynicz@phys.ksu.edu

Adrian Carmichael, N. Sanjay Rebello, Kansas State University

Sadhana Puntambekar, University of Wisconsin, Madison

In our research, we often use data collected during teaching/learning interviews[1] to investigate student learning. While the teaching/learning interview is intended to model a natural learning environment, it is different than an actual classroom learning atmosphere. A teaching/learning interview typically involves one to four students working with one researcher/facilitator in an interview room. The interaction is audio and video recorded. These differences may potentially cause students to act differently than they would in their actual class. To investigate this possibility, we used the same instructional materials in a teaching interview and laboratory setting. The instructional materials were from the CoMPASS curriculum which integrates hypertext-based concept maps with design-based activities[2]. All participants were enrolled in introductory concept-based physics. We will describe how the data collected in these two settings compare.

*This work is funded in part by the U.S. Department of Education, Institute of Education Sciences, Award # R305A080507

1. Engelhardt, P.V., et al. "The Teaching Experiment - What it is and what it isn't," Physics Education Research Conference, 2003. Madison, WI.
2. Puntambekar, S., A. Stylianou, and R. Hübscher, "Improving navigation and learning in hypertext environments with navigable concept maps," *Human-Computer Interaction*, 2003. 18: pp. 395-428.

AG05: 10:10–10:20 a.m. Effectiveness of Hands-on Experiments vs. Computer Simulations in Mechanics*

Adrian Carmichael, Kansas State University, Manhattan, KS 66506-2601; adrianc@phys.ksu.edu

Jacquelyn J. Chini, N. Sanjay Rebello, Kansas State University

Sadhana Puntambaker, University of Wisconsin, Madison

Research has shown that simulations can be more effective than hands-on activities when studying microscopic phenomenon such as electric currents.[1] It has yet to be determined if they have the same effectiveness with macroscopic phenomenon, such as those in mechanics. This study investigates the effectiveness of replacing a hands-on laboratory with a computer simulation in the context of a unit on inclined planes in the CoMPASS curriculum.[2] CoMPASS integrates hypertext-based concept maps in a design-based context. Students in three of the five introductory physics laboratory sections completed the hands-on experiment, while the other two sections performed the experiment virtually. The post-test scores of the students who used the simulations were found to be significantly greater statistically than those of students who completed the hands-on experiment.

*This work is funded in part by the U.S. Department of Education, Institute of Education Sciences, Award # R305A080507.

1. N.D. Finkelstein, et al., "When learning about the real world is better done virtually: A study of substituting computer simulations for laboratory equipment." PRST-PER, 2005. 1: p. 010103.

2. Puntambekar, S. A. Stylianou, and R. Hübscher, "Improving navigation and learning in hypertext environments with navigable concept maps.," *Human-Computer Interaction*, **18,** 395-428, 2003.

Session AH: Innovations in Introductory Laboratories

Location: Dennison 170
Sponsor: Committee on Physics in Undergraduate Education
Date: Monday, July 27
Time: 8:30–10:30 a.m.

Presider: Joseph Kozminski

AH01: 8:30–8:40 a.m. Tablet PCs as Digital Lab Notebooks

Clarisa Bercovich-Guelman, California State University San Marcos, San Marcos, CA 92096; cguelman@csusm.edu*

Charles De Leone, Edward Price, California State University San Marcos

In many introductory physics labs, students use both computers (to acquire and analyze data) and a paper lab book (to keep notes). The paper notebook has remained valuable because students can quickly record a diagram, equation, or calculation, but these notes are not easily integrated with data collected and analyzed on a computer, or with a formal lab report. Tablet PCs allow students to accomplish these tasks in one place. With Tablet PCs and digital ink, students can create hand-written graphics, drawings, and equations on the same computer used for data acquisition, simulation, analysis, and write up. Students can add screenshots from other applications and annotate them with digital ink, and share data through networked sessions. We will describe our experience using digital lab books and present examples of students' work.

*Ssponsored by Edward Price

AH02: 8:40–8:50 a.m. Evidence of Critical Thinking in Undergraduate Laboratory Reports

Jennifer Blue, Miami University, 133 Culler Hall, Oxford, OH 45056; bluejm@muohio.edu

At Miami University we hope our students learn to think critically. We have developed a rubric to use for research papers written as part of capstone courses, where students do original research. We then adapted this rubric for use with formal laboratory reports in a 100-level course. Evidence of critical thinking in this 100-level course, or the lack thereof, will be presented along with implications for instruction.

AH03: 8:50–9 a.m. Experimental Determination of Properties of the Sun Using Kitchen Equipment

A. James Mallmann, Milwaukee School of Engineering, Milwaukee, WI 53202-3109; mallmann@msoe.edu

A project will be described to determine an approximate value for the temperature of the surface of the Sun and an accurate value for the average density of the Sun. The experimental data can be obtained using equipment available in a typical kitchen, including aluminum foil, wax paper, and clear plastic film. That data can be analyzed using the principles of introductory physics. The goals of the project can be accomplished without needing to know the diameter of the Sun or the distance from Earth to the Sun.

AH04: 9–9:10 a.m. Mythbusting in the University Introductory Physics Lab

Stephen J. Van Hook, Penn State University, University Park, PA 16802; sjv11@psu.edu

Michael J. Cullin, Lock Haven University

The television show "Mythbusters" on the Discovery Channel is popular with many of today's college students. We will describe a style of introductory physics lab (inspired by the show) developed to engage students in physics and scientific inquiry and adapted to the constraints of the laboratory component of a large university introductory physics course.

AH05: 9:10–9:20 a.m. Crash Safety in the Introductory Physics Lab

Daniel Ludwigsen, Kettering University, Flint, MI 48504; dludwigs@kettering.edu

Janet Brelin-Fornari, Kettering University

This curriculum development project brings together research-based pedagogy for the introductory physics laboratory with context and topics from the field of crash safety. The mechanics content encountered in introductory physics is critical to the work of the Crash Safety Center on the campus of Kettering University. The new lab activities, with versions for both high school and university physics classes, are developed to emphasize the link to the real world and improve student attitudes about the relevance of physics. The second goal is improved conceptual understanding. Sample activities and video clips from the deceleration sled will be presented to demonstrate the curricular materials. (This work is supported the NSF-CCLI grant DUE-0736766.)

AH06: 9:20–9:30 a.m. Chladni Patterns on Drums: A "Physics of Music" Laboratory Exercise

Randy Worland, University of Puget Sound, Tacoma, WA 98416-1031; worland@ups.edu

In our "Physics of Music" course for nonscience majors, students perform a laboratory exercise involving the production and interpretation of Chladni sand patterns on drum heads. In addition to observing the nodal patterns of 2D standing waves and the nonharmonic overtones of the drum, students manipulate the applied membrane tension using the drum's tuning lugs. The effects of nonuniform tension on both the sound of the drum and the symmetry of the sand patterns are observed. This exercise illustrates the distinction between the ideal modal patterns seen in textbooks and those displayed in practice on a real drum. I will describe a simple implementation of this exercise and show student results.

AH07: 9:30–9:40 a.m. Investigating the Otto Cycle with an Adiabatic Gas Laws Apparatus

Mickey D. Kutzner, Andrews University, Berrien Springs, MI 49104-0380; kutzner@andrews.edu

S. Clark Rowland, Andrews University

Heat engines and their efficiencies are frequently discussed in introductory courses but challenging to construct and measure as a laboratory exercise. The Ideal Otto Cycle models the gasoline engine and consists of four key strokes (a) combustion (constant volume), (b) adiabatic expansion, (c) heat rejection (constant volume) and (d) adiabatic compression. These four strokes may be performed in reverse using the adiabatic gas laws apparatus. Measurements are made of the work performed on and by the gas during the two adiabatic strokes. The ratio of the network (on the gas) to heat (expelled by the gas) is compared with the theoretical efficiency of the Otto cycle.

AH08: 9:40–9:50 a.m. Using Springs to Promote Understanding

William H. Bassichis, Texas A&M University, College Station, TX 77843; bassichis_w@hotmail.com

Many metal springs require a load greater than a certain minimum before behaving like ideal springs. This feature, called initial tension, can be used to greatly increase the pedagogical effectiveness of the usual elementary physics experiment. The experiment could increase student understanding of Newton's second law and potential energy functions. The educational benefit of using such springs results from the fact that the usual, memorized formulae for the spring force and its potential energy function are not valid.

AH09: 9:50–10 a.m. Rolling to a Value for the Acceleration of Gravity

Bruce A. Weber, Montogomery College, Takoma Park, MD 20912; bruce.weber@montgomerycollege.edu

The measurement of the acceleration of gravity presents an opportunity to teach students how to look at and think about the physical world.

AH10: 10–10:10 a.m. Potato Cannons

Leopold Mathelitsch, Inst. of Physics, Univ. of Graz, Univ.platz 5, Graz, A 8010, Austria; leopold.mathelitsch@uni-graz.at

Eduard Schittelkopf, Univ. of Teacher Education Styria

Self-made cannons are used mainly for motivational reasons, at high schools or science fairs. Such cannons can be interesting tools also at the undergraduate level, experimentally building the apparatus and measuring speeds and accelerations, and theoretically modelling and computing the parameters. Therefore, quite a few articles on this topic can be found in the literature. The propulsion of such a cannon can be achieved in three different ways: by over- or low pressure of air, or an explosion of some propellant. Naturally, these methods need different theoretical models of explanation. We compared these methods by using the same cannon accelerating a piston in the three different ways. We measured in detail the accelerations of the piston within the cannon by attaching a small magnet to it and wrapping coils around the cannon. We compared the data of the three different methods of propulsion with their theoretical predictions.

AH11: 10:10–10:20 a.m. The Cat Twist Revisited

John Ron Galli, Weber State University, Ogden, UT 84408-2508; jrgalli@weber.edu

An inverted cat can right itself to land on its feet without a net torque. This paper will explain several ways that rotation can take place without a net change in angular momentum. This will be done with diagrams and with mechanical models, with and without muscles (springs). It will be argued that the standard textbook model is, at best, only partly complete and is likely not the preferred model by the discriminating cat. More information may be found at www.physics.weber.edu/galli.

AH12: 10:20–10:30 a.m. The Synchronization Issue–One of the Major Student Complaints, and Ways of Fixing It

Shahzad Riaz, 310 N. Thayer St., #2, Ann Arbor, MI 48104; Touva@aol.com

Outside of the usual classroom lecture and physics lab, other methods such as web-based home work, class demonstrations, lecture slides, discussion sections etc. are now being incorporated in the teaching of basic physics. Trying to make sense of it all, the students attend a lecture on one topic, go to the lab on a different one. Later in the day they have web homework to do on a chapter sometimes not covered in their class yet. It is easy to overlook the disconnect this may cause for the student. New innovations in technology will provide even more options for teaching in the future. It is important to make sure each of these components are synchronized in a somewhat coherent order to minimize the disconnect for the student and to bridge this gap. This talk will highlight one student's major complaints as learned by teaching on an individual basis and potential options to remedy problems.

Session AI: Astronomy at the University of Michigan

Location: Dennison 182
Sponsor: Committee on Space Science and Astronomy
Date: Monday, July 27
Time: 9:30–10:30 a.m.

Presider: Kevin Lee

This session will showcase local research done in astronomy and related fields.

AI01: 9:30–10 a.m. The Ultimate Origin of Water on the Earth

Invited – Edwin A. Bergin, University of Michigan, Ann Arbor, MI 48109; ebergin@umich.edu*

Water on the Earth is believed to originate from outgassing with a potential contribution from impacts by icy planetesimals. But where did the water molecules form? After all oxygen and hydrogen need to react to make H_2O. In this talk we will outline some of the evidence pointing to the origin of water in the depths of interstellar space a million years before the Sun was born. We will discuss observations of water vapor in the gas clouds that eventually collapse and form stars and planets and how these observations hint at the physical and chemical mechanisms of water formation at very cold temperatures (T ~ 20 Kelvins).

*Sponsored by Kevin Lee

Session PST1: Posters –

Introductory Labs, Upper Division Labs, Pre-High School, Teacher Training, Implementing & Evaluating Curriculum, PER Methods, & Assessments, Conceptual Understanding & Reasoning

Location: Dana Hall Atrium, 1024, 1028, 1046
Sponsor: AAPT
Date: Monday, July 27
Time: 8:30 a.m.–10 p.m.

(Posters will be displayed beginning at 8:30 a.m., but authors will be present at the times listed below with their abstracts. Snacks will be provided from 8:30–10 p.m.)

(A) Introductory Labs

PST1A-01: 8:30–9:25 p.m. Comparison of Three Types of MBL Experiments for Newton's Second Law

In Seung Yi, Korea National University of Education, Chung-Buk, 363-791; arah79@nate.com

So Yeon Kim, Jung Bog Kim, Se Jung Jang, Department of Physics Education

We have decided the best experiment for instruction of Newton's second law in three representative experiments using MBL which are hand experiment (forcing on cart with hands), spring experiment (using simple harmonic oscillation vertically), and weight experiment (using the gravitational force of weights). Hand experiment has been regarded to be the most suitable experiment considering convenience of experimental setting, efficiency of experimental time, accuracy of data (with less than 2% of average error), degree of difficulty of related physical concepts, etc.

PST1A-02: 9:15–10 p.m. Rocket Launch Project to Investigate Impulse and Momentum

Mark Schober, John Burroughs School, 755 South Price Rd., St. Louis, MO 63124; mschober@jburroughs.org

Duane Merrell, Brigham Young University

During the study of impulse and momentum, students design a water rocket to carry an egg as high as possible while still landing the rocket and egg safely. During the project, the relation between water mass and impulse is determined through static thrust tests; drag is measured in a simple wind tunnel and also calculated from high-speed video of the launches; triangulation reveals the maximum launch height; and high-speed video analysis reveals the acceleration during launch, the burnout velocity, and the coasting deceleration. In the poster I'll share photos, data, equipment sources, and curriculum ideas.

PST1A-03: 8:30–9:15 p.m. Investigating Tangential Acceleration in the Laboratory with a Rotation Wheel

Elizabeth A. George, Wittenberg University, Springfield, OH 45501; egeorge@wittenberg.edu

Paul A. Voytas, Wittenberg University

A typical rotational motion experiment in the introductory mechanics laboratory involves an apparatus in which a hanging weight produces a torque on a rotating wheel that can be loaded with additional masses. Varying the distance from the axis at which the masses are placed changes the moment of inertia, and the effect on the angular acceleration can be measured. We have developed an experiment in which the students are asked to consider the masses to be cars on a carnival ride and to investigate how the cars' tangential acceleration depends on their distance from the axis. As the masses are moved farther from the axis, the moment of inertia increases monotonically, but the tangential acceleration of the masses goes through a maximum. Students are typically initially surprised at this behavior, but are able to understand it by thinking about limiting cases.

PST1A-04: 9:15–10 p.m. The Flying Pig – Quantifying Centripetal Force

Paul Robinson, San Mateo High School, Redwood City, CA 94062; laserpablo@aol.com

The Flying Pig is a delightful lab for students to quantitatively demonstrate centripetal force equals mv^2/r. The pig flies in a conical pendulum. Students analyze the component forces of the tension to show that velocity square root rg tan (θ) and compare this to the experimentally obtained value of $2\pi r/T$. Students easily obtain comparable values within 3%. A delightful lab—and very instructive.

PST1A-05: 8:30–9:15 p.m. A Static Equilibrium Laboratory

Mickey D. Kutzner, Andrews University, Berrien Springs, MI 49104-0380; kutzner@andrews.edu

Andrew Kutzner, Andrews Academy

The two conditions of static equilibrium include (a) the vector sum of external forces acting on an object must be zero and (b) the sum of torques due to external forces about any axis through an object must be zero. We present a laboratory suitable for introductory physics courses utilizing two force sensors, a meterstick, and a weight that clearly teaches these concepts. The meterstick first models a bridge with supports provided by the force sensors and load provided by the weight. Forces and torques are measured and shown to add to zero. The system is then arranged to represent a cantilever, making the lab particularly appealing to students of architecture. The lab may easily be extended for pre-medical and pre-physical therapy students to include a model forearm with bicep force provided by a string with tension measured by a force sensor.

PST1A-06: 9:15–10 p.m. Experimental Verification of Boyle's Law and Adiabatic Gas Law

Mickey D. Kutzner, Andrews University, Berrien Spings, MI 49104-0380; kutzner@andrews.edu

S. Clark Rowland, Andrews University

The adiabatic gas law apparatus is used to perform a slow, isothermal compression to demonstrate that pressure is inversely related to volume at constant temperature (Boyle's Law). The same apparatus compressed rapidly approximates an adiabatic process and permits a determination of gamma (ratio of specific heats). Areas under the P vs. V curves for these two processes are compared with the theoretical predictions for work.

PST1A-07: 8:30–9:15 p.m. Differentiating the Sources of the Standing Wave Frequency Components in Students' Own Speech

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

Students can see the standing-wave frequencies due to their vocal cords alone, the standing-wave frequency formant pattern due to their oral/nasal cavity alone, and then how these frequencies are superposed, in their normal voicing of vowel sounds. A PASCO sound sensor in oscillator mode with FFT display was used. Students can see what determines the distinctive sounds characteristic of each vowel and what causes each person's voice to sound unique. Simple instructions with FFT graphs will be shown.

PST1A-08: 9:15–10 p.m. Under Pressure: A Learn-and-Demonstrate Lab

Susan Hallman, University of Tampa, Tampa, FL 33606; shallman@ut.edu

Using classroom demonstrations is a great way to get students interested in the basic principles of physics. Most of us have at least a few good demonstration apparatus tucked away in the corners of our classrooms. In fact, for some topics, one may have so many demonstrations that it is hard to choose which ones to use. This conceptual fluids and pressure lab allows the students to get their own hands on the equipment, increasing their interest by increasing interaction. Students learn one or several very simple experiments, research the science behind the apparatus, then present their demonstrations and findings to their classmates. The lab can be adjusted to be a two-hour lab, or a 50-minute activity and requires minimal equipment purchase.

PST1A-09: 8:30–9:15 p.m. Electrostatics with the Fun Fly Stick?

Robert A. Morse, St. Albans School, Mount St. Albans, Washington, DC 20016; robert_morse@cathedral.org

A new toy, the Fun Fly Stick by Unitech Toys, Inc., distributed by a number of suppliers, is a miniature Van de Graaff Generator. A nice toy by itself, costing about $30, it is worth leaving out in a classroom for students simply to play with. With a few inexpensive modifications and accessories it can be turned into a useful laboratory tool for qualitative and moderately quantitative experiments in electrostatics. This paper will describe the device, the modifications, and some of the measurements that can be made using computer interfaced charge sensors.[1]

1. R. A. Morse, "Electrostatics with Computer-Interfaced Charge Sensors," *Phys. Teach.* **44**(8), 498–502 (Nov. 2006).

PST1A-10: 9:15–10 p.m. An Apparatus for Investigating the Magnetic Field Due to a Wire*

Sytil K. Murphy, Kansas State University, Manhattan, KS 66506-2601; smurphy@phys.ksu.edu

Dean Zollman, Kansas State University

A new apparatus has been developed for exploring the magnetic field due to a wire. The apparatus is made of clear Plexiglas with a wire running through a triangular channel. The wire is connected to a battery and a switch. A compass can be used to detect the strength and direction of the magnetic field due to the wire and, because the apparatus is clear, compasses placed above and below the wire can be viewed simultaneously. When the switch is tapped, a compass placed above or below the wire may deflect depending on the orientation of the apparatus relative to an external magnetic field. Using the compass as a detector, the direction and strength of the magnetic field due to the wire can be investigated. In addition, the apparatus can be used to investigate the resonance frequency of a compass in a magnetic field.

*Supported by NSF Grant DUE 04-26754

PST1A-11: 8:30–9:15 p.m. Analysis of a Magnet Falling Through a Coil Connected into a Simple Electric Circuit

So Yeon Kim, Department of Physics Education, Korea National University of Education, Chung-Buk, 363-791; star_lit@hanmail.net

Jung Sook Lee, Min Chae, In Seung Yi, Jung Bog Kim, Department of physics education

When the magnet approaches toward an electric circuit that is composed of bulb, battery, and electric wire, especially the bulb, many students think the brightness of the bulb will change. This paper describes an experiment designed to show the electric current by electromagnetic induction. We measured the induced current by using MBL and photo detector when the magnet falls through the coil connected into a simple electric circuit. We analyzed the current varying the number of turns 100, 200 and 400 on the coil and the height of the falling magnet.

PST1A-12: 9:15–10 p.m. Using Reverse Game Play to Engage Students in Formulating and Testing Hypotheses

Mark F. Masters, Indiana University Purdue University Fort Wayne, Fort Wayne, IN 46805; masters@ipfw.edu

David P. Maloney, Indiana University Purdue University Fort Wayne

We have become deeply aware of the need to teach the nature of science to students in all science classes. Typically, it is assumed that students will "get" the idea of the nature of science through implicit instruction in the laboratory. We believe that for students to understand science, explicit experience working with scientific processes is required. However, given the background understanding necessary to effectively function scientifically it is difficult for students to gain these insights into the scientific process in the laboratory setting. To resolve this situation we have developed an activity based on a quote from Feynman that utilizes abstract strategy games in which the students use data derived from actual play of a game to determine the rules of the game. This activity can be encapsulated within a single laboratory session and addresses the essence of formulating and testing hypotheses.

PST1A-13: 8:30–9:15 p.m. Computational Modeling in Intro Physics Labs: Tracker and EJS*

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

In an already packed introductory physics curriculum, it has not been easy to include computational modeling without dramatically changing the course itself or investing a good deal of time to teaching computer programming (often at the expense of other material). However, some recently developed resources based on the Open Source Physics library have greatly reduced this barrier. This poster will describe how we incorporated computational modeling (without teaching computer programming) into some standard introductory physics laboratory exercises using both Tracker (Video Analysis and Modeling Tool) and Easy Java Simulations (Ejs). These resources are available from the OSP (Open Source Physics) Collection on ComPADRE at http://www.compadre.org/osp.

*Supported in part by NSF Grant #DUE-0442581.

PST1A-14: 9:15 –10 p.m. Conversion to Problem-Solving Laboratories*

William A. Schwalm, University of North Dakota-Grand Forks, Grand Forks, ND 58202-7129; william.schwalm@und.edu

Mizuho K. Schwalm, University of Minnesota-Crookston

The objective was to make effective use of the time students spend in the laboratory. The concept was developed at University of Minnesota-TC. We had intended to adapt the Minnesota materials, but found we had to change and augment the original system. Success depends on coordinating lectures and labs and on training of TAs. Exercises comprise collaborative problem solving in which students work in teams. The problems have context, as textbook problems do, but the solutions involve measurement. Students are assigned roles within the groups. In our adaptation, melamine whiteboards are used for reporting by the groups to the class. Students answer pre-lab questions before entering lab to enforce reading of the textbook. We have created a two-volume laboratory book, independent from the U of M lab books. They contain a completely different set of context rich laboratory activities. We hope some of these innovations will be of interest to others.

*Supported by by NSF (0510570).

PST1A-15: 8:30–9:15 p.m. Update on Appalachian State's Redesigned Introductory Physics Lab Project

Patricia E. Allen, Appalachian State University, Physics & Astronomy, Boone, NC 28608; allenpe@appstate.edu

John E. Cockman, Jon M. Saken, Appalachian State University

The algebra-based physics laboratories have been redesigned over the past year. Two of six lab sections were used to examine the effects of redesigned introductory lab activities and pedagogy on student performance and attitudes. Preliminary results (mostly positive), as well as some of the resources used in the redesign project will be presented. QuickGuides, short documents developed to guide students during lab activities, will also be discussed.

(B) Upper Division Laboratories

PST1B-01: 8:30–9:15 p.m. Writing and Peer Review for Advanced Laboratories: A Proposal

Mark F. Masters, Indiana University Purdue University Fort Wayne, Fort Wayne, IN 46805; masters@ipfw.edu

Stevens Amidon, Timothy T. Grove, Indiana University Purdue University Fort Wayne

There are a number of significant goals and issues associated with the teaching of advanced laboratories. Faculty teaching advanced laboratories often experience a feeling of isolation. For students, the laboratory should be a critical tool for synthesis of physics knowledge which can be challenging to achieve. Our proposed solution to these seemingly dissimilar issues is a new paradigm for the advanced laboratory that encourages students to write scientifically, includes calibrated peer reviews, and crosses school boundaries to create a shared mission for faculty. Writing can force synthesis but when students write a "lab report," they tend to write for the all-knowing professor which inhibits synthesis. By providing a journal to which students submit articles and for which students review the articles, the students are forced to face the audience of their unknown peers. Through this process faculty and students will form communities and students will engage in writing about physics.

PST1B-02: 9:15–10 p.m. Simple Construction of a Spherical Air Bearing*

Mark F. Masters, Indiana University Purdue University Fort Wayne, Fort Wayne, IN 46805; masters@ipfw.edu

We present a method of constructing a spherical air bearing for use in student laboratories. The method consists of casting the bearing out of polyester resin and requires tools no more complex than a drill press. A single air bearing can be constructed for less than $25. Frictional effects indicating that the drag is proportional to the angular velocity and an investigation of precession are used to demonstrate the functionality of this bearing.

*Supported by NSF DUE #0127078

PST1B-03: 8:30–9:15 p.m. The Gyroscope as a Modern Intermediate Physics Lab

Svilen D. Kostov, Georgia Southwestern State University, Americus, GA 31709; skostov@gsw.edu

Daniel Hammer, Georgia Southwestern State University

Gyroscopic motion is fascinating and counterintuitive to both the introductory physics student and the more advanced one. Too often this phenomenon is either entirely omitted from the curriculum or limited to a brief discussion of the idealized, nutation-free precession resulting from the external torque. We have developed a laboratory exercise at the intermediate physics level combining both experimental and numerical analysis of gyroscopic motion using a commercial demonstration unit equipped with rotational motion sensors, which were slightly adapted. Precession and nutation are measured simultaneously and then compared to simulated curves obtained from numerically solving the exact equations of motion for the equivalent symmetrical top. The comparison of the experimental and theoretical data gives good agreement. Variations of this experiment suitable for a general physics lab or a more advanced and extensive independent research project are discussed.

PST1B-04: 9:15–10 p.m. Intermediate Mechanics Labs

Martin Kamela, Elon University, 2625 C.B., Physics Department, Elon, NC 27244; mkamela@elon.edu

The intermediate mechanics course (ex. at the level of Fowles and Cassidy) has been generally taught as a theory class. Recent pedagogical innovations such as tutorials, of Ambrose and Wittmann, have been shown to improve student learning by increasing the level of student engagement. In this poster I report on the initial effort to include a laboratory component in the course. The purpose of including laboratory exercises is to increase student engagement and to make the ideas from the course more relevant to students with an experimental or applied physics interest. Students examine in detail physical situations that exemplify ideas from the course using video analysis or Vernier motion sensors, combined with writing simulations in Mathematica.

PST1B-05: 8:30–9:15 p.m. Construction of an Inexpensive Copper Heat-Pipe Oven*

Timothy T. Grove, Indiana University Purdue University Fort Wayne, Fort Wayne, IN 46805; grovet@ipfw.edu

Mark F. Masters, Indiana University Purdue University Fort Wayne

We present a new, low-cost method of building an all copper heat-pipe oven. Many optical and spectroscopic experiments such as resonance ionization spectroscopy, atomic and molecular spectroscopy, optically pumped lasers, and four-wave mixing in atomic vapors require a high vapor pressure of the studied material. To produce this high vapor pressure requires elevated temperatures. These requirements result in difficulties of optically accessing the vapor while keeping the vapor from condensing on the windows. The heat-pipe oven solves the problem of a hot vapor and cold windows. Copper heat pipe ovens have several advantages over more traditional stainless steel ovens for use in student laboratories. They heat up/cool down more rapidly, are ideal for experiments involving magnetic fields, and are less expensive. For our design, the construction parts are available at local hardware and plumbing supply stores, and the the assembly techniques employed are simple and require no machining.

*Supported by NSF DUE #0127078

PST1B-06: 9:15–10 p.m. A Student-Assembled Spectrograph Using a Simple Webcam

Timothy T. Grove, Indiana University Purdue University Fort Wayne, Fort Wayne, IN 46805; grovet@ipfw.edu

Mark F. Masters, Indiana University Purdue University Fort Wayne

We describe a spectrograph using a "webcam" detector that is assembled by students to assist them in understanding how optical monochromators and spectrographs function. This project stemmed from our students treating our commercial spectrometer as a black box. The detailed directions (to protect our precious instrument) simply kept the students from thinking about how to use the spectrograph and limited their functional understanding of it. By having students build their own spectrometer, they had fewer problems aligning and using the commercial device. The apparatus also works well as a low-cost demonstration helping students make connections between an atomic spectrum observed by eye, relative intensity vs. wavelength diagrams, and the simple optical components in the device.

PST1B-07: 8:30–9:15 p.m. Modifying the Optics Laboratory for Greater Conceptual Understanding*

Timothy T. Grove, Indiana University Purdue University Fort Wayne, Fort Wayne, IN 46805; grovet@ipfw.edu

Mark F. Masters, Indiana University Purdue University Fort Wayne

We developed a sequence of optics laboratories that assist the student in understanding critical concepts in optics. Our approach relies upon discussion, direct confrontation of misconceptions, and leading questions as opposed to a series of detailed, cookbook-like instructions. Through the labs we build conceptual understanding in subjects like image formation by lenses and mirrors, ray optics, and ultimately elliptical polarization while fostering laboratory independence. Initial support structure in the laboratory is progressively removed. In the final three weeks, students complete an independent research project. In this poster we present details of our laboratory sequence and our impressions of the modifications.

*Supported by NSF Grant #0410760

PST1B-08: 9:15–10 p.m. Increasing Student Independence and Insight in the Intermediate Physics Laboratory*

Timothy T. Grove, Indiana University Purdue University Fort Wayne, Fort Wayne, IN 46805; grovet@ipfw.edu

Mark F. Masters, Indiana University Purdue University Fort Wayne

David P. Maloney, Indiana University Purdue University Fort Wayne

Imagine you are investigating new physics with tools that you have never used previously and you have to reproduce results achieved by many others. How would you proceed to acquire the data? What would you learn in the process if you were given fairly detailed directions? This is the dilemma faced by many students in the modern physics laboratory. Students only have their introductory laboratory experience to guide them through more difficult investigations involving much more complex physics. Rather than having students perform a series of unrelated classic modern physics investigations, we developed an approach to the modern physics laboratory course that involves conceptually focused investigations to help the students through these difficulties and improve their understanding of physics, experimentation, and independence. The conceptually focused investigations typically start with an “introductory physics like” analog of the “modern physics” phenomenon they are to investigate. The subsequent investigations build upon these concepts.

*Supported by NSF DUE #0127078

PST1B-09: 8:30–9:15 p.m. Modified Scanning Monochromator for Undergraduate Laboratory

DaeHwan Kim, Seoul National Univ., Physics Education Dept. 18-506, San 56-1 Sillin-Dong Kwanak-Gu, Seoul, 151-742; kdh2707@snu.ac.kr

SungMuk Lee, Seoul National Univ Physics Education Dept.

We made a modified scanning Czerny-turner monochromator using self-developed rotational flexure bearing. Especially, we realized more detailed scanning monochromator by using the siphon principle and distinguished doublet and triplet of Mercury lamp. Also, we could advance the ability of Modern Physics in an undergraduate laboratory student by using application of modified scanning monochromator system.

PST1B-10: 9:15–10 p.m. Integrating Experimentation and Instrumentation in Upper-Division Physics*

N. Sanjay Rebello, Kansas State University, Manhattan, KS 66506-2601; srebello@phys.ksu.edu

Qi Zhang, Kristan Corwin, Brian Washburn, Kansas State University

A knowledgeable and successful experimental physicist must understand the conceptual underpinnings of experiments as well as the techniques of modern instrumentation, data collection, and analysis. We are currently reforming an electronics course to better connect it with modern and advanced physics laboratory courses that students have taken previously. After introducing students to the basics of analog and digital electronics the second half of the electronics course is dedicated to a capstone experience during which students revisit experiments from their previous modern and advanced physics laboratory courses. Their capstone experience focuses on designing instrumentation that automates control, data collection, and analysis in these experiments using their newly gained knowledge about electronics and LabVIEW programming. We describe some of the capstone experiences that students are engaged in and report on feedback from students on these experiences.

*This work is supported in part by U.S. National Science Foundation grant 0736897

PST1B-11: 8:30–9:15 p.m. Physics in Art: An Interdisciplinary Lab Course

Sudha R. Swaminathan, Worcester State College, Department of Physical and Earth Sciences, Worcester, MA 01602; sswaminathan@worcester.edu

F.J. Lamelas, Worcester State College

Conservation scientists often image sub-surface drawings and paintings using x radiography and infrared reflectography. Additional analytical methods include ultraviolet fluorescence, characterization of paint samples with a scanning electron microscope, and measurement of elemental composition with neutron activation analysis. We describe a course with a focus on the use of physical methods in the analysis of art objects. Our course includes many hands-on experiments in which paints and samples prepared by undergraduate students are analyzed with techniques similar to those used in the art world. Physics in Art makes modern physics accessible in a nontraditional context, and is important as an introductory science course that will appeal to students in any major.

(C) Pre-High School

PST1C-01: 8:30–9:15 p.m. Atomville: A Multimedia Project for Children and their Parents

Cindy B. Schwarz, Vassar College, Poughkeepsie, NY 12604; schwarz@vassar.edu

Jill A. Linz, Skidmore College

Atomville follows the animated adventures of Niles and Livvie, two atoms who accidentally invent a “macroscope” and discover the strange and mysterious world of human beings. Atomville will change the way children view science by teaching basic lessons in physics and chemistry through stories that feature actual atomic traits and real atomic interactions. Since less than 1 percent of the entire U.S. population ever sees atomic physics, the need for this project is clear. The first stage of the project is now complete, the book *Adventures in Atomville: The Macroscope* is in print. Targeted for third through fifth grade readers, Atomville will ultimately incorporate other multimedia outlets including TV and Internet. Come hear about the project.

PST1C-02: 9:15–10 p.m. Excited States of Elementary Students Engaged in Interactive Physics Activities

Leith D. Allen, Physics Education Research Consultant, 4301 Coolidge Ct., Sykesville, MD 21784; leith_allen@yahoo.com

Over the past two years we have conducted a series of interactive physics demonstrations with elementary school students in grades K-3. Content themes included such topics as states of matter, density, light and how we see, electricity, and forces and motion. Sessions were taught either as an after school club or during regular science class times. In this poster, we will share several activity sequences, highlighting students' predictions as well as some of their thought processes as they interacted with materials either in a hands-on or demonstration setting. Overall, the experience has been very positive for the students and the instructor.

PST1C-03: 8:30–9:15 p.m. The Potential of Informal Science Education for Development of Individuals and Institutions

Jessica E. Bartley, University of Colorado at Boulder, Boulder, CO 80302; Jessica.Bartley@Colorado.edu*

Laurel M. Mayhew, Noah D. Finkelstein, University of Colorado at Boulder

We present findings from the University of Colorado's Partnership for Informal Science Education in the Community (PISEC).[1,2] This model of university-community partnerships brings together elementary school students with university educators in Math, Engineering, and Science Achievement (MESA)-sponsored after-school programs. The elementary school students worked through flexible inquiry-based circuit activities based on The Physics and Everyday Thinking (PET) curriculum[3] with physics graduate and undergraduate students learning about education in the community. We document the interactions that these informal science education (ISE) environments support, present findings on conceptual learning gain and attitude shifts of the children who participated, and compare these findings with measures of learning and attitudes in a comparative group of children in a traditional elementary school class covering similar curriculum.

1. N.D. Finkelstein and L. Mayhew, "Acting in Our Own Self-Interest: Blending University and Community," Proceedings of the 2008 Physics Education Research Conf, AIP Press. Melville NY, 1064, (2008).
2. L. Mayhew and N.D. Finkelstein, "New Media and Models for Engaging Under-Represented Students in Science," Proceedings of the 2008 Physics Education Research Conf, AIP Press. Melville NY, 1064, (2008).
3. S. Robinson, F. Goldberg, and V. Otero,

*Sponsored by Noah D. Finkelstein

PST1C-04: 9:15–10 p.m. Informal Science Teaching Experience Informs Formal Science Teaching Training

Laurel M. Mayhew, University of Colorado, Physics Education Research, Boulder, CO 80309-0390; Laurel.Mayhew@colorado.edu

Noah D. Finkelstein, University of Colorado

The University of Colorado Partnerships for Informal Science Education in the Community (PISEC)[1] Program provides opportunities to teach science in K-12 after-school programs. Formative and summative evaluations included pre-, post-, and in-situ video taping of student teaching, surveys of student attitudes about science and teaching, observations, and ethnographic field notes. We document positive changes in the students with respect to content knowledge; attitudes and beliefs about science, the nature of science, and the nature of informal science education; teaching ability, and the ability to communicate in everyday language. The present poster focuses on case studies which demonstrate the impact of this program and particularly on the abilities of university students to communicate in everyday language. We find that students with more interactive experiences post larger gains than students whose experiences were less interactive.

1. PISEC, Partnerships in Informal Science Education in the Community, http://per.colorado.edu

PST1C-05: 8:30–9:15 p.m. PUM: Developing Reasoning Skills in the First Physics Course*

Suzanne White Brahmia, Rutgers University, Dept. of Physics and Astronomy, Piscataway, NJ 08854; brahmia@physics.rutgers.edu

Hector Lopez, Tara Bartiromo, Joseph Santonacita, James Finley, Rutgers University

Physics Union Mathematics (PUM) is a new physics curriculum spanning from middle to high school. The physics curriculum is based on the successful college-level Investigative Science Learning Environment (ISLE) curriculum in which students engage in the thought processes physicists use to construct new knowledge. An important feature of PUM is the development of mathematical reasoning skills from the outset in the context of learning physics. PUM is infused with grade-appropriate mathematical tools, and activities in which students use those tools to reason about physics. Starting in September 2008, 40 New Jersey teachers field-tested modules of the curriculum. In this poster we focus on the development of specific mathematical tools used in scientific reasoning-integers and zero, graphs and rates of change, bar charts, proportional reasoning, and algebraic descriptions-and how students at this level use them to reason. We will share the results of the implementation of four modules.

*Sponsored by NSF grant # DRL-0733140

PST1C-06: 9:15–10 p.m. IMPACT 2 Progress Report

Gordon J. Aubrecht, Ohio State University at Marion, Marion, OH 43302; aubrecht@mps.ohio-state.edu

A program to work with virtually all science teachers in Marion's single middle school was funded by the Ohio Department of Education.* The program has now completed one year with the expectation for a second year of funding. We report in this poster on the successes and failures of our intervention program.

*Ohio Dept. of Education Grant #60018325

(D) Teacher Training

PST1D-01: 8:30–9:15 p.m. Study of a Physics by Inquiry Program for K-12 Teachers*

Robert J. Endorf, University of Cincinnati, Cincinnati, OH 45221-0011; Robert.Endorf@uc.edu

Don Axe, Amy Girkin, Jeffrey Radloff, University of Cincinnati

Kathleen M. Koenig, Wright State University

Physics by Inquiry professional development programs for K-12 teachers have been held each summer since 1996 at the University of Cincinnati. A 12 credit-hour four-week graduate course in Physics by Inquiry is given for teachers in grades 5-12 and a separate 6-credit-hour two-week course is given for teachers in grades K-5. This study is based on over 400 teachers who have completed one of these summer courses, using Physics by Inquiry[1] modules developed by Lillian McDermott and the Physics Education Group at the University of Washington. Data will be presented from pre-tests and post-tests taken by the participants. The results of the study demonstrate that our Physics by Inquiry programs have produced large gains in the teachers' science content knowledge, science process skills, and in the teachers' confidence in their ability to prepare and teach inquiry-based science lessons.

* Supported by The Improving Teacher Quality Program administered by the Ohio Board of Regents.

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

PST1D-02: 9:15–10 p.m. Physics by Inquiry for Education Majors in a Learning-Living Community

Todd B. Smith, The University of Dayton, Dayton, OH 45469; tbsmith@udayton.edu

Mary Kay Kelly, Said Elhamri, University of Dayton

Beth Basista, Wright State University

The University of Dayton has committed itself to providing a transformative education through learning-living communities (LLCs). All first-year students living on campus are members of an LLC that lives together and takes certain classes together. The Curiosity in the Classroom LLC for education majors seeks to make direct connections between science content courses and teacher education courses in the hope of overcoming the disconnect that often exists between the two for future teachers. The physics and geology instructors endeavor to model current best practices in teaching, including inquiry-based learning, while providing outside the classroom experiences, such as field trips and meet-a-teacher nights with current middle school science teachers. To assess the effectiveness of this model, students in the LLC were given pre- and post- assessments for science content, attitudes toward teaching, and the Lawson test for scientific reasoning. Results for these assessments will be given in this talk.

PST1D-03: 8:30–9:15 p.m. Impact of PhysTEC-Supported Introductory Physics Lab Reform

Laird Kramer, Florida International University, FIU Dept. of Physics, Miami, FL 33199; Laird.Kramer@fiu.edu

Eric Brewe, David Jones, Idaykis Rodriguez, Leanne Wells, Florida International University

We report results from a multiple measure, two-semester study of introductory physics lab reform at Florida International University (FIU). FIU's PhysTEC Project trained and placed prospective pre-service teachers serving as undergraduate Learning Assistants (LAs) in 16 lab sections implementing tutorial-based curriculum over a two-semester time span. LAs facilitated epistemological and metacognitive discussions designed to challenge and then refine student understanding of physics concepts. We examined conceptual understanding (using the Force Concept Inventory (FCI),[1] beliefs about physics [using the Maryland Physics Expectation Survey (MPEX),][2] and performance on common exam questions for students enrolled in 16 reform and 18 non-reformed labs. Results of the study and measured impact on lab reform FIU PhysTEC is supported by a grant from APS, AIP, & AAPT. Also supported by CHEPREO, NSF Awards #0312038 and #0802184.

1. D. Hestenes, M. Wells, & G. Swackhamer, *Phys. Teach.* **30,** 141-158 (1992).
2. E.F. Redish, Physics Education Research Group, University of Maryland, 2003.

PST1D-04: 9:15–10 p.m. A Slice of the PIE for Elementary School

Kenneth Cecire, Hampton University, Hampton, VA 23668; cecirek@gmail.com

For the past three years, the Hampton University Center for the study of the Origin and Structure of Matter has sponsored the Physics Is Elementary (PIE) program as part of the education and outreach component of its NSF grant. In this program, high school teachers have facilitated standards-based monthly workshops in physics for grade four and five teachers. The results of this experience, including evaluation data from the 2008-2009 program, will be discussed. This work is made possible by the National Science Foundation.

PST1D-05: 8:30–9:15 p.m. Teaching Joy of Learning About Student Thinking in Physics*

Hunter G. Close, Seattle Pacific University, Seattle, WA 98115; hclose@spu.edu

Learning Assistants (LAs) are undergraduate peer instructors that help teach tutorials and labs in a reformed physics teaching environment. Another purpose of an LA program is to recruit K-12 physics teachers. LAs at SPU prepare for the lessons they teach, but they also participate in separate pedagogy sessions, in which they learn about the basics of teaching and learning that are offered by PER.

*Supported in part by the NSF grant DRL-0822342.

PST1D-06: 9:15–10 p.m. Physics Teacher Training: An Approach Combines Theory and Practice

Nilufer Didis, Physics Education Major, Middle East Technical University, Orta Dogu Teknik Universitesi, Ankara, 06531, Turkey; dnilufer@metu.edu.tr

Ali Eryilmaz, Middle East Technical University

Pedagogical knowledge of a teacher contains information about classroom management, instructional methods, theories of learning, measurement and evaluation, educational technology, and educational psychology. In this study, we propose an approach to training a physics teacher that is used in one of our pedagogy courses. The course, Practice Teaching in Secondary Education, is a compulsory course for physics education students at the Department of Physics Education. In this approach, pre-service physics teachers are encouraged to give lectures both on the scope of this course and in practice. During their teaching processes, pre-service physics teachers are expected to use all the theoretical knowledge they have learned in pedagogy courses to create a good physics instruction in practice. The details of this study explain how pre-service physics teachers combine theory and practice; and how their motivation, satisfaction, and success during their teaching are encouraged.

PST1D-07: 8:30–9:15 p.m. Student Teachers' Understanding on Objectives of Laboratory

Ville Nivalainen, Dept. of Physics and Mathematics, University of Joensuu, Joensuu, Finland 80100; ville.nivalainen@joensuu.fi

Pekka E. Hirvonen, University of Joensuu

In this study we focus on student teachers' understanding of the objectives of laboratory work in physics education. Third-year student teachers (N=32) were assigned to write essays on the purposes of practical work in teaching physics at the beginning of a physics laboratory course and seven of them were interviewed to get a more profound view of student objectives of laboratory work. The results show that student teachers considered motivation on learning physics, connecting theoretical knowledge to the real world, and learning to report measurements as the most essential objectives. Results indicate that student teachers have not understood some of the most important objectives of laboratory work described in the literature (e.g. development of practical skills, understanding nature of science and understanding of scientific process). By knowing these shortcomings on student teachers, physics teacher education can answer for this call.

PST1D-08: 9:15–10 p.m. Elementary Teachers' Analysis of Energy Transformations in their Own Units*

Lezlie Salvatore DeWater, Seattle Pacific University, Issaquah, WA 98119; dewater@spu.edu

Hunter Close, Eleanor Close, Seattle Pacific University

Elementary teachers came to SPU for a recent week-long workshop in order to learn more about energy transformations. We chose to take an approach to the professional development that focuses their content learning on their own district-selected science units. This approach demonstrates the universal applicability and flexibility of the energy transformation model (by applying it to many different and varied scenarios), and generates buy-in from the teachers by taking their instructional materials seriously. Applying the energy transformation model to so many "messy" scenarios also illustrates to the teachers that the model can be faithfully and correctly applied without generating only one right answer to each and every question, which turns out to be useful for helping the teachers learn how to open up dialogue during science instruction in the elementary classroom. A variety of examples of teachers' work from the course will be presented.

*This work is supported in part by the NSF grant DRL-0822342.

PST1D-09: 8:30–9:15 p.m. Teacher Characteristics and Student Learning in Secondary Science: Research Review

Eleanor W. Close, Seattle Pacific University, Seattle, WA 98119; closee@spu.edu

A large body of research has been done attempting to identify the best ways to assess teacher quality and to influence student learning. Many of these studies have found that teacher characteristics are important variables affecting student achievement; however, pinpointing the particular teacher characteristics that matter to student learning is difficult. While some principles of effective teaching are described in the science education reform literature, there is a scarcity of rigorous research on the effects of teacher preparation and professional development on science teaching practice and student learning. A recently completed review of the research literature will be summarized, including relevant studies relating teacher characteristics to student learning, as well as studies documenting intermediate steps such as relationships between teachers' coursework and their epistemological beliefs, content understanding, and choice of teaching methods.

PST1D-10: 9:15–10 p.m. Teacher Education in China

Zhixin Huang, College of Physical Science and Technology, Central China Normal University, Wuhan, Hubei PR China 430079; zxhuang@phy.ccnu.edu.cn*

Xiumei Feng, Cuilan Qiao, Yuan Pi, Central China Normal University

In China, teacher education is carried out primarily by Normal Universities. In recent years, there has been increasing pressure on producing large numbers of qualified teachers. However, how to effectively train students to become capable teachers in the current changing society is an important question for research. In this paper, we will first introduce the typical features of current teacher education programs in China. Then we compare the different teaching schemes among different Normal Universities in China. We will discuss the current consensus and activities for finding a suitable way for training students to become qualified teachers.

*Sponsored by Lei Bao

PST1D-11: 8:30–9:15 p.m. Pathway – 24/7 Online Pedagogical Assistance for Teachers of Physics*

Dean Zollman, Kansas State University, Manhattan, KS 66506-2601; dzollman@phys.ksu.edu

Sytil K. Murphy, Brian Adrian, Kansas State University

Scott Stevens, Michael Christel, Carnegie Mellon University

The Physics Teaching Web Advisory (Pathway) continues to expand its efforts to address pedagogical issues of many physics teachers via the Web. Pathway's "Synthetic Interviews" engage inexperienced teachers in a natural language dialog about effective teaching of physics. These virtual conversations are now coupled to related graphical materials as well as the National Science Education Standards and comPADRE. Thus, pre-service and out-of-field in-service teachers can obtain the advice of experienced teachers and quick connections to other related material. The database is a growing digital library and now contains about 7,000 different recorded answers and over 10,000 question/answer pairs. Additional video material, including films from the old AAPT Film Repository, provides additional videos for classroom use. Pathway is available at http://www.physicspathway.org.

*Supported by the National Science Foundation under Grants 0455772 & 0455813.

PST1D-12: 9:15–10 p.m. Online Graduate Course in Physics Education Scholarship for H.S. Teachers

Dan l. MacIsaac, Buffalo State, Buffalo, NY 14222; macisadl@buffalostate.edu

Luanna L. Gomez, Buffalo State

PHY500: Physics Education Seminar (online) is designed to lay a foundation of Pedagogical Content Knowledge (PCK) in high school Physics Teaching scholarship, to engage high school Physics Teachers as practical consumers of physics and science education scholarship, and to foster critical reflection on their own teaching practices. We describe content, activity, and lessons learned from offering PHY500 to more than 75 high school physics teachers since 2002.

PST1D-13: 8:30–9:15 p.m. Preparing High School Math and Science Teachers at UNC-CH*

Alice D. Churukian, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599-3255; adchuruk@physics.unc.edu

Laurie E. McNeil, University of North Carolina at Chapel Hill

UNC-BEST (University of North Carolina Baccalaureate Education in Science and Teaching) program at UNC-CH is a collaboration between the College of Arts & Sciences and the School of Education. Students in the UNC-BEST program are physics or biology majors who, in addition to the courses for their majors, complete the requirements for subject specific, secondary licensure in North Carolina by enrolling in three highly intensive Education courses, one discipline specific pedagogy course—taught within the respective discipline—and student teaching. Mathematics, Geology, and Chemistry departments are currently in the process of joining the program with student enrollment expected to begin in the fall of 2009. Scholarship support for students in the program has been obtained from the Burroughs-Wellcome Foundation and the PhysTEC NOYCE Scholarship Program. The first students graduated in May. Triumphs and tribulations will be presented.

*Partially supported by the PhysTEC program of the APS, AAPT and AIP with funds from he National Science Foundation (NSF), individual and corporate contributions to the American Physical Society (APS), and the Fund for the Improvement of Postsecondary Education (FIPSE) of the U.S. Department of Education.

PST1D-14: 9:15–10 p.m. Computation-Based vs. Concept-Based Standardized Test Questions: High School Physics Teachers' Perceptions

Luanna Gomez, SUNY at Buffalo College, Buffalo, NY 14222; gomezls@buffalostate.edu

Daniel MacIsaac, Joseph Zawicki, SUNY at Buffalo College

The New York State Regents physics examination is a standardized assessment of high school students' competencies after completing a year of introductory physics. The analysis of select items taken from 1500 students will be provided. We have compared traditional computational problems to less traditional conceptual problems to examine the extent to which the response pattern provides insight to the difficulty of the two types of questions. This discussion will form a context in which teachers' perceptions of the nature of numeric and concept questions, of their relation to physics understanding, and of their implications to physics instruction will be addressed.

PST1D-15: 8:30–9:15 p.m. ATE Program for Physics Faculty*

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

Dwain M. Desbien, Estrella Mountain Community College

The ATE Program for Physics Faculty has finished its third year and its 13th workshop/conference. In this poster, we will display some of the materials from these various workshops/conferences and illustrate some of the activities, sessions, and individuals involved—particularly from the VICS Workshop at Southeast Community College (NE), TIP Workshop at Lee College (TX), ISIP Workshop at Estrella Mountain Community College (AZ), and the NFTC Follow-Up at the 2009 AAPT Summer Meeting (MI).

*Sponsored in part by NSF grant 0603272

Is this your first AAPT meeting?

First Timers' Gathering

Monday, July 27
7–8:30 a.m.
Michigan League, Koessler

(E) Implementing & Evaluating Curriculum

PST1E-01: 8:30–9:15 p.m. Implementing Studio Physics at an Undergraduate Engineering School

Philip W. Young, University of Wisconsin - Platteville, Platteville, WI 53818; youngp@uwplatt.edu

University of Wisconsin - Platteville is a primarily undergraduate school with about 1600 engineering students. The physics faculty are in the second year of preparations to implement flexible lecture/lab instruction with the support of NSF-DUE CCLI grant 0633583. Studio classrooms were included in a new engineering building that opened this past spring. Instructors will be encouraged to adapt their own teaching strengths to the studio format. Two instructors implemented some aspects of studio instruction into their sections this spring semester. This poster will highlight the current status of our preparations including classroom design, assessment plans, and the laboratory component of the curriculum.

PST1E-02: 9:10–10 p.m. Implementation of Elements of the Physics Suite at UCF

Dan Maronde, University of Central Florida, Orlando, FL 32816-2385; maronde@physics.ucf.edu

Costas Efthimiou, Enrique Del Barco, University of Central Florida

Tim McGreevy, Embry-Riddle Aeronautical University

Stefanie McCole, McDaniel College

The University of Central Florida Physics Department is completing the second year of an NSF CCLI grant. The project is comparing the learning of students taught using various components of The Physics Suite with the learning of students taught with traditional methods. The amount of student learning is quantified by a normalized-gain comparison between pre- and post-tests. Some of the lecture sections of both Physics I, Mechanics, and Physics II, Electricity & Magnetism, are including Interactive Lecture Demonstrations as part of the instruction. Several of the Lab sections corresponding with Physics I & II are using Real Time Physics. Student performance is compared among four groups: Students who have been taught using both of the applied elements of The Physics Suite, students who have had one component or the other, and students who have learned in a traditional lecture and lab. Statistics have been collected from classes taught from the fall semester of 2007 through the Spring semester of 2009. A comparison of student performance in classes including different approaches to the recitation component of the course is in the early stages and early results are presented.

PST1E-03: 8:30–9:15 p.m. Developing a Community of Practice in Large-Enrollment Introductory Calculus-Based Physics

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

Dedra Demaree, Oregon State University

At Oregon State University, we are undergoing curriculum reform in our large-enrollment introductory calculus-based physics sequence. As part of this reform, we are integrating materials borrowed from the ISLE (Investigative Science Learning Environment) curriculum at Rutgers and California State University, Chico. ISLE has been found to help students develop scientific abilities through science processes practiced as authentic scientists. Using Peer Instruction to engage students in these practices, our curricular reforms assist the development of a community of practice (Wenger, 1998) through which students participate in social interactions and make meaning of their experiences in class to build a shared repertoire of knowledge. This poster will describe the development of this community of practice and what we can do to support it.

PST1E-04: 9:15–10 p.m. High School Physics Curriculum Reform and Its Impact in NingXia China

Yibing Zhang, The School of Physics and Electrical Information, Ningxia University, China, Ningxia,Yinchuan, PR China 750021; nxzhangyb@163.com

Bingxun Yang, Chaohong Cheng, Lingfang Jing, Cheng Wang, Ningxia University

NingxiaYinchuan, Second High School

China started a new curriculum reform in high school science courses five years ago, and Ningxia, which is a minority populated state, is one of the first experimental areas to implement the new curriculum. The high school students who have gone through these new courses started to enter colleges and universities in 2007. By comparing students going through the old and the new curricula, we study how students' knowledge and abilities in physics are influenced by the curriculum reform. Using multiple instruments, including physics concept tests and general reasoning tests, we collected data from freshman to senior-level college students in Ningxia University. In this poster, we will discuss the changes in students' physics knowledge, and their abilities in posing questions, conducting scientific inquiry, and reasoning.

PST1E-05: 8:30–9:15 p.m. Students' Perceptions of the Use of Tutorials at the University of Colorado

Chandra A. Turpen, University of Colorado at Boulder, Boulder, CO 80305; Chandra.Turpen@colorado.edu

Noah D. Finkelstein, Steven J. Pollock, University of Colorado

While research on educational transformation has traditionally focused on studying the processes of transformation and student learning outcomes, little work has examined students' perceptions of these innovations over time. We present analyses of students' perceptions of the Tutorials[1] over time at the University of Colorado (CU). We share results based on two types of data: 1) data from a "Student Assessment of Their Learning Gains" (SALG) style instrument[2], designed to identify students' broad perceptions of the utility and enjoyment of Tutorials, and 2) more detailed survey data that specifically targets students' perceptions of student-student interactions in the Tutorials, student-TA interactions in the Tutorials, and the coordination of the Tutorials with other course components. We find some overall trends that exist across both introductory physics courses and have also identified certain semester-by-semester differences in student perceptions within each of the two introductory (Phys 1 and Phys 2) courses.

1. L.C. McDermott, P.S. Shaffer, and PEG at the University of Washington, *Tutorials in Introductory Physics* (Prentice Hall, Upper Saddle River NJ, 2002).
2. E. Seymour, D. Wiese, A. Hunter, & S.M. Daffinrud, *Creating a Better Mousetrap: On-line Student Assessment of their Learning Gains.* Paper presented at the National Meeting of the American Chemical Society, San Francisco, CA. (2000, March). More information available at http://www.salgsite.org/about.

PST1E-06: 9:15–10 p.m. Student Learning of Specific Physics Content in the "Studio/SCALE-UP" Environment*

Sarah Burleson, Ithaca College, Ithaca, NY 14850; sburles1@ithaca.edu

Andrew D. Crouse, Luke Keller, Matt Price, Michael Rogers, Ithaca College

The Physics Education Research Group at Ithaca College is actively engaged in a multi-year study of student learning in the "Studio/SCALE-UP" environment. This study is being conducted in both general-education astronomy and introductory algebra-based physics courses. Student learning is being probed using written pre- and post-tests as well as interviews and reflection logs. Written questions include standard multiple-choice diagnostic instruments, open-ended conceptual questions targeting known student difficulties, and surveys concerning the nature of science. Students chosen to form a representative sample of the class are participating in interviews and writing reflection logs at predetermined times during the course. Results from pre- and post- tests of specific physics topics will be presented.

*Funded in part by NSF DUE CCLI grant # 0536246 and Ithaca College.

PST1E-07: 8:30–9:15 p.m. Longer Term Impacts of Transformed Pedagogies on Student Conceptual Understanding

Steven J. Pollock, CU Boulder, University of Colorado at Boulder, Boulder, CO 80309; steven.pollock@colorado.edu

We measure student performance on a research-based conceptual instrument in E&M at various stages of the physics major track—before/after freshman E&M, and before/after upper-division E&M. We use Washington's Tutorials in Introductory Physics in our freshman curriculum, and have more recently transformed our first-semester upper-division E&M course. In this >10 semester study, we track individuals from freshman through upper division. On average, post-test scores do not change significantly from freshman to upper division E&M I, nor from E&M I to E&M II. We do find a significantly stronger performance at the upper-division level for students who went through freshman Tutorials, indicating a long-term positive impact of those Tutorials on conceptual understanding.

PST1E-08: 9:15–10 p.m. Concept Map of Curriculum: A Cognitive Architecture of Concepts

Paul Tarabek, Didaktis – member of the European Educational Publishers Group, Hasselager, Denmark, Bratislava, Slovakia, EU, Hyrosova 4, Bratislava, 81104; didaktis@t-zones.sk

Premysl Zaskodny, College of Applied Economic Studies, Curriculum Studies Research Group

The concept map of curriculum construed from data of curriculum theory will be presented. The map describes most of the features of the curriculum and shows a curriculum development and an education as a simple chain of curriculum levels: conceptual, intended, project, operational, implemented, and attained. The first three levels relate to the curriculum development and design, the next two to the instructional process, and the last one to the transformation of an implemented educational content into knowledge applicable in practice.

PST1E-09: 8:30–9:15 p.m. Physics Instructors' Knowledge About and Use of Research-Based Instructional Strategies*

Charles R. Henderson, Western Michigan University, Kalamazoo, MI 49008-5252; charles.henderson@wmich.edu

Melissa H. Dancy, Johnson C. Smith University

Although substantial time and money has gone into developing Research-Based Instructional Strategies (RBIS) in physics, little effort has gone into understanding the extent to which these products are used by physics instructors. In fall 2008, a web survey was delivered to a national sample of physics faculty. This poster will present the preliminary results of the survey based on responses from more than 700 physics faculty, roughly evenly divided between three types of institutions: 1) two-year colleges, 2) four-year colleges that offer a B.A. as the highest physics degree, and 3) four-year colleges that offer a graduate degree in physics. Survey participants were asked about their knowledge and use of a selection of currently available RBIS as well as their general attitudes toward teaching.

*Supported by NSF #0715698.

PST1E-10: 9:15–10 p.m. Great Expectations? The Relationship Between Implementors and Innovators During Instructional Reform

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Carrie M. Swift, The University of Michigan - Dearborn

While innovative curricular materials are being developed for upper-level physics courses, prior research[1] has signaled the need to understand the expectations of two groups of faculty: the Physics Education Research (PER) specialists developing these materials and non-PER faculty implementing them. We are interested in facilitating the implementer-innovator relationship in order to improve student outcomes in the implementer's classroom and provide useful feedback to the innovator. Our work is an outgrowth of an existing PER project [2] in intermediate mechanics. Through the use of pre- and post-implementation surveys, we seek insight to questions such as: How do implementers come to understand the motivations behind the innovations? How can innovators anticipate the needs of the implementers for support during the implementation? How does an implementer go from "novice" to "experienced," and how can the innovator assist in this transition? We continue to gather surveys and encourage implementers to participate.

1. Henderson and Dancy, *Am. J. Phys.* 76 (1), 79-91 (2008)
2. Ambrose, *Am J. Phys.* **72** (4), 453-459 (2004)

(F) PER Methods & Assessments

PST1F-01: 8:30–9:15 p.m. A Review of Standardized Testing in Physics

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

Beth Thacker, Texas Tech University

Perhaps one of the more polarizing topics in physics education (and education in general) is standardized testing. Though few want an environment where we teach to the test, standardized testing has a purpose and place in undergraduate physics education. The AP exam is used to award college physics credit, the GRE Physics subject test is used for evaluating prospective graduate students, the Major Field Test in physics is used to evaluate senior undergraduates, and various conceptual inventories are used to evaluate conceptual mastery. In chemistry, the ACS (American Chemical Society) Examinations

Institute has created a standardized test in general chemistry since 1934 and today creates tests for all subjects in the undergraduate chemistry curriculum, from organic chemistry to physical chemistry. Yet no similar standardized exams exist in physics. This talk will review standardized testing and will present a case for developing a standardized physics exam for introductory physics.

PST1F-02: 9:15–10 p.m. Factor Analysis and the Force Concept Inventory

Courtney W. Willis, University of Northern Colorado, Greeley, CO 80639; courtney.willis@unco.edu

Matthew R. Semak, Richard D. Dietz, University of Northern Colorado

Four sections of introductory physics (n=244) at the University of Northern Colorado took the Force Concept Inventory (FCI) both before and after instruction in Newtonian mechanics. Factor analyses of the results reveal several interesting contrasts that may shed some light on the development of concept organization in the introductory physics course. Post-test FCI results indicate that at the end of the semester student responses have become more closely aligned with the particular Newtonian concept associated with each question by the authors of the FCI.

PST1F-03: 8:30–9:15 p.m. Predicting Force Concept Inventory Gain with Nonverbal Intelligence Test

Matthew R. Semak, University of Northern Colorado, Greeley, CO 80639; matthew.semak@unco.edu

Courtney W. Willis, Richard D. Dietz, University of Northern Colorado

We have administered a commercial, nonverbal intelligence test (Gama) to students in two introductory physics courses, one algebra-based and one calculus-based.

PST1F-04: 9:15–10 p.m. Development of a Fluids Diagnostic Exam

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Sam Cohen, Adam Moyer, Grove City College

Fluids topics have not gotten the attention from the PER community that other topics have, yet they are covered in many introductory courses in both high school and college. We have been developing a series of multiple-choice questions to probe student understanding of fluids topics such as density, pressure, and buoyancy, with the goal of eventually producing an FCI-style assessment that can be used to identify student difficulties and improve instruction. The purpose of this poster is to share our current question set with others and to get feedback about topics and concepts we may be overlooking that others would like to see included. Please stop by and share your ideas.

PST1F-05: 8:30–9:15 p.m. Using Cluster Analysis to Group Student Responses on the Force, Motion, and Conceptual Evaluation (FMCE)

R. Padraic Springuel, University of Maine, Orono, ME 04469; R.Springuel@umit.maine.edu

Michael C. Wittmann, University of Maine

Most researchers use the FMCE to analyze the scores and normalized gains for students in their classes in order to evaluate students' overall grasp of force and motion (and the gains in their understanding). Smith[1] has shown, however, that it is possible to look in more detail at both the correct and incorrect ideas that students have. Up to now, though, the researcher has had a predetermined notion of what to look for. Using cluster analysis, a data mining method designed to group data based on feature similarity, we show that it is possible to find common patterns of answers on the FMCE. We let these student-generated patterns of meaning drive our search for meaning in the data. In this poster, we present the results of our cluster analysis.

1. T. I. Smith and M.C. Wittmann, "Applying a resources framework to analysis of the force and motion conceptual evaluation," *Phys. Rev. ST Phys. Educ. Res.* **4**, 020101 (2008).

PST1F-06: 9:15–10 p.m. Comparing Cluster Analysis and Traditional Analysis Methods in PER: More Data

R. Padraic Springuel, University of Maine, Orono, ME 04469; R.Springuel@umit.maine.edu

Adam Kaczynski, Michael C. Wittmann, John R. Thompson, University of Maine

Previous work with applying cluster analysis to free-response questions about two-dimensional motion has shown suggestive similarities between the groups found by the cluster analysis and the traditional classifications of student responses[1]. A comparison of cluster analysis and traditional classifications over a single class, however, was unable to make any hard and fast conclusions because the cluster analysis results were unreliable for that population size (N =106).[2] In this poster we present the results of making the same kind of pivot table comparison over a larger data set (N = 677) which served to reduce the amount of noise in the cluster analysis results.

1. R.P. Springuel, M.C. Wittmann, and J. R. Thompson, "Applying clustering to statistical analysis of student reasoning about two-dimensional kinematics," *Physical Review Special Topics - Physics Education Research* **3**, 020107 (2007).
2. R. P. Springuel, M. C. Wittmann, and J. R. Thompson, "Comparing cluster analysis and traditional analysis methods in PER," AAPT Summer National Meeting (2007).

PST1F-07: 8:30–9:15 p.m. The Influence of Motivation in Completing Low-Stakes Assessments

Melissa S. Yale, Purdue University, West Lafayette, IN 47906; myale@purdue.edu

Lynn Bryan, Deborah Bennett, Mark Haugan, Purdue University

Research targeted at curriculum reform often relies on low-stakes assessments to measure improved student understanding and quality of instruction. However, many factors contribute to the scores attained on pre-/post-assessments, such as level of motivation in completing the assessment. To measure student motivation in taking the low-stakes assessments, this research incorporated a question of self-reported motivation levels. The Force Concept Inventory and Energy Assessment were randomly distributed to students in a university-level introductory calculus-based physics course. During fall 2008 and spring 2009, self-reported motivation levels were collected at the end of the assessment. This study compares the results of test performance with the self-reported motivation level and the implications for using gain scores as evidence of changes in conceptual understanding.

PST1F-08: 9:15–10 p.m. How Does Classroom or Interview Room Environment Affect Research Data?*

Adrian Carmichael, Kansas State University, Manhattan, KS 66506-2601; adrianc@phys.ksu.edu

Jacquelyn J. Chini, N. Sanjay Rebello, Kansas State University

Sadhana Puntambekar, University of Wisconsin, Madison

Research conducted in the contrived setting of an interview room, while intended to model a natural learning environment, may produce different results than data collected in an actual classroom. A teaching/learning interview[1] in the interview room typically involves one to four students working with one researcher/facilitator while being audio and video recorded. This setting has the potential to cause students to respond differently than they would in the actual classroom. To investigate this possibility, we used the same instructional materials in a teaching interview and laboratory setting. The instructional materials were from the CoMPASS curriculum that integrates hypertext-based concept maps with design-based activities[2]. All participants were enrolled in introductory concept-based physics. We will describe how the data collected in these two settings compare.

*This work is funded in part by the U.S. Department of Education, Institute of Education Sciences, Award # R305A080507.

PST1F-09: 8:30–9:15 p.m. Can Simulations Replace Hands-on Experiments in Mechanics

Jacquelyn J. Chini, Kansas State University, Manhattan, KS 66506-2601; haynicz@phys.ksu.edu

Adrian Carmichael, N. Sanjay Rebello, Kansas State University

Sadhana Puntambaker, University of Wisconsin, Madison

It has previously been demonstrated[1] that an appropriately designed simulation can be more effective than analogous hands-on activities in the context of circuits. Circuits involve microscopic phenomenon such as the movement of electrons, which can be modeled more clearly by a computer than real equipment. Will simulations be more effective than hands-on activities in other contexts, too? We investigated whether simulations could effectively replace hands-on experiments in a unit on inclined planes from the CoMPASS curriculum, which integrates hypertext concept maps with design-based activities[2]. Three sections of an introductory physics laboratory completed hands-on experiments and two sections completed the same experiment in simulation. Students who used the simulations performed significantly better statistically on the post-test than students who completed the hands-on experiments.

*This work is funded in part by the U.S. Department of Education, Institute of Education Sciences, Award # R305A080507.

1. Finkelstein, N.D., et al., "When learning about the real world is better done virtually: A study of substituting computer simulations for laboratory equipment," *PRST-PER*, 2005. 1: p. 010103.
2. Puntambekar, S., A. Stylianou, and R. Hübscher, "Improving navigation and learning in hypertext environments with navigable concept maps," *Human-Computer Interaction*, 2003. **18** pp. 395-428.

PST1F-10: 9:15–10 p.m. Peer Instruction for Quantum Mechanics*

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

Guangtian Zhu, University of Pittsburgh

We are developing and evaluating resource material for "Peer Instruction" in quantum mechanics. One central component of the resource material is research-based concept tests that can be used by instructors as a formative assessment tool. The instructors can use these tools for bridging the gap between the abstract quantitative formalism of quantum mechanics and the qualitative understanding necessary to explain and predict diverse physical phenomena. Asking questions during the lecture and asking students to discuss it with each other before polling the class has already been shown to be effective at the introductory level. This method provides a mechanism to convey the goals of the course and the level of understanding that is desired of students and also helps students monitor their learning. We will discuss the development and assessment of these tools for quantum mechanics.

*This work is supported by the National Science Foundation (NSF-PHY-0653129).

(G) Conceptual Understanding & Reasoning

PST1G-01: 8:30–9:15 p.m. Testing Student Interpretation of Kinematics and Calculus Graphs

Nadia Perez-Goytia, Tecnologico de Monterrey, Garza Sada 2501, Monterrey, NL Mexico 64849; perezgnf@gmail.com

Angeles Dominguez, Genaro Zavala, Tecnologico de Monterrey

This study investigates student interpretation of graphs in kinematics and in calculus. We study two different populations: an Introductory Physics course (nine sections of engineering students) and an Introductory Calculus course (eight sections of engineering and social science students). The instruments are based on the Test of Understanding Graphs in Kinematics (TUG-K).[1] A modified version of this test (ModTUG-K) is used to evaluate the interpretation of kinematics graphs, while a new and context-free version (TUG-C) is used to evaluate the interpretation of graphs in calculus. Four sections of the Introductory Physics course and four sections of the Introductory Calculus course took the ModTUG-K and the rest of the sections took the TUG-C. We will present results showing the influence of the Introductory Calculus course in the interpretation of kinematics graphs, and the influence of the Introductory Physics course in the interpretation of calculus graphs.

1. Robert J. Beichner, "Testing students interpretation of kinematics graphs," *Am. J. Phys*. **62**, 750-762 (1994).

PST1G-02: 9:15–10 p.m. Exploring Student Consistency in Vector Addition Method*

Jeffrey M. Hawkins, University of Maine, Orono, ME 4469; jeffrey.hawkins@maine.edu

Michael C. Wittmann, John R. Thompson, University of Maine

The mathematical operation of two-dimensional vector addition arises in multiple physics contexts. The vectors are presented with different features (axes, grids, etc.) depending on the values and physical contexts. As part of a larger survey developed by Van Deventer in 2007, we asked four two-dimensional vector addition questions, with different contextual features, in both a math and a physics context. Consistent with the previous results of Meltzer and Nguyen (2003), we find that changing the graphical presentation of vectors may affect the methods students use to add vectors. We also conducted interviews consisting of two sets of five different two-dimensional vector addition questions with a distracter task between sets. We expected that during the interviews students would change methods of vector addition based on the presentation of the vectors. However, students used the method they used on the first representation, right or wrong, for all following representations.

*Supported in part by NSF grant DRL-0633951.

PST1G-03: 8:30–9:15 p.m. The Concept of Vector Direction Among Entering Students in a Mexican University

Genaro Zavala, Tecnologico de Monterrey, Garza sada 2501, Monterrey, NL 64849, Mexico; genaro.zavala@itesm.mx

Pablo J. Barniol, Tecnologico de Monterrey

This contribution will present the details of a study among students entering a Mexican university in which the main objective was to investigate how students understand the concept of direction of a vector. The study includes a pre-test, interviews, and a post-test. Part of a previous study[1] among American students was used to design the evaluation tools in this study. From a previous contribution,[2] we will show that there are similarities of understanding vectors, but also some differences between American and Mexican students. One of the differences is related to the concept of direction. We will show that language and cultural issues play a role in this understanding.

1. Ngoc-Loan Nguyen and David E. Meltzner, "Initial understanding of vector concepts among students in introductory physics courses," *Am. J. Phys*. **71**, 630-638 (2003).
2. Christian Moran and Genaro Zavala, "An investigation of the concept of vectors with college students in Mexico," PERC Conference, Edmonton, Canada (2008).

PST1G-04: 9:15–10 p.m. Changes in Student Understanding of Vector Products

Eleanor C. Sayre, Ohio State University, Columbus, OH 43202; le@zaposa.com

Andrew F. Heckler, Ohio State University

As part of a large study of how student ideas change in response to instruction, we collect student test data frequently throughout a course, allowing for the measurement of the time-evolution of student knowledge. Some student ideas peak and decay rapidly during a quarter, while others change more slowly. In this poster, we focus on foundational vector manipulation skills in introductory physics. There appears to be a difference between low- and high-performing students on when they learn the material, how much they learn, and how much they forget. This research is partially supported by a grant from the Institute of Education Sciences, U.S. Department of Education (#R305H050125).

PST1G-05: 8:30–9:15 p.m. Identifying "A-ha" Moments in Group Problem Solving

Kate Hayes, Center for Science and Mathematics Education Research University of Maine, Eddington, ME 04428; katie.mccann@umit.maine.edu

Michael C. Wittmann, University of Maine

Brandon Bucy, Randolph Macon Academy

In a previous talk, we showed a video of students working on the Intermediate Mechanics Tutorials (http://perlnet.umaine.edu/imt/). In this poster, we present encoded data and a transcript that indicate potential "a-ha" moments in tutorial instruction. These a-ha moments occur when something clicks—a student gets it. We use discourse analysis methods provided by Tannen[1,2] to identify speakers' expectations about an activity. We track the frequency with which these elements appear in student discourse, both in total quantity and in words per minute. We find that the frequency of language that indicates expectations violations increases dramatically as students approach independently identified "a-ha" moments while solving a problem.

1. Tannen, D. "What's in a Frame" S*urface Evidence for Underlying Expectations. New Directions in Discourse Processing*, ed. by Roy Freedle, 137-181 (Norwood, NJ: Ablex, 1979).

2. Tannen D. "The effect of expectations on conversation," *Discourse Processes,* Vol 1, (1978).

PST1G-06: 9:15–10 p.m. Modeling the Creation of Procedural Resources

Katrina Black, University of Maine, Orono, ME 04469; katrina.black@umit.maine.edu

Michael C. Wittmann, University of Maine

A problem in resource theory is to describe the creation of new, high-level resources. We give an example of resource creation by analyzing four student groups separating variables in a group quiz setting. The task was to solve an air-resistance problem with uncommon initial conditions. The fluency of each group is described by three observables: use of overt mathematical language (such as divide, subtract, or equals), use of covert mathematical language (such as moving, bringing, or pulling over), and use of accompanying gestures (such as circling, grabbing, or sliding). For each group, the type of language and gesture used corresponds to how easily they carry out separation of variables. We create resource graphs for each group to organize our observations and use these graphs to describe a potential reification process [3] for the procedural resources grouping and separate variables.

PST1G-07: 8:30–9:15 p.m. Evolution in Student Models of Force, Velocity, and Acceleration Relationships

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Eleanor C. Sayre, Andrew F. Heckler, The Ohio State University

Students' difficulties with conceptual questions about force, velocity, and acceleration have been well documented. However, there has been no systematic study of student understanding of all paired

relations among the concepts of force, velocity, and acceleration. We report on results from a test designed to probe the structure of student conceptual understanding of the relations between the directions of force, velocity, and acceleration. We find evidence suggesting that students view the directional relationship between force and velocity differently than the directional relationship between acceleration and velocity. For example, students respond that an object's velocity can oppose its acceleration more frequently than they respond that an object's velocity can oppose the net force on it. We also find evidence that these patterns are different for higher level students than for lower level students. In addition, we report on differences in students' responses after they complete a computer-based learning session.

PST1G-08: 9:15–10 p.m. Student Understanding Difficulties with Tension Force in Introductory Physics Courses

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Maria Dolores Gonzalez, New Mexico State University

Juan Luna, Fernando Estrada, Jesus Estrada, University of Juarez

Many students enrolled in introductory mechanics courses have learning difficulties related to the concept of force in the context of tension in massless strings. One of the potential causes could be a lack of functional understanding through a traditional instruction. We show a collection of this kind of students' difficulties at New Mexico State University, Arizona State University, and at the Independent University of Ciudad Juarez in Mexico. These difficulties were collected during an investigation conducted not only in lab sessions but also in lecture sessions. The first part of the investigation is developed in the contexts of proximity and the length of strings.

PST1G-09: 8:30–9:15 p.m. Concept Mapping of Aristotelian and Newtonian Level of the Concept "Force"

Paul Tarabek, Didaktis – member of the European Educational Publishers Group, Hasselager, Denmark, Bratislava, Slovakia, EU, Hyrosova 4, Bratislava, 81104; didaktis@t-zones.sk

The concept maps of the concept "force" at the Aristotelian (empirical) and Newtonian (exact) cognitive level based on the model of the cognitive architecture of common and scientific concepts will be presented. Two versions of the concept maps will be shown: the historical one and the version construed from answers of students. The lower levels of the concept maps will be compared with the schemas of the Force Dynamics of Talmy.

PST1G-10: 9:15–10 p.m. Concept Mapping of Vygotian Phases of Electricity Concepts

Paul Tarabek, Didaktis – member of the European Educational Publishers Group, Hasselager, Denmark, Bratislava, Slovakia, EU, Hyrosova 4, Bratislava, 81104; didaktis@t-zones.sk

Veronika Adamcikova, Educational Publisher Didaktis

The concept maps of the concept "conductor of the electric current," construed from answers of students demonstrate the Vygotian phases of concept formation—complex, pseudo-concept, and fully developed concept. The other concept map of Ohm's law created from answers of students, will be compared with the Ohm's p-prims of diSessa.

PST1G-11: 8:30–9:15 p.m. Elementary School Students' Recognition of Electric Circuit Elements

JungSook Lee, Korea National University of Education, Chungbuk, Korea 363-791; lydia102@hanmail.net

JungBog Kim, Korea National University of Education

We have researched elementary students' recognition of both basic components such as batteries, bulbs, wires, and the circuit itself, in untypical situations in order to develop instructional materials for conceptual understanding. Students were asked about the brightness of an electric bulb in untypical situations, such as a physical size of a battery, an electric bulb with broken glass or a disconnected filament, length of electric wire, zigzag wires, various relative positions of the bulb along the electric wire, and various relative vertical heights between the bulb and the battery. Eighty students in the fourth and fifth grade took a designed problem set. They were shown new misconceptions that had not been detected in problems on circuit elements in typical situations. They recognized that a bulb connected to the larger-sized battery was brighter than the smaller-sized battery. They had a scientific concept for the bulb with a disconnected filament; however, they concluded that the bulb with broken glass would not light. Almost all students in the fifth grade had the wrong conception.

PST1G-12: 9:15–10 p.m. How Do Students Differentiate Electrical Energy and Electrical Current?

Andy P. Johnson, Black Hills State University - Center for Math and Science Education, Spearfish, SD 57799-9005; andyjohnson@bhsu.edu

*Anna Hafele, Jessica Juhrend, Black Hills State University**

When introductory physics students study electric circuits, they often do not initially distinguish between current and energy but instead think of a generalized flow of "electricity." This leads to trouble later with conservation of current, and with transmission of energy. Using a modified version of the CPU "Current Electricity" unit in a Physics Survey course we found that measurement of currents in simple circuits helps students think of current as a conserved quantity. However, despite comparing models of energy flows with current flows, students did not spontaneously think of two distinct "types of stuff" flowing in wires. We believe that concept differentiation of "electricity" into two components requires significant innovation by students. We developed "energy flow rate sensors" which enabled students to directly measure energy flow rates (power) in circuits.

*Hafele and Juhrend are sponsored by Johnson

PST1G-13: 8:30–9:15 p.m. Examining Students Understanding of Lenz's, Faraday's Law*

Casey Sanchez,[1] California State University Fullerton, Fullerton, CA 92834; cws@csu.fullerton.edu

Michael Loverude, California State University Fullerton

Magnetic induction has been known to be a particularly difficult concept in introductory physics. In this project, we build upon various pieces of scholarly work to construct a survey to probe the difficulties students have with magnetic flux in regards to Lenz's Law and Faraday's Law. The survey was administered to students in algebra-based and calculus-based introductory courses in electricity and magnetism at CSUF. This presentation will show several student responses and examine the reasons why students have difficulties comprehending the material. Although the preliminary version of the survey identifies several difficulties students have, the student responses demonstrate that a revision is needed to better ascertain specific difficulties.

*Research supported in part by CSUF LSAMP program and McNair Fellowship.

1. Casey Sanchez sponsored by Michael Loverude

PST1G-14: 9:15–10 p.m. Pictorial Representations of Longitudinal Standing Waves

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Edgar G. Corpuz, Rolando Rosalez, The University of Texas – Pan American

We reviewed 10 introductory college physics textbooks and it was found that the illustrations for longitudinal standing waves of air columns in tubes can be categorized into several typical representative models. In depicting the same phenomena, those textbook representations vary from one another and some have misleading aspects. The solutions for partial differential equations on sound propagation in terms of air displacement and pressure are utilized as the foundation for determining the adequacy of the models. A quasi-experimental study was conducted to investigate the comparative effectiveness of the different representations in helping students learn the underlying concepts. The results of this study along with the mathematical basis of the phenomena can provide an empirical basis in proposing a more adequate and effective representation of longitudinal standing waves.

PST1G-15: 8:30–9:15 p.m. Addressing Student Difficulties in Entropy and Heat Engines*

Trevor I. Smith, University of Maine, Orono, ME 04469; Trevor.I.Smith@umit.maine.edu

Warren M. Christensen, John R. Thompson, Donald B. Mountcastle, University of Maine

In an ongoing investigation of student understanding of thermodynamics and statistical mechanics concepts in the upper division, we have uncovered several student difficulties with the topic of entropy. Based on the results of our research, we have developed and implemented a three-tutorial sequence designed to guide students to develop a robust understanding of entropy and its applications. We present the rationale behind, and the design intent of, the third tutorial in this sequence, dealing primarily with entropy considerations of heat engines. We also present pre- and post-instruction data from the first implementation of this tutorial showing evidence of its effectiveness at improving student understanding.

*Supported in part by NSF Grants REC-0633951 and DUE-0817282.

PST1G-16: 9:15–10 p.m. University Students' Pre-Instruction Knowledge About Temperature and Adiabatic Compression

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Pekka E. Hirvonen, Mervi Asikainen, University of Joensuu

David E. Meltzer, Arizona State University

This study concentrates on analyzing problems and conflicts that university students faced when asked to define temperature and solve a task about the adiabatic compression of an ideal gas. In the case of adiabatic compression, students were far more likely to incorrectly apply the ideal gas law than to make use of the first law of thermodynamics. They also had difficulties in describing, understanding, and applying basic concepts such as temperature, often using them inconsistently. For example, some students who defined temperature using explanations related to thermal motion later reasoned that collisions between particles cause temperature. Based on these and similar findings in the literature, we suggest that instruction should emphasize the importance of the first law and of differences between adiabatic and isothermal processes. Students' inaccurate micro-level conceptions should also be explicitly taken into account when teaching microscopic models in order to reduce or eliminate common misconceptions.

PST1G-17: 8:30–9:15 p.m. Conceptual Difficulties with Binomial Distributions in Statistical Physics*

Donald B. Mountcastle, University of Maine, Orono, ME 04469-5709; mtcastle@umit.maine.edu

John R. Thompson, Trevor I. Smith, University of Maine

As part of our continuing research on the teaching and learning of concepts in upper-division thermal physics at the University of Maine, we report on student responses to questions about binomial distributions and the changes in those distributions with an increasing number of trials (N). We have administered questions before and after traditional instruction and guided-inquiry activities that probe understanding of multiplicities, probabilities, and their distributions over N, covering more than six orders of magnitude in N. Preliminary results indicate some positive learning outcomes, along with some persistent problems; e.g., confusion over the dependence of macrostate probability on multiplicity, and whether the probability of a single (N/2) macrostate emerges at large N to dominate the distribution, or not. Results are discussed in the context of the term "overwhelming probability," commonly used to describe the connections with equilibrium thermodynamic (very large N) systems

*Supported in part by NSF Grants #PHY-0406764, DRL-0633951 and DUE-0817282.

PST1G-18: 9:15–10 p.m. Student's Understanding of Stern Gerlach Experiment*

Guangtian Zhu, University of Pittsburgh, Pittsburgh, PA 15260; guz11@pitt.edu

Chandralekha Singh, University of Pittsburgh

To improve students' understanding of quantum mechanics by helping them develop a good grasp of the Stern Gerlach experiments, we are developing quantum interactive learning tutorials (QuILTs) and tools for Peer Instruction.We will discuss the common students' difficulties with issues related to the Stern Gerlach experiment, and discuss ways to bridge the gap between quantitative and conceptual aspects of quantum mechanics using this topic as a tool.

*Supported by NSF.

(H) Physics Education in China

PST1H-01: 8:30–9:15 p.m. Symmetry in Physics

Le Liang, Southeast University, Nanjing, Jiangsu 211189, PR China; liangle_0620@yeah.net

Hongdong Hu, Tiancheng Ge, Southeast University

Thanks to the "Introduction to Bilingual Physics" course established by Professor Yun, we are gradually developing the interest of doing research and reading English materials regarding physics. In accordance with its requirements, our group chose to do the project of symmetry in physics, due to its significance in the explorations of the material world. In our essay, the first part tells of the definition of symmetry in physics, followed by some typical representatives of it; the second part explains the corresponding relationship between symmetry and conservation laws, and the third concerns its wide applications. In the end, we will present our guess about black and white holes with the guidance of symmetry principles.

PST1H-02: 9:15–10 p.m. Solitons in Optical Fibers

Yan Liu, Southeast University, Nanjing, Jiangsu 211189 PR China; liuyanpp@gmail.com

Zhenhua Jiang, Shiqi Wang, Southeast University

As we studied in the course "Bilingual Physics with Multimedia" by Yun Ying, we decided to study solitons in optical fibers as a team. Solitons in optical fibers is one of the main applications of solitons and will benefit people a lot in the future. In this essay, what a soliton is and what a soliton looks like are introduced first. And then it presents the principle of solitons which propagating in optical fibers in details and tells the advantages of optical soliton communication. At last the impact of soliton in both science and society is mentioned a little. During the process of this course, we really achieved and improved far more than our expectation.

PST1H-03: 8:30–9:15 p.m. Physics in Shenzhou Manned Space Flight

Cai Mufan, Southeast University, Nanjing 211189, PR China; cmf9003@126.com

Liu Ze, Southeast University

People dreamed of flying for thousands of years until the middle of the 20th century. In this article, we focused on physics knowledge in space technology, taking China's Shenzhou manned space shuttle as an example. We reviewed the history of space traveling and then studied Shenzhou manned space flight in four aspects: First, how does a rocket change direction in space; second, why is spacecraft's shape so strange; third, what is the impact of the "dark barrier zone" on the spacecraft; and fourth, how can the capsule insulate heat when flying through the atmosphere.

PST1H-04: 9:15–10 p.m. Relevant Discussion About Polar Light

Heng Yang, Southeast University, Nanjing 211189, PR China; ya_ya_hei90@126.com

Qianqian Chen, SHa Xia, Southeast University

The myths and legends were summarized along with a historical retrospect of the development of human beings' knowledge about aurora. Compared with neon lights, the formation of aurora was explored, the mystery of its beautiful color revealed, and the suitable sites for observation suggested. As the result, the high-energy electrons of aurora are meaningful for everyday life; hence the importance of further research.

PST1H-05: 8:30–9:15 p.m. Theories and Applications of Soft Matter

Zhiyi Gu, Southeast University, Nanjing, Jiangsu 211189, PR China; guzhiyi1990@163.com

Xiaolong Chen, Zhou Qian, Southeast University

Soft matter is a sub-area of condensed matter, referring to the matter between the solid and the ideal fluid. Soft matter covers three scientific areas, including physics, chemistry, and biology. As freshmen, studying on such a leading scientific area is not common. But last semester, we took the course "Blingual Physics with Multimedia" which was set by Professor Yun. It stimulated our interests in extra-curricular studies. So we decided to study soft matter science from the freshman's view. In the first part of this paper, we give an introduction to the basic theories of soft matter. The second part tells a few useful applications of soft matter. The last part discusses the development of soft matter science in the future.

PST1H-06: 9:15–10 p.m. MHD (Magneticohydrodynamic) Power Generation—Fantasy or Solution?

Ziqin Qu, Southeast University, Nanjing 211189, PR China; Skunk_Ozone@yahoo.cn

As the industrialization of human society keeps leveraging, energy becomes a critical issue, and finding new technology for power generation becomes a must. The MHD power generation devises a new method to produce electricity in a more efficient and environmentally friendly way. It turns heat energy directly into electric energy by introducing magnetized plasma fluid passing across magnetic lines. This paper draws a brief picture of MHD power generation and attempts to attract more attention to this promising technology.

PSTH-07: 8:30–9:15 p.m. Analysis of Quantum Cryptography and BB84 Protocol

Chenxi Zhai, Southeast University, Nanjing, Jiangsu 211189, PR China; oliver_hildebrand@163.com

Xinru Zheng Jianwei Yang

The appearance of the quantum computer is wiping out the RSA algorithm and other encryptions gradually. To cope with the quantum computer's astonishing decoding ability, the only method is to use quantum cryptography. BB84 protocol, the most basic protocol in quantum cryptography, has its unique advantages. We are freshmen with an interest in quantum cryptography inspired by Professor Yun Ying's idea of education. In "Introduction to Bilingual Physics," the course initiated by Prof. Yun, we operated a simple study on it, and this essay explains the principles of quantum cryptography and how BB84 protocol works. At last, we analyze the safety factors and restrictions.

PST1H-08: 9:15–10 p.m. Gravity Anomaly – Never Take Gravity for Granted

Kaixuan Zhang, Southeast University, Nanjing 211189, PR China; cashionchang@126.com

Bingxun Wang, Lei Li

Since Newton discovered Gravity in the 17th century, many people have taken gravity for granted while they pay no attention to how gravity comes into being and the fact that the theoretical gravity is often different from the normal gravity. The difference between theoretical gravity and normal gravity mainly results from the irregular mass distribution of the Earth. We call it gravity anomaly. The definition of gravity anomaly may be simple, but its application in aspects such as seismology, gravity prospecting, and space science deserves our attention. In recent years, there has been much research in gravity anomaly. Surely we are going to have a better understanding of our Earth.

PST1H-09: 8:30–9:15 p.m. Graphene – Material for the Future

Jiaji Zhou, Southeast University, Nanjing 211189, PR China; swordsnow@126.com

Wenbo Song, Hongma Liu

After having studied the course "Introduction to Bilingual Physics," we chose "Graphene" as the topic of our final essay. Graphene is currently the cutting edge of condensed physics and material science. This amazing two-dimensional material exhibits exceptionally high crystal and electronic quality, and, during the short time scale of four years, it has already shown tremendous glamour in new physics and potential applications. The first part tells the background information and the discovery of graphene; the second is about the definition and its unique properties; the third focuses on potential applications. The conclusion is that, whereas one can be certain of the realness of applications only when commercial products appear, graphene no longer requires any further proof of its importance in terms of fundamental physics. By writing the essay, we reach the aim of the course—to read some English materials and to do some research work as early as possible.

PST1H-10: 9:15–10 p.m. Iris Recognition

Peipei Zhou, Southeast University, Nanjing, Jiangsu 211189, PR China; memoryzpp@yahoo.cn

Yingying Chu, Kuidong Chen

Owing to the course "Bilingual Physics with Multimedia,"we get a chance to do research as a group and prepare for our paper. The article addresses a range of information on iris recognition, by outlining and explaining the procedure and involving the theory "Gabor wavelet" to carry out the verification. The iris recognition is considered to be of the greatest significance among other identity verification methods in the 21st century.

Plenary: Symposium on Plasma Physics

Location: Mendelssohn Theater
Sponsor: American Physical Society/DPP
Date: Monday, July 27
Time: 10:30 a.m.–12 p.m.

Presider: Andrew Zwicker


John Goree


Cary Forest

P1-01: The Electrical Charge and Motion of Objects Inserted into a Plasma

John Goree, University of Iowa

Plasma is gas that has been ionized, with freely moving electrons and ions. Examples of plasma include the solar wind, and a glow discharge made by applying high voltage to a pair of electrodes in a vacuum container filled with low-pressure gas. Plasma has high temperature, usually many thousands of degrees, so it surprises many people to learn that it is possible to insert a solid object into plasma without melting it. This is possible when the plasma has a very low density, so that it has little heat capacity. For example, the Moon is immersed in the solar wind, and it doesn't melt. Objects immersed in plasma develop an electric charge by collecting electrons and ions. I will describe experiments in the laboratory and on board the International Space Station where micron-size plastic spheres are immersed in plasma. These microspheres gain a charge of thousands of electrons, so that they move very easily when they experience electric fields. Videos will be shown of the microspheres in experiments, showing the rich variety of their collective motion.

P1-02: Turbulent Liquid Metal Dynamo Experiments

Cary Forest, University of Wisconsin

The self-generation of magnetic fields in planets and stars—the dynamo effect—is a long-standing problem of magnetohydrodynamics and plasma physics. Until recently, research on the self-excitation process has been primarily theoretical. This talk will address how dynamo experiments, using high speed flows of liquid sodium, have been investigating the key processes of the geodynamo and solar dynamo. I will begin with a brief tutorial on how magnetic fields are generated in planets and stars, describing the "Standard Model" of self-exciting dynamos known as the alpha-omega dynamo. In this model, axisymmetric differential rotation can produce the majority of the magnetic field, but some non-axisymmetric, turbulencedriven currents are also necessary. Understanding the conversion of turbulent kinetic energy in the fluid motion into electrical currents and thus magnetic fields, is the biggest challenge for both experiments and theory at this time. Experimental evidence for these currents has recently been discovered in a 1-m diameter, spherical, liquid sodium dynamo experiment at the University of Wisconsin. These experiments will be described and future directions, including the possibility of a plasma dynamo experiment, will be discussed.

Session BAA: Crackerbarrel: Physics and Society Education

Location: CC Little 1512
Sponsor: Committee on Science Education for the Public
Date: Monday, July 27
Time: 12–1:30 p.m.

Presider: Ernest Behringer

Join your colleagues to discuss ways that AAPT members can contribute to the teaching of physics-related societal issues in different settings. Come with ideas for future sessions organized by the informal Physics and Society Education Group.

Session BBB: Crackerbarrel: Web Resources for Teaching Astronomy

Location: CC Little 1505
Sponsor: Committee on Space Science and Astronomy
Date: Monday, July 27
Time: 12–1:30 p.m.

Presider: Kevin Lee

The growth of the Internet has placed an abundance of wonderful teaching resources at our fingertips. Simulations, data repositories, wikis, 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.

Session BBC: Crackerbarrel: Professional Concerns of PER Faculty

Location: CC Little 1518
Sponsors: Committee on Research in Physics Education, Committee on Professional Concerns
Date: Monday, July 27
Time: 12–1:30 p.m.

Presider: Tom Foster

Physics Education Researchers are inherently interdisciplinary which means that where ever we work, at whatever level we work, no place is a perfect fit. Fortunately the issues, concerns, and solutions at one place can be informative for those elsewhere.

Session BA: Panel – Reforming the Introductory Physics Course for Life Science Majors

Location: CC Little 1528
Sponsor: Committee on Physics in Undergraduate Education
Date: Monday, July 27
Time: 1:30–3:30 p.m.

Presider: Juan R. Burciaga

Recently several prominent organizations have called on the physics community to reform and rethink the introductory physics sequence for the life sciences, e.g., BIO 2010. The session will feature speakers who will address the need for reform from the perspective of these organizations. In essence, the session will discuss the questions: What is wrong with the current approach? What is good about the current approach? How should we be thinking of the course? What are some of the alternate approaches? What are the expectations of the course by institutions outside of physics? What efforts are under way?

BA01: 1:30–1:50 p.m BIO 2010 and Physics in the Undergraduate Education of Biologists

Panel – Charles J. De Leone, California State University, San Marcos, San Marcos, CA 92096-0001; cdeleone@csusm.edu

Contributions to current biological research often require extensive use of quantitative and computational tools. In light of this situation, researchers and funding agencies have become concerned that the traditional undergraduate biology curriculum is not preparing biologists who can immediately contribute to research. As biologists look to adjust their curriculum accordingly, physics educators have the opportunity to reconsider their role in the preparation of future biologists. This talk aims to explore the open question of how physics instructors can best serve the evolving needs of biology. Some of the issues discussed include: the origin of the calls for change in the biology curriculum including BIO 2010, the current state of the introductory physics courses for biologists, what has been learned from efforts to remake this course, and ways that physics educators can enhance their contribution to the undergraduate biology curriculum.

BA02: 1:50–2:10 p.m. The 2009 AAMC-HHMI Report and Its Implications for Introductory Physics

Panel – Robert C. Hilborn, University of Texas at Dallas, Richardson, TX 75080; rhilborn@utdallas.edu

In 2007, the Association of American Medical Colleges (AAMC) in collaboration with the Howard Hughes Medical Institute (HHMI) set up a committee to examine and make recommendations on the Scientific Foundations for Future Physicians. Consisting of a mix of medical school faculty and undergraduate STEM faculty members, the committee prepared a report recommending a list of scientific and mathematical competencies for both undergraduates preparing to enter medical school and for medical school graduates. That report was released for comments in the spring of 2009. This talk will explain why the committee decided to emphasize competencies (rather than courses), what those competencies are, and the implications of those recommendations for the role of physics in the preparation of future physicians.

BA03: 2:10–2:30 p.m. Less Stuff – More Thought

Panel – Peter Lindenfeld, Rutgers University, Princeton, NJ 08540; lindenf@physics.rutgers.edu

Suzanne White Brahmia, Rutgers University

We all know that our introductory courses tend to be crammed too full of material. The textbooks have become unwieldy doorstops that students can't wait to get rid of at the end of the course. Our aim should rather be to lay a foundation of basics and reasoning ability on which students can build. That is also what the MCAT exams are moving to. Boxed equations to be memorized serve little purpose. Instead, we need to make the mathematics part of our language. Exercises and problems are important, but they need to be more than obscure puzzles. Physicists often think they are catering to the life sciences by including material on biology, but biologists tend to want us to stick to physics. That, after all, is what we know how to do. This talk will consider the general goals and the role of the textbook to achieve them.

BA04: 2:30–2:50 p.m. Physics for the Life Sciences at the University of Michigan

Panel – Timothy McKay, University of Michigan, Ann Arbor, MI 48109-1040; tamckay@umich.edu

Over the last decade, the borders among the sciences have continued to blur. Physics, Chemistry, and Biology are increasingly drawn together under the banner of the life sciences. Students working on life must possess a serious core of knowledge in all of these areas. The NRC report "Bio 2010" makes very strong statements to this effect, specifically endorsing the revision of introductory physics courses for the life sciences. Beginning in fall 2006 the University of Michigan instituted a new two-semester "Physics for the Life Sciences" introductory physics sequence. The course significantly rethinks the introductory physics course; altering the subject matter, choice of examples and problems, tools used by the students, and methods of instruction. The goal is to provide students with an introduction to many more areas of physics most relevant in the life sciences, presented within the context of realistically complex biological examples.

The following posters will also be mounted in Session PST2D on Tuesday:

BA05: 2:50–3:30 p.m. Introductory Physics for Life Science Students

Poster – Phil Lockett, Centre College, Danville, KY 40422; lockett@centre.edu

I am developing a one-semester introductory physics course designed for life science students. The course assumes students have completed a one-semester physics course covering the basic concepts of mechanics. The course will study fluids, waves, thermal physics, electromagnetism, optics, and nuclear physics. One term is not long enough to cover these topics in depth, so the coverage will be tailored to the needs of life science students. I plan to develop experiments that will be particularly useful in the life sciences. Computer simulation and visualization will play an important role in the course. Topics not normally taught in introductory courses will be studied. Examples include: 1. Dimensional Analysis, Scaling and Power Laws; 2. Non-Linear Systems; 3. Thermal Physics: e.g. Random Walks, Diffusion; 4. Interaction of Radiation with Matter; 5. Image Processing Using ImageJ.

BA06: 2:50–3:30 p.m. Applications-Oriented Problems & Laboratories for Introductory Physics for Life Science Students

Poster – Suzanne Amador Kane, Haverford College, Haverford, PA 19072; samador@haverford.edu

We have developed a series of biomedically oriented homework and laboratory exercises for our physics courses at the introductory level that support our pre-medical and pre-biology students, as well as informing our physics majors about opportunities in biological physics. Examples of topics include laser tweezing, biosensors, microfluidics, fiber optics in medicine, laser surgery, ultrasound imaging and therapy, nuclear medicine, radiography and CT, PET, Magnetic Resonance Imaging and radiation therapy. These resources are available with solutions for instructors through the web and other means.

BA07: 2:50–3:30 p.m. Strategies for Teaching Physics to Undergraduate Biologists

Poster – Dawn Meredith, University of New Hampshire, Durham, NH 103824; dawn.meredith@unh.edu

Jessica Bolker, Christopher Shubert, University of New Hampshire

James Vesenka, University of New England

Most undergraduate students in the life sciences are required to take physics; few understand why, or realize much benefit. We are transforming a traditional one-year algebra-based college physics course populated primarily by such students, by integrating biological examples that both exemplify and motivate the physics. We describe several strategies: emphasizing topics of particular importance to biologists; including examples of physics-rich biological research; developing homework and exam problems built around biological phenomena; and designing concept questions that encourage students to think about biology in a physical frame.

BA08: 2:50–3:30 p.m. A Stand-Alone Course in Optics, Electricity, and Magnetism for Life Sciences

Poster – Catherine Crouch, Swarthmore College, Swarthmore, PA 19081, ccrouch1@swarthmore.edu

While many universities offer two different year-long introductory physics courses, one for physical science and engineering students, and one for life science and pre-medical students, small liberal arts colleges often lack the enrollments and teaching resources needed to offer two such courses. Furthermore, in the spirit of a liberal arts education, many small college biology departments do not require a year-long course in physics for its majors; those students who are not also meeting premedical requirements are unlikely to take any physics. To address these issues at Swarthmore College, I have developed a semester-long course in optics, electricity, and magnetism, targeted at life science students, that can be taken either on its own, without any additional physics, or as part of a two-semester sequence with the mechanics course that is part of our current introductory physics curriculum for non-majors.

BA09: 2:50–3:30 p.m. Evolving Reform of an IPLS Course Serving a Significant Under-Prepared Student Population

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

Introductory Physics solely for Life and Health Science students has been taught by this presenter since 1996 at an institution whose mission is to help those who have been underserved and underrepresented. The two main reforming challenges that have evolved are: 1) to make the course more motivationally meaningful and relevant for these students and 2) to get the students' foundational physics understanding to the point where they can effectively transfer it to the variety of real life and health scenarios they will face in their future fields. Materials developed and adapted to meet the first challenge will be summarized. The trying experiences towards meeting the second challenge, for student long-term integration and effective transfer of the fundamentals, may shed light on what is needed in appropriate curricular approaches now being considered by the wider IPLS community.

Session BB: KSTF Teaching Fellowships: Preparing and Retaining Outstanding High School Science Teachers

Location: Chemistry 1200
Sponsors: Committee on Teacher Preparation, Committee on Physics in High Schools
Date: Monday, July 27
Time: 1:30–3:30 p.m.

Presider: Drew Isola

A discussion of the benefits of the Knowles Science Teaching Fellows in Physical Science (KSTF) and testimony of new teachers.

BB01: 1:30–2 p.m. KSTF Teaching Fellowships: Preparing and Retaining Outstanding High School Science Teachers

Invited – Nicole M. Gillespie, Knowles Science Teaching Foundation, Moorestown, NJ 08057; ngillespie@kstf.org

Roseanne Rostock, Knowles Science Teaching Foundation

There are now five active cohorts of Knowles Science Teaching Fellows in Physical Science and two cohorts of alumni. Many of these individuals have started teaching physics and physical science around the country and have been receiving a wide range of mentoring, support and professional development through KSTF as they have progressed through the Learning to Teach Continuum. This session seeks to describe those supports and their effectiveness at producing outstanding teachers of physics. The session will begin with an overview of the KSTF Program and its documented results and then follow up with presentations by Knowles Fellows that have begun their teaching in a variety of settings. These beginning teachers will be sharing specific examples of what types of support were the most meaningful for their development toward becoming effective teachers.

BB02: 2–2:10 p.m. America's Next Top Science Rockers: Project-Based Learning

Matthew D. Randall, Lindbergh High School, Renton, WA 98058; matthew.randall@rentonshools.us

Casey O'Hara, Carlmont High School

The Knowles Science Teaching Foundation's summer meeting provides Knowles fellows opportunities to work together to improve their practice and to share and build from what other fellows are doing in their classrooms. The authors will describe the development of a physics of sound unit ("America's Next Top Science Rockers") through the lesson study component of the fellowship. The authors will also describe how this project-based learning unit was shared with other Knowles fellows. Are you ready to Rock?

BB03: 2:10–2:20 Engineering at the High School Level – KSTF Support for Innovative Teaching

Jeanine G. Gasper, Grand Rapids Catholic Central High School (KSTF Fellow '05), Grand Rapids, MI 49507; jeaninegasper@grcss.org

One of the benefits of the KSTF Teaching Fellowship is support for summer professional development. This presentation will discuss a pre-engineering course developed by a physics teacher and former civil engineer that was supported byKSTF summer PD. The course focuses on the engineering design process, technical writing and problem solving in a student-centered learning environment. In 2009, students in this course designed a Handy Typer to help persons with disabilities succeed in the workplace. This design won first place in the Junior Engineering Technical Society/Ability One

National Engineering Design Challenge and has solicited partnership proposals from manufacturers and Universities. The presenter will also share work she is doing with other KSTF Teaching Fellows and physics teachers to design engineering courses of their own.

BB04: 2:20–2:30 p.m. KSTF and IceCube: A Collaboration Between Teachers and Scientists

Kristen Fancher, 8964 Posey Dr., Whitmore Lake, MI 48189; ancherk@dansville.org

Six KSTF Teaching Fellows are collaborating with scientists on IceCube, the largest research project ever attempted in Antarctica that will survey the universe looking for high-energy cosmic rays and neutrinos. One Knowles fellow will be traveling as a PolarTREC teacher to the South Pole in December of 2009 to help work on the IceCube project, while the other five team members work to bring the IceCube project into their own classrooms by following the expedition via an online journal and webinars. This collaboration is being used as a means of exciting students about current polar research and will allow students insight into what "real" scientists do. This presentation will focus on the work KSTF teachers have done with IceCube so far, including the lesson plans developed for high school students to be used in their own physics, chemistry, biology, and mathematics classrooms.

BB05: 2:30–2:40 p.m. The Evolution of a KSTF Fellow's Teaching Model

Rosalind Echols, 4811 Ridge Ave., Philadelphia, PA 19129; rosalind.echols@gmail.com

After many years of traditional science education, stepping into a science classroom of diverse learners with little science background can be a surprising experience. What do you do with students who don't know what science is? How do you teach when you want more than concept recall? In this portion of the session, a third-year teacher discusses how various workshops in modeling and inquiry made possible through KSTF have shaped how she views and practices science education. This will focus specifically on what she has learned about providing students with a clear idea of what constitutes science and enabling them to become critical independent thinkers by constructing models supported by evidence.

BB06: 2:40–2:50 p.m. Trading Labs: Long-Distance Relationships Stressing the Nature of Science

Ben M. Buehler, 400 S. College Ave., Muncie, IN 47303; bbuehler@brv.k12.in.us

Authentic physics labs deserve an authentic audience. Submitting lab reports to be scored by the instructor is a common method to assess student learning in the laboratory, however, this process seems to undermine the idea that science is a process that takes part inside a larger community. This presentation will focus on one way to make the physics lab and lab report more coherent to the nature of science. A research question is developed, investigated, and results are analyzed in one classroom. A lab report is written and sent to a peer physics classroom in a different location. The peer physics class attempts to reproduce the experiment. They draw conclusions based on their data and compare results. Feedback is given to the lab report's authors, and classroom teachers are able to discuss the importance of reproducibility on the scientific process.

BB07: 2:50–3 p.m. KSTF Supported Mentoring

Erin K. McCamish, Knowles Science Teaching Foundation, 18 Penny Lane, Ithaca, NY 14850; erin.mccamish@gmail.com

Heather Buskirk, Knowles Science Teaching Foundation/Johnstown High School

This presentation will focus on benefits of mentoring to both teachers involved and how KSTF supports such relationships. Two KSTF fellows will share their experiences with mentoring, and describe other examples of successful mentoring relationships. Examples of goals for mentoring and possible mentoring projects will also be discussed, showcasing a unit plan on waves created collaboratively by a mentoring team.

BB08: 3–3:10 p.m. KSTF Supported Mentoring: A Mentor's Perspective

Heather Buskirk, Knowles Science Teaching Foundation/Johnstown High School, Guilderland, NY 12084; heather.buskirk@gmail.com

Erin McCamish, Knowles Science Teaching Foundation

This presentation will discuss how KSTF supports the development of positive mentoring relationships. A KSTF fellow serving as a mentor teacher will discuss how KSTF's support made a non-traditional mentor relationship possible. Examples of benefits and challenges of the mentoring relationship will be shared with an emphasis on creative solutions. In particular the presentation will focus on how to build a collaborative mentoring relationship.

BB09: 3:10–3:20 p.m. Regional KSTF Meetings as an Effective Way to Support

Maurice O. Telesford, 473 Parkview Dr., Detroit, MI 48214; maurice.telesford@gmail.com

This presentation will focus on the benefits to new teachers of the KSTF-supported regional meetings. KSTF provides funding for groups of KSTF Fellows located in the same region to meet on a monthly basis. At these meetings, KSTF fellows discuss a variety of teaching issues and strategies for teaching specific topics in science and mathematics. Some fellows have mentioned that regional meetings are useful because most of the teachers are working with a similar population of students and face similar challenges. Additionally, the regional meetings have been an excellent avenue for building relationships and community across cohorts within the body of KSTF.

Session BC: Issues in Student Problem Solving

Location: Chemistry 1210
Sponsor: Committee on Research in Physics Education
Date: Monday, July 27
Time: 1:30–3:30 p.m.

Presider: Paula Engelhardt

This Session is Dedicated to the Memory of Cornelius Bennhold

BC01: 1:30–1:40 p.m. Students' Performance on Similarity Rating and Case Reusability Tasks*

Fran Mateycik, Kansas State University, Manhattan, KS 66506-2601; mateyf@phys.ksu.edu

N. Sanjay Rebello, Kansas State University

David Jonassen, University of Missouri, Columbia

Case-reuse strategies focus on enabling students to productively transfer what they have learned in a previously presented case to a new context. These strategies are designed to hone students' abilities to see the differences and similarities between problems and thereby the students become more effective at extracting the conceptual schema from previous cases and adapting them to new problems. We interviewed students participating in a semester-long study focused on facilitating case reuse strategies in problem solving. Students were asked to rate the similarities between problem pairs, identify the underlying principles of these problems and determine which problems from the collection might be most or least helpful as worked out examples to solve a new challenging problem. We will report on the results from these individual interviews as well as present a comparison with expert responses to these questions.

* This work is funded in part by the NSF under grant DUE –06185459.

BC02: 1:40–1:50 p.m. Individual Teaching/Learning Interviews to Facilitate Student Problem Solving*

Dong-Hai Nguyen, Kansas State University, Manhattan, KS 66506-2601; donghai@phys.ksu.edu

N. Sanjay Rebello, Kansas State University

Problem-solving strategies form the basic toolbox of scientists and engineers. Learning these strategies in different problems' contexts and representational forms is at the heart of training future scientists and engineers. We conducted individual teaching/learning interviews with 20 students in a calculus-based physics course. A total of four interview sessions were conducted during the semester, with each session following an exam in their physics class. During each interview, students were asked to solve a problem that had been selected from their exam. They then were presented with one or two more problems that shared deep structural similarities but had surface differences from the first problem. The problems differed in representation, context, or both. The students were asked to "think aloud" while working out the solutions to the problems. Appropriate hints were provided when students were unable to proceed. We discuss some common trends in students' responses to the hints provided.

* This work is supported in part by NSF grant 0816207.

BC03: 1:50–2 p.m. Influence of Hands-on Activity on Problem Solving

Bijaya Aryal, Lake Superior State University, Sault Ste. Marie, MI 49783; baryal@lssu.edu

This study compared introductory college level physics students' problem-solving performance and strategy in two different problem-solving sequences. Sequence 1 involved textbook problem solving followed by a context-rich problem solving activity. Sequence 2 was composed of a hands-on activity followed by the same context-rich problem solving activity. The textbook problem, the hands-on activity, and the context-rich problem all involved the same underlying physics concepts. The two sessions of each sequence were separated by approximately one hour. The students worked in groups of three or four in the first session and individually in the second session. The result of the study indicates that the students who participated in Sequence 2 performed better in the second session and more often exhibited expert-like problem-solving strategies. In addition, these students transferred both qualitative and quantitative skills from the first session to the second session better than Sequence 1 students.

BC04: 2–2:10 p.m. Learning from Worked Examples: What Do Students Actually Read?

Adam D. Smith, University of Illinois at Urbana-Champaign, Urbana, IL 61801; adsmith2@illinois.edu

Jose P. Mestre, Brian H. Ross, University of Illinois at Urbana-Champaign

We report on an eye-tracking study of what students enrolled in a calculus-based introductory course look at when they read and (hopefully) attempt to learn from worked out examples. The worked examples gave students the opportunity to focus on both the application of concepts and the application of equations, thereby allowing a comparison of the emphasis that students place on each. Students' eye-gaze patterns were recorded as they read the worked examples. Two experimental conditions are compared: In one condition students were shown a specific "target" problem followed by worked examples to help them solve it; in the other they were told that they would be given a problem to solve after being shown worked examples similar to it.

BC05: 2:10–2:20 p.m. Do Advanced Students Learn from their Mistakes Without Explicit Intervention?

Andrew J. Mason, University of Pittsburgh, Pittsburgh, PA 15260; ajm_per@yahoo.com

Chandralekha Singh, University of Pittsburgh

One attribute of physics experts is that they learn from their own mistakes while solving physics problems. Experts are unlikely to make the same mistakes when asked to solve a problem a second time especially if they had access to the correct solution after their initial unsuccessful attempt. Here, we discuss a case study that explores whether advanced physics students use the opportunity to learn from their mistakes. The performance on the final exam shows a wide distribution of students' performance on problems administered a second time, which suggests that many advanced students may not automatically exploit their mistakes as an opportunity for learning, and repairing, extending, and organizing their knowledge structure. We also conduct individual interviews with a subset of students to obtain a better insight into students' attitudes toward problem-solving and learning and to understand how well students are able to retrieve knowledge relevant for solving the problems.

BC06: 2:20–2:30 p.m. Revisiting Categorization

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

Andrew Mason, University of Pittsburgh

We revisit the classic study by Chi et al. related to categorization of introductory physics problems. However, ours is an "in vivo" study conducted in the classroom environment rather than an "in vitro" study conducted by Chi et al. with a few student volunteers. We asked introductory physics students in the calculus- and algebra-based courses to categorize or group together mechanics problems based upon similarity of solution. We find that the introductory physics students in the calculus-based courses perform significantly better than those in the algebra-based courses even though the categorization task is conceptual. Moreover, there was a big overlap between the students in the calculus-based courses and physics graduate students with regard to their categorizations that were assessed "good." This finding contrasts from Chi's study in which all introductory students were labeled novices and all graduate students were labeled experts. We conclude that it is misleading to label all introductory physics students "novices" and all physics graduate students "experts."

BC07: 2:30–2:40 p.m. ACCESS – A Problem-Solving Protocol Based on Cognitive Processes

Cornelius Bennhold, George Washington University, Washington, DC 20052; bennhold@gwu.edu

Raluca Teodorescu, Jerry Feldman, Larry Medsker, George Washington University

We have developed and tested a new physics problem-solving protocol, called ACCESS. Structured around a series of specific cognitive processes, our protocol develops the component skills of classifying the problem, representing the data, designing a strategy, executing a solution, evaluating the answer and reflecting on the learning. These cognitive processes are organized according to Robert Marzano's New Taxonomy (MNT) of Educational Objectives (2007), which updates 50 years of learning research since Bloom's Taxonomy. MNT provides a new "Thinking Skills" hierarchy that classifies cognitive and meta-cognitive processes along with the domains of declarative and procedural knowledge. In order to develop the individual component skills of the protocol in a systematic fashion, the students work on selected traditional and PER-based problems and exercises that are classified according to the thinking skills they cultivate.
We will show formative and summative assessment data obtained using rubrics and discuss the current results in the context of physics education research.

BC08: 2:40–2:50 p.m. Why Don't We Bring into Play Diverse Problems?

Lin Ding, The Ohio State University, Columbus, OH 43210; ding.65@osu.edu

Neville Reay, Albert Lee, Lei Bao, The Ohio State University

Research on problem-solving has given rise to diverse types of problems that are suitable for use in introductory science classes. These include context-rich problems, jeopardy problems, estimation problems, and design problems. As opposed to traditional end-of-chapter exercises, these problems are more connected to the real world and can promote skills beyond simple math manipulations ("plug-and-chug"). However, in real teaching practices instructors often choose not to use these problems. We interviewed eight physics and eight engineering professors to study how faculty members value these research-based problems and what factors they take into consideration when deciding whether or not to use these problems. We report interview findings and discuss implications for effective dissemination of education research results.

BC09: 2:50–3 p.m. Analyzing Students' Epistemic Cognition Through Introductory Physics Multiple-Possibility Problem Solving

Vazgen Shekoyan, Queensborough Community College, CUNY, Bayside, NY 11364; VShekoyan@qcc.cuny.edu

Eugenia Etkina, Rutgers University

Studies of workplace needs indicate that problem solving is one of the most important abilities students need to acquire. Most of the real-life and professional problems are multiple-possibility problems. As opposed to single-possibility problems, these problems do not have one right answer and require the successful solver to engage in epistemic cognition, that is, examine different possibilities, assumptions, and evaluate the outcomes. Epistemic cognition is of crucial importance when one is solving multiple-possibility problems. But in educational settings we polish problems and make them single-possibility problems. We report on our pre-post-treatment study in which we explored the impact of using multiple-possibility problems in an introductory-level physic course on students' epistemic cognition and the overall quality of student solutions. We developed a coding scheme for measuring epistemic cognition and a rubric for formative assessment solutions. Our approach was based on the theory of cognitive apprenticeship.

BC10: 3–3:10 p.m. Assessment of Student Problem-Solving Processes

Jennifer L. Docktor, University of Minnesota, Minneapolis, MN 55455; docktor@physics.umn.edu

Ken Heller, University of Minnesota

At Minnesota we have been developing a rubric to evaluate students' written solutions to physics problems that is easy to use and reasonably valid and reliable. The rubric identifies five general problem-solving processes and defines the criteria to attain a score in each (useful description, physics approach, application of physics, math procedures, and logical progression). An important test of the instrument is to check whether these categories represent the actual processes students engage in during problem solving. We will report an analysis of problem-solving interviews conducted with students enrolled in an introductory physics course and discuss the implications of these results for the rubric.

BC11: 3:10–3:20 p.m. Development of an Assessment of Textbook Problem-Solving

Jeffrey D. Marx, McDaniel College, Westminster, MD 21158; jmarx@mcdaniel.edu

Karen Cummings, Southern Connecticut Sate 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 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 primarily concerned with how successfully and thoughtfully students solve standard textbook-style problems. In this talk, we will present our progress on the development of a multiple-choice survey, the function of which is to reasonably characterize the problem-solving ability of introductory, undergraduate physics students in the realms of dynamics, energy, and momentum. Specifically, we will discuss our particular motivations and goals for this project, share some specific examples of items we have developed, and invite interested faculty to participate in the testing of our instrument.

BC12: 3:20–3:30 p.m. Using Didactic Structures to Achieve Attitudinal Gains in Introductory Physics

Raluca Teodorescu, The George Washington University, Washington, DC 20052; rteodore@gwmail.gwu.edu

Cornelius Bennhold, Gerald Feldman, George Washington University

Cognitive science research has revealed that student ability to solve problems is intimately related to proficiency in building relevant knowledge structures. Consequently, physics courses must employ instructional methods that help students structure their physics knowledge appropriately. We will present constructs such as learning progressions and concept maps that we have developed and implemented in our introductory physics course. Their purpose is to: 1) help students build local and global coherent knowledge structures, 2) develop more context-independent problem-solving skills, 3) gain confidence in problem solving, and 4) establish connections between everyday phenomena and underlying physics concepts. We organize traditional and research-based physics problems such that students experience a gradual increase in complexity related to problem context, problem features and cognitive processes needed to solve the problem. The Colorado Learning Attitudes about Science Survey (CLASS) was administered pre- and post-instruction and shows significant positive shifts in student attitudes in all targeted categories.

Session BD: Getting Published

Location: Chemistry 1300
Sponsor: Committee on Physics in Two-Year Colleges
Date: Monday, July 27
Time: 1:30–3:30 p.m.

Presider: Mary Beth Monroe

The session will talk about the preparation of papers for submission for publication in The Physics Teacher. The presentations will include tips from both the editors and published authors.

BD01: 1:30–1:50 p.m. Writing for The Physics Teacher

Invited – Karl C. Mamola, Appalachian State University, Boone, NC 28608; mamolakc@appstate.edu

The Physics Teacher welcomes submissions from all sectors of the physics teaching community. In this talk I will outline the broad spectrum of materials that are suitable for publication in *TPT*, our manuscript review process, and the criteria we use in choosing the papers that will appear in the journal. I will also provide some hints for authors, including a list of do's and don'ts, for preparing a manuscript that has a good probability of being accepted for publication. In addition I will describe our editorial policies and trace the path of a "typical" submission from its being received in the editorial office to its appearance in the pages of *The Physics Teacher.*

BD02: 1:50–2:10 p.m. Sharing Knowledge Is like Sharing Toys, Everybody Is Responsible

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

I once saw a bumper sticker that said, "Whoever has the most toys when he dies wins." A common response is, "But what good does that do me since I have never seen a hearse with a luggage rack on top?" Being a community college physics teacher, scholarship in the form of publishing isn't required. However, recently I published an article in *The Physics Teacher*. Why? Everybody has something that they can share. Hear some of the reasons why it's important to publish even when you don't have to. Make an effort to share your toys, not only is it your responsibility, you can't take them with you. When you publish then everybody wins!

BD03: 2:10–2:30 p.m. My Journey into Publishing in *TPT*, Not that Bad

Invited – Dwain M. Desbien, Estrella Mountain CC, Avondale, AZ 85323; dwain.desbien@emcmail.maricopa.edu

Having been encouraged by a working meeting among TYC faculty on getting published in the *TPT,* I submitted an article to *TPT*. I will share my experience (all positive) from writing to submitting to working through the changes with reviewers to the excitement of seeing it in print. I will share suggestions for success from an author's point of view and also what my future plans include.

BD04: 2:30–2:50 p.m. Two-Year College Faculty Do Have Something to Say in *AJP*!

Invited – Michael C. Faleski, Delta College, University Center, MI 48710; michaelfaleski@delta.edu

The time and effort of two-year college faculty primarily is focused on students and classes. Research and publication generally is not a requirement. Sometimes a problem comes along, usually arising from class, which results in the old creative juices starting to flow. Spare time is spent pondering the problem, calculations are doodled between classes, and little experiments are set up on the desktop to study the problem further. I'd like to share how one such problem slowly evolved from a simple curiosity to classroom demonstration to presentation at a state physics teachers meeting and finally into an article for the *American Journal of Physics.* While the recent history of *AJP* reveals few publications by TYC faculty, by playing with a "simple" problem that has always been personally puzzling, any TYC faculty, or really any faculty, can develop something for publication in *AJP*!

BD05: 2:50–3 p.m. Two-Year College Writing Session at Greensboro Summer Meeting

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

Mary Beth Monroe, Southwest Texas Junior College

Dwain M. Desbien, Estrella Mountain Community College

We organized a one-day writing session for the 2007 AAPT Summer Meeting in Greensboro, NC, to encourage a group of TYC faculty to write articles to be submitted to *The Physics Teacher*. Invited individuals were asked to prepare a draft of their article prior to the meeting. During the writing session, we critiqued each other's ideas, discussed the ideas with Karl Mamola, the editor of *TPT*, and revised the draft based on these discussions and critiques. This talk will describe the need for such a session, the writing process, and the results of this session.

BD06: 3–3:10 p.m. Publishing Team Work

Jerry O'Connor, San Antonio College, San Antonio, TX 78712; joconnor@mail.accd.edu

Jill Marshall, University of Texas at Austin

Eric A. Hagedorn, University of Texas at El Paso

As co-authors of a recent publication in *Physical Review Special Topics- Physics Education Research*, we will describe the process of creating an article for publication based on team work, in this case the work of the Texas Physics Assessment Team. Many of us are involved in collaborations whose work we may think of in terms of service rather than research, but dissemination of the work of these teams is important, and the many partners bring different strengths to the collaboration. We will present suggestions for future team work publications, including prospective publications in *The Physics Teacher* involving the work of the Committee on Physics in Two-Year Colleges, as well as other AAPT area committees.

Session BE: Data Mining to Study Learning

Location: Chemistry 1400
Sponsors: Committee on Research in Physics Education, Committee on Educational Technologies
Date: Monday, July 27
Time: 1:30–3:30 p.m.

Presider: Andrew Pawl

Online learning and testing systems and our penchant for testing are accumulating data that can reveal details of how students learn (or don't learn). Systematic analysis of these data is just beginning, but promises to provide detailed assessment of students, reveal beneficial learning strategies and habits, and generally serve as a formative guide to further instruction whether in the classroom or by computer adaptive tutoring.

BE01: 1:30–2 p.m Copying Online Homework and Declining Student Performance

Invited– David E. Pritchard, MIT, Cambridge, MA 02139; dpritch@mit.edu

David Palazzo, United States Military Academy, West Point

Young-Jin Lee, University of Kansas

The pattern of student interactions with an online homework tutor was analyzed to give a probability that each problem was copied. The observed patterns of copying suggest that time pressure on students who don't start their work early is the proximate cause. Surprizingly, copying correlated with over one sigma decline in analytic problem solving, but had insignificant correlation with conceptual gain. Copying is a better predictor of bad performance on the final exam than doing poorly on tests early in the course, and has an effect size of two standard deviations. Results from a standard survey of self-reported cheating were compared with reality. The survey and the observed copying patterns suggested ways to reduce copying. Corresponding changes in course format and practices have reduced copying by more than a factor of 4. Homework copying is the strongest correlate of course failure and is the most amenable to improvement by the professor.

BE02: 2–2:30 p.m. Modeling How Pre/Post Gain Depends on Prior Knowledge

Invited – Young-Jin Lee, University of Kansas, Lawrence, KA 66045-7535; yjlee@ku.edu

Lei Bao, Ohio State University

David E. Pritchard, MIT

A learner's prior knowledge ought to affect the rate at which they learn new material. We exhibit analytic models[1] that introduce a "learning connectivity" parameter. When $\beta = 0$ (no dependence of learning rate on prior knowledge) the learning is pure memory-based (cf. Tabula Rasa), and the predicted normalized gain is constant vs. prescore. When $\beta = 1$, the learning rate depends linearly on the amount of prior knowledge (cf. constructivism) and students with higher prescores are predicted to have higher normalized gain. Interestingly, $\beta = 1$ predicts an IRT skill gain independent of pretest score. The model fits high quality data for normalized gain vs. pre-test score within error. Pre/post MBT data from MIT have $\beta \sim 0$ (memorization), consistent with using an instructional format similar to the test. FCI data from University of Minnesota have $\beta = 0.5$, perhaps because their instructional format differs from the test and requires transfer of understanding.

1. David E. Pritchard, Young-Jin Lee, and Lei Bao, "Mathematical learning models that depend on prior knowledge and instructional strategies," Phys. Rev. ST Phys. Educ. Res. 4, 010109 (2008)

BE03: 2:30–3 p.m. Modeling Student Bottom-Out Hint Use with Logged Response

Invited – Benjamin Shih, Carnegie Mellon University, Pittsburgh, PA 15232; shih@cmu.edu

Kenneth R. Koedinger, Carnegie Mellon University

Educational software produces vast quantities of data, much of which is not fully utilized. For example, log files contain student response times for various steps on various problems. These response times can be used to estimate unobserved activities, such as self-explanation. For instance, when a student chooses to bypass abstract hints in search of a concrete example, this behavior has traditionally been labeled as gaming or help abuse. We propose that some examples of this behavior are not abusive and that bottom-out hints can serve as worked examples, so long as students self-explain. To demonstrate this, we create a model for distinguishing good bottom-out hint use from bad bottom-out hint use. This model is built from the logged response times and from other, often unused student interaction data. This model not only predicts learning, but captures behaviors related to self-explanation.

BE04: 3–3:30 p.m. Mining Data from the FCI

Invited – Helena Dedic, Vanier College, Montreal, QC H4L3X9; dedich@vaniercollege.qc.ca

Ivan Ivanov, Steven Rosenfield, Vanier College

Nathaniel Lasry, John Abbott College

Using Latent Class/Transition Analysis (LCA/LTA) on different groups of FCI questions (involving Newton's Second/Third Laws) we uncovered multiple characteristic knowledge states (latent classes). Knowledge states are characterized by which mental models students use in their reasoning, in the contexts of the questions. LCA provides, for each student, the probability of belonging to a particular latent class, i.e., the probability of her/him using a particular set of mental models. LTA provides information concerning the change in knowledge state (transition) of students after a term of instruction. Analysis shows students progress through states in particular patterns, largely hierarchical, from naive mental models toward consistent use of Newtonian laws. However, sometimes "you can't get there from here" applies. Such analyses have implications for the physics teaching community. Using the FCI, or similar instruments, coupled with LCA and LTA, we have a tool for real-time guidance of instruction and for designing Physics curricula/textbooks/conceptual inventories.

Session BF: PIRA (Physics Instructional Resource Association) Session: Demonstrations & Misconceptions

Location: Chemistry 1640
Sponsor: Committee on Apparatus
Date: Monday, July 27
Time: 1:30–3:30 p.m.

Presider: Wayne Easterling

The speakers for this session will address the various relationships between physics misconceptions and physics demonstrations. For example, how demonstrations might be used to help correct certain student misconceptions, or if used incorrectly how a demonstration might actually strengthen or create a student's misconception.

BF01: 1:30–2 p.m. Misconceptions in Common Lecture Demonstrations

Invited – Richard E. Berg, University of Maryland, College Park, MD 20742; reberg@umd.edu

Many simple demonstrations used in elementary physics classes are not really so simple to explain. In fact, a significant collection of demonstrations have some degree of mythology associated with their use in class or with their explanation. I will discuss several of these demonstrations and point out some of the problems with the demonstrations and with their explanations, and will also point out some of the historical and physics issues that led to this mythology.

BF02: 2–2:30 p.m. Physics Demonstrations – A Refuge from Misconceptions

Invited – James C. Reardon, University of Wisconsin, Madison, WI 53706; reardon@physics.wisc.edu

Physics demonstrations at UW-Madison have been profitably used by the Wonders of Physics outreach program, by teaching assistants in small discussion sections, and by lecturers in large lecture halls. Physics demonstrations are herein considered as the vanguard of physics education, by which the naive student is first exposed to physics, and the experienced student to a new physics topic. The first duty of the instructor is to show memorable phenomena, and only after accomplishing this, to provoke the student to a qualitative or quantitative description. The same demonstration can be used before a vast range of audiences, if only the instructor chooses appropriate descriptive words. The instructor may avoid planting misconceptions in the mind of a student, if what has not been clearly perceived is not described. Two venerable demonstrations involving a rotating platform will be discussed: the rotating platform and dumbbells (PIRA 1Q40.10) and the rotating platform and bicycle wheel (PIRA 1Q40.30).

BF03: 2:30–3 p.m. Keep It Simple Students – Low-Tech Demos to Enhance Understanding

Invited – Peter Hopkinson, Vancouver Community College, Burnaby, BC V5J 2K5; phopkinson@shaw.ca

Misconceptions, preconceptions, alternative conceptions, common sense conceptions ... different labels but we all know what they mean. In his excellent guidebook for physics teachers, *Five Easy Lessons*, Randy Knight urges us to deal explicitly with students' alternative conceptions. In my 30 odd years (well, most of them were odd) of teaching physics I have collected quite a few demos, many of them from colleagues at AAPT and PIRA, which I believe help to address some of these conceptions. Most of them require only simple low-tech equipment, and are quick and easy to set up. (Don't let the technology obscure the physics!) Some of them are interactive, requiring students to predict the outcome, and explain the results in their own words, and all of them are fun.

Session BG: Energy and Environment

Location: Dana 1040
Sponsor: Committee on Science Education for the Public
Date: Monday, July 27
Time: 1:30–3:30 p.m.

Presider: Richard Flarend

This session is about clean energy applications.

BG01: 1:30–2 p.m. Experiences from the Summer Energy Academy at Cabrillo*

Invited – John Welch, Cabrillo College, Aptos, CA 95003; jowelch@cabrillo.edu

In the summer of 2008, Cabrillo College (a California Community College) hosted the first year of an NSF-funded Summer Energy Academy designed to attract new students to science and engineering. The curriculum included global energy issues, peak oil and climate change issues, basic physics of energy, hands-on experience with electricity and solar electric systems, and a community service project. The class of 25 students met 20 hours per week for one month. The students were at the beginning of their college careers, undecided about their majors, and mostly from underrepresented groups. We used lab activities, games, student projects, field trips, and guest speakers to create a fun and interesting learning environment. In this talk, I will describe our successful first year, share some of the activities we developed, and take questions and comments.

*The Energy Academy website is at <http://www.cabrillosteep.org>. Funding was provided by an NSF STEP grant: DUE-0757114.

BG02: 2–2:30 p.m. Teaching Global Warming, and Some Personal Reflections

Invited – Art Hobson, University of Arkansas, Fayetteville, AR 72701; ahobson@uark.edu

Every citizen's education must include socially relevant science because, as the AAAS says, "Without a scientifically literate population, the outlook for a better world is not promising." I've developed a conceptual physics course that includes societal topics (see *Physics: Concepts and Connections*, Prentice Hall, 4th edition 2007). I'll outline ideas for incorporating global warming into this or any other introductory physics course. Then, stepping outside my teaching and textbook author's role, I'll present personal reflections. Comparison of the histories of ozone depletion and global warming, one sees the critical importance of the business community's response. Dow and Dupont eventually responded helpfully to ozone depletion, and the problem was solved (Richard Benedick, Ozone Diplomacy). This hasn't happened in the case of global warming. Now global warming has deepened to the point that a moratorium on new coal plants, at least until incorporation of sequestration, appears essential.

BG03: 2:30–3 p.m. Auto Fuel Economy, Size, and Safety

Invited – Marc H. Ross, The University of Michigan, Ann Arbor, MI 48109; mhross@umich.edu

The potential to improve the fuel economy of light-duty vehicles while also improving traffic safety is in dispute because of the widely held belief that lighter vehicles are especially dangerous. A prestigious expert recently said: "There are safe cost-effective ways to boost mileage, but cutting the size and weight of vehicles is not one of them." I find to the contrary that mass reduction is critical to major improvement of fuel economy. Moreover, in the energy crisis of the late 1970s, gasoline shortages led to the virtual elimination of the heaviest cars being manufactured. The fraction of new cars over 4000 lbs decreased from 50 percent of sales in 1975 to 4 percent in 1981, and there was no jump in fatalities. In fact, the risk of injuries to occupants in all vehicles in a crash tends to be reduced when vehicle masses are similar. The basic observation is that most serious injuries in crashes are associated with "intrusion" (due to changes in the shape of the passenger compartment), instead of with the recoil. Thus, a strong passenger compartment, even if light, tends to be safe.

BG04: 3–3:10 p.m. Physics and Environmental Concerns – Part III Geothermal Energy (Cont.)

Celia Chung Chow, CSU, Weatogue, CT 06089; cchungchow@comcast.net

This is a continuation of our last talk on the subject. This talk will concentrate on what has happened to New Zealand's 30-year application and research on thermal energy as our reference. When should we teach this topic to our students?

BG05: 3:10–3:20 p.m. Liquid Fuel Trends and their Implications for the U.S. and World Economies

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

Petroleum is the energy source for transportation. The spectacular rise and fall in oil prices was a meaningful economic signal. The big price swings—which are not over yet—are being driven by demand, finance, and limitations on production. Studies of oil discovery and consumption by independent geologists show that worldwide oil production is not likely to increase, and must begin to decline within a few years. Despite our best efforts, the decline will not reverse but deepen as time goes on. At current or extrapolated levels of consumption, alternative fuels cannot fill in for missing petroleum. This presentation takes a data-driven approach to the liquid fuel system and explains why we can expect more troubles with energy if/when the world economies start growing again unless we drastically change our energy consumption and production patterns.

BG06: 3:20–3:30 p.m. Teaching Energy Through Design: A Strategy to Engage Minority Students

Yael Bamberger, School of Education, University of Michigan, Ann Arbor, MI 48109; yaelbamb@umich.edu

Clara Cahill, Morten F. V. Lundsgaard, Joseph Krajcik, University of Michigan

This presentation illustrates a teaching strategy developed to engage middle-school students from diverse economic and racial backgrounds in learning about forms of energy. In technological design projects tied to contemporary issues in sustainability, the students explore various energy forms and how energy can be transferred and also transformed. Throughout the curriculum, discussions, reflection, and practical experiences help students develop an understanding of energy concepts, the process of design, and the nature of technology. The curriculum will be piloted during a free two-week summer science camp at the end of July at the University of Michigan for students from a diverse Midwestern school district in which over 50% of the students qualify for free or reduced-price lunch. Learning the curriculum, which utilizes current research in learning sciences, students will acquire necessary knowledge and skills for the 21st century.

Session BH: Cutting-Edge Research at Michigan State University

Location: Dennison 170
Sponsor: Committee on Graduate Education in Physics
Date: Monday, July 27
Time: 1:30–3:30 p.m.

Presider: Michael Thoennessen

BH01: 1:30–2 p.m. The Physics of Protein Folding

Invited – Lisa J. Lapidus, Michigan State University, East Lansing, MI 48824; lapidus@msu.edu

In this talk I shall present some aspects of protein folding, the process by which polypeptide chains assume biologically active conformations. Folding is spontaneous and depends in detail on the physical interactions within the chain and with the surrounding water. In particular I shall focus on recent results on the early stages of folding in which the chain is relatively unstructured and may be described by models from polymer physics. The exact nature of the unfolded state may determine the subsequent folding steps and play a crucial role in aggregation, misfolding and subsequent disease.

BH02: 2–2:30 p.m. Exploring the Universe Using Particle Accelerators

invited – Kirsten Tollefson, Michigan State University, East Lansing, MI 48824; tollefson@pa.msu.edu

Particle physicists at MSU are attempting to answer basic questions about the universe such as: What are the fundamental forces in nature? What are the basic constituents of matter? and What are the origins of mass? In order to recreate conditions that occurred a few seconds after the Big Bang and probe the smallest building blocks of nature, we analyze data from experiments located at the world's two largest particle accelerators in Batavia, IL, and Geneva, Switzerland. I will show results from ongoing research and discuss future research opportunities.

BH03: 2:30–3 p.m. Where Did Matter Come From?

Invited – Filomena Nunes, National Superconducting Cyclotron Laboratory, 1 Cyclotron Lab, East Lansing, MI 48824; nunes@nscl.msu.edu

Although most of the matter in nature is stable, the formation of the stable nuclei that surround us involved other nuclei that are very exotic and decay rapidly and that have large proton/neutron asymmetries. One of the most important questions identified for the new century is: "How are the elements formed?" Even though many efforts have made progress in answering this huge question, there are still many open problems to resolve. Today many of the investigations are done in modern rare isotope facilities, in which unstable nuclei are produced. Indeed, some of these unstable nuclei are being seen in the laboratory for the very first time. In this talk I will give an overview of where we stand and provide a few examples of ongoing studies with rare isotopes that help answer the big question.

BH04: 3–3:30 p.m. Astrophysics and Cosmology at Michigan State University

Invited – Megan Donahue, Michigan State University, East Lansing, MI 48824-2320; donahue@pa.msu.edu

I will discuss some of the exciting research in astrophysics and cosmology by Michigan State University faculty, post-docs, and students. Our astronomy group at MSU is active in observing the universe with NASA space-based observatories and our own 4-meter ground-based telescope in Chile, SOAR. We also have a growing group of theorists simulating the universe with supercomputers. I will highlight my work on studies of cosmology and galaxy evolution, using clusters of galaxies as distant laboratories and as tracers of how systems grow gravitationally.

Session BI: How to Prepare Undergraduates for Graduate School

Location: Dennison 182
Sponsor: Committee on Graduate Education in Physics
Date: Monday, July 27
Time: 1:30–3:30 p.m.

Presider: Chandralekha Singh

BI01: 1:30–2 p.m. A Larger View: Physics Before Graduate School

Invited – Charles H. Holbrow, Colgate University/ MIT (visiting), Cambridge, MA 02139-4510; cholbrow@mail.colgate.edu

Probably no undergraduate physics program should have as its main mission preparation of students for graduate school. That said, a program that does not provide coverage and rigor sufficient to prepare a good student for graduate work in physics is surely deficient. After discussing how the undergraduate physics curriculum supports the graduate physics curriculum, I will review skills and experiences important to graduate work in physics and ways to help undergraduates acquire these. Undergraduates considering graduate work in physics also need special advising. They need to understand the apprenticeship nature of graduate work; they need to know how important their thesis supervisor will be to them as mentor, as role model, for financial support, and as someone to help them find suitable jobs when they finish graduate work. They may also need some forewarning of the primacy of research and the centrality of external funding in graduate programs.

BI02: 2–2:30 p.m. Preparing Students for Graduate School: Beyond Coursework and Research Experiences

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

Success in graduate school depends on many factors. Every student is different but there are skills that are useful but often neglected in undergraduate education. Beyond the courses and examinations, graduate students must be able to work constructively with other people, to communicate effectively, solve complex and ill-defined problems, and to structure their own learning. In addition to taking courses, passing high-stakes examinations, and learning their research area, graduate students are also expected to teach with little preparation or guidance. Without adequate undergraduate preparation, this combined pressure can cause a high level of stress on the student. This presentation will discuss some useful preparation centered on collaboration and problem solving skills and give suggestions for purposefully integrating them into the undergraduate experience.

BI03: 2:30–3 p.m. How Research Experiences Prepare Students for Graduate

Invited – Sherry J. Yennello, Texas A&M University, Cyclotron Institute, College Station, TX 77845-3366; yennello@comp.tamu.edu

Undergraduate courses enable our students to learn physics through a variety of channels, including lectures, recitations and laboratories. Undergraduate laboratories are designed to allow students to discover the physical laws that govern the universe for themselves, yet they are constructed to be successful. Graduate research breaks new ground. Students experiment—sometimes for extended periods of time—on things that never end up working. The direction and pace of a project is often largely in the hands of the student. The answers are not known a priori. Undergraduate research experiences can be the bridge between the typical well-designed experiments in undergraduate laboratories and the self-directed research projects of graduate school.

BI04: 3–3:10 p.m. Teaching Critical Research Skills to Undergraduate Astronomy Majors

Eric G. Hintz, Brigham Young University, Provo, UT 84602; doctor@tardis.byu.edu

As part of our B.S. in Physics and Astronomy we require a senior thesis project. To help students complete this requirement, the Phscs 329, Observational Astronomy, class was introduced in 1999. In the past 10 years the class has evolved into hands-on exposure to the wide variety of skills that are used in research astronomy. The final products of the class are expected to be a telescope proposal, two journal-style articles, and a meeting poster. The goal is to make these projects as real as possible with at least the proposal actually being submitted. We will discuss the successes and failures that have occurred in the class over the years.

BI05: 3:10–3:20 p.m. Thinking Like a Physicist: Transforming Upper-Division Electricity & Magnetism*

Stephanie V. Chasteen, University of Colorado at Boulder, Boulder, CO 80309; stephanie.chasteen@colorado.edu

Steven J. Pollock, Michael Dubson, Ed Kinney, Paul Beale, Katherine Perkins, University of Colorado at Boulder

We expect certain skills in graduate students, such as the ability to justify problem-solving strategies, choose and apply problem-solving techniques, and recognize the interconnectedness of ideas in physics. But these skills are typically not explicitly taught. We are using research-based teaching methods to transform upper-division Electricity & Magnetism so as to directly define and address these learning goals and help students become more sophisticated thinkers through active engagement. In this talk, we will highlight key results regarding effectiveness and sustainability of these transformations. We used the principles of learning theory to guide teaching practices, and student observations and interviews to identify common student difficulties with the course content. The transformed course included consensus learning goals, interactive lecture with "clicker" questions and small group activities, weekly tutorials, homework study groups, and a conceptual diagnostic assessment. 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.

BI06: 3:20–3:30 p.m. Development of Technical Reading Skills: A Research Proposal

Paul J. Camp, Spelman College, Atlanta, GA 30314; pcamp@spelman.edu

I describe a proposal to investigate the development of technical reading as a professional practice. I will present preliminary survey data that indicates a significant gap between the approaches of undergraduates and professionals to decoding scientific text. This data is coupled with an argument based on fundamental cognitive research in reading to motivate a proposal for a two-pronged research strategy. I propose a series of in-depth snapshot studies of readers at various stages of development using video-recorded structured interviews and a verbal protocol analysis. In parallel, a microgenetic study in a class of undergraduates based on the reciprocal teaching strategy will investigate the the developmental process for technical reading as a cognitive skill.

Awards: Millikan Medal to Arthur Eisenkraft

Arthur Eisenkraft

Location: Mendelssohn Theater
Sponsor: AAPT
Date: Monday, July 27
Time: 3:30–4:30 p.m.

Presider: Lila Adair

Arthur Eisenkraft, University of Massachusetts Boston, Graduate College of Education, Boston, MA 02125-3393; arthur.eisenkraft@umb.edu

Physics for All: From Special Needs to Olympiads

Can a physics course be considered "real" physics if all students feel welcome? *Physics First* and *Physics for All* have become a success story for thousands of students in urban, suburban, and rural districts. Simultaneously, the International Physics Olympiad and other competition programs have raised the expectation of what the most highly motivated students can achieve. Many physics educators are exploring ways to set higher goals for our most gifted students while also providing physics instruction to those students previously excluded from our physics classes. Great novels and symphonies are accessible to people of different backgrounds and levels of expertise. Both the literary scholar and the casual reader can enjoy Steinbeck's *Grapes of Wrath*. We should develop teaching strategies that enable us to share an understanding of physics with all students—because everyone deserves a peek at the wondrous workings of our universe.

Session CA: Distance Learning

Location: Chemistry 1200
Sponsor: Committee on Educational Technologies
Date: Monday, July 27
Time: 4:30–6 p.m.

Presider: Leon Hsu

In this contributed session, participants will describe projects and courses related to the learning of physics in non-face-to-face environments.

CA01: 4:30–4:40 p.m. Best Practices for Teaching Current Pure-Online Physics

Ricardo J. Rademacher, Futur-E-Scape, LLC, 503 McAlpin Ave., Cincinnati, OH 45220; ricardo@futur-e-scape.com

At the 2009 AAPT Winter Meeting, Dr. Rademacher presented "An assessment of current pure-online physics courses." In this follow-up, we will build on that assessment to present practical ideas to overcome the challenges of teaching a pure-online physics class. Among some of the challenges we will discuss are how to motivate discussion-based assignments within a physics context, how to deal with the inability of most Learning Management Systems to display equations, and how to improve on the lab requirement in an online environment. The audience will walk away with a set of best practices that they can incorporate into their own online physics classes. This topic will be more thoroughly examined in a forthcoming book.

CA02: 4:40–4:50 p.m. Clickers and Problem Solutions at an Asynchronous Distance

Michael R. Meyer, Michigan Technological Univerisity, Houghton, MI 49931; mrmeyer@mtu.edu

We use "clickers" in our classroom sections of College Physics and recordings of these sections in our online classes. In this talk I will show a system I've created to allow distance-learning students to respond to these same questions, even though the videos are delivered asynchronously. This system simultaneously gives me insight into how (and how well) students are using the recordings. Finally, I'll share a unique method I've discovered to quickly create flexible, audio-narrated problem solutions for online distribution.

CA03: 4:50–5 p.m. Interactive Online Demonstration in a Blackboard Learning Environment

Cheng Ting, Houston Community College System, Houston, TX 77087; cheng.ting@hccs.edu

Interactive lecture demonstration (ILD) can be adapted for online courses. The concept of an instantaneous center of rotation in a perfect rolling motion was used for an ILD, then shown in the Blackboard website, provided by Houston Community College. Concepts of equilibrium of rigid body and torque were also developed in ILD. The differences between lecture demonstration and online demonstration will be discussed.

CA04: 5–5:10 p.m. Low-Cost Thermodynamics Home-Lab Experiments

Farook M, Al-Shamali, Athabasca University, Athabasca, AB T9S 3A3; farooka@athabascau.ca

Martin Connors, Athabasca University

A perception exists among students, and many instructors, that highly quantitative experiments can only be done in supervised physics laboratories and using specialized and costly equipment. This restrictive view poses an obstacle for the development of correspondence/online courses. With good imagination and adequate research, we believe that high-quality physics experiments can be designed and performed safely and independently by the students at home using common materials and low-cost devices. With this in mind, several home-lab experiments are presented, which allow students to: 1) measure the heat of fusion of water and the specific heat of a metal, 2) demonstrate Charles's law and estimate the absolute zero temperature, 3) demonstrate the anomalous expansion of water and estimate the temperature at which water reaches its maximum density. In these experiments, students use commercially available equipment and common household items to perform quantitative measurements that are comparable to traditional physics labs.

CA05: 5:10–5:20 p.m. Teaching a Laboratory-Intensive Online Introductory Electronics Course*

Mark E. Markes, University of Nebraska-Kearney, Kearney, NE 68849; markesme@unk.edu

Most current online courses provide little or no hands-on laboratory content. This talk will describe the development and initial experiences with presenting an introductory online electronics course with a significant hands-on laboratory content. The course is delivered using a Linux-based Apache web server, a Darwin Streaming Server, a SMART Board interactive white board, and SMART Notebook software. The laboratory uses primarily the Global Specialties PB505 trainer and a Tenma 20MHz Oscilloscope that are provided to the students for the duration of the course and then returned. Testing is performed using Course Blackboard course management software.

*The development of this course was supported by the University of Nebraska-Kearney Physics Department and Division of Continuing Education.

CA06: 5:20–5:30 p.m. The Team Experience of On-line Astronomy Lab Development

Shan C. Huang, Sinclair Community College, Dayton, OH 45402; shan.huang@sinclair.edu

One of the greatest challenges in developing online science labs is creating online interactive tools and activities that can be substituted for traditional hands-on experiments. We started with a one-year Faculty and Professional Learning Community (FPLC) project co-funded by the Ohio Learning Network (OLN) and our college to explore the possibilities. The project result led to a one-year intense team development work that involved instructional designer, graphic designer, Flash program designers, lab technician, photographer, video script writer and producer, and faculty developer. The result was a sequence of three astronomy labs offered entirely online. This achievement completed our college's goal of offering a degree fully online. The team experience and lessons learned will be shared in this presentation.

CA07: 5:30–5:40 p.m. Online Teacher Professional Development in the Physical Sciences

Robert Steiner, American Museum of Natural History, Central Park West at 79th St., New York, NY 10024; rsteiner@amnh.org

Online teacher professional development is providing teachers across the United States and around the world with opportunities to deepen their scientific understanding by connecting them to scientists, colleagues, tools, and resources beyond their local community and by taking advantage of the unique pedagogical opportunities of the Web. This presentation highlights the opportunities and challenges of online professional development in the physical sciences, including those from the American Museum of Natural History, the National Science Teachers Association, and WGBH Teachers Domain. The session will include demonstration of cutting-edge science education resources, Web 2.0 innovations, and opportunities that blend face-to-face and online learning. A free CD of course resources in the physical sciences will be provided to all attendees.

Session CB: Research Regarding Student Interactions and Collaborations

Location: Chemistry 1210
Sponsor: Committee on Research in Physics Education
Date: Monday, July 27
Time: 4:30–6 p.m.

Presider: Eric Brewe

CB01: 4:30–4:40 p.m. When Talking Is Better than Keeping Quiet

Nathaniel Lasry, John Abbott College, Montreal, QC H9X3L9; lasry@johnabbott.qc.ca

Elizabeth Charles, Chris Whittaker, Dawson College

Michael Lautman, John Abbott College

The effectiveness of Peer Instruction is often associated to the importance of in-class peer-discussions. Reflection or time-on-task may also explain this effectiveness because students answering ConcepTests reflect more and spend more time thinking about concepts. An identical sequence of conceptual questions was given to three groups of students in a Canadian two-year college. All groups were polled twice on each question. They differed in the task assigned between the first and second poll. Between polls, the first group was given a distraction task (eg. sequence of "funny" science cartoons), the second group was asked to reflect for a minute and the third group was asked to discuss their choice with a peer. All three groups displayed gains between the first and second poll. The "Distract" group had less gain (3.4%) than the "Reflect" group (9.7%) while the "Discuss" group had most (21.0%). The significant difference in gains for the "Discuss" group confirms the notion that peer discussions play a central role in learning.

CB02: 4:40–4:50 p.m. Student Perceptions and Instructional Choices in Educational Reform: Studies of Peer Instruction

Chandra A. Turpen, University of Colorado at Boulder, Boulder, CO 80305; Chandra.Turpen@colorado.edu

Noah D. Finkelstein, University of Colorado at Boulder

While institutional and instructor buy-in is essential in the adoption of research-based materials, how faculty use these materials in practice is equally important. We document and describe variation in classroom practices for six different faculty implementing Peer Instruction.[1] These variations include: discussion of incorrect answer options, prevalence of professor-student discussion during the voting time, time given to respond to the clicker question, grading practices, etc. Based on these documented differences in practices, we claim that collections of these classroom practices send different messages to students about doing Peer Instruction. We associate these findings with the results of survey data on students' perceptions of Peer Instruction and how these vary in the different courses. We find that faculty members do affect what students think is important about Peer Instruction and what students perceive as their role during Peer Instruction.

1. E. Mazur, *Peer Instruction: A User's Manual* (Prentice Hall, Upper Saddle River NJ, 1997).

CB03: 4:50–5 p.m. Studying the Effectiveness of Lecture Hall Design on Group Interactions

Sissi L. Li, Oregon State University, 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. As part of this reform, we have remodeled our large lecture hall to promote instructor/student and student/student interactions. The aim of our current study is to see if student discourse during group work is affected by the classroom design. We have previously reported strong FCI gains (0.4) comparable to those in interactive-engagement classrooms at other colleges and universities in the first of a three-quarter sequence. We also observed student and instructor preference for the remodeled room with swivel chairs, double-row tiers, additional pathways for instructor interaction, and enhanced technology to facilitate instructor mobility. This talk will showcase our research methods and describe the nature of student discourse and interactions.

CB04: 5–5:10 p.m. The Effect on Student Performance of Three Physics Teaching Methods

Maria C. Babiuc, Marshall University, One John Marshall Dr., Huntington, WV 25755; babiuc@marshall.edu

New studies suggest that students do better in science classes that are taught interactively, rather than passively, and excel in an environment that promotes interaction. We want to employ three different pedagogical approaches in teaching introductory level physics: the lecture-based method, the peer instruction method, and the active learning laboratories based on the Physics Suite. We present the data on student performance on exams, homework, lab activities, and standardized tests, from more than 200 students taking the 200 level introductory physics courses at Marshall University, in West Virginia. We discuss the efficiency of each method in fostering the success of students in the introductory physics courses. We find that subtle differentiations can be implicitly detected in students' exam grades, homework, participation, and background. The expected benefit of this study is that we will improve our understanding on how different pedagogical methods can influence undergraduate level students to perform better in physics.

CB05: 5:10–5:20 p.m. Promoting Effective Collaboration in the College Physics Classroom*

Geraldine L. Cochran, Chicago State University, Dept. of Chemistry and Physics, Chicago, IL 60628; moniegeraldine@gmail.com

Mel S. Sabella, Chicago State University

The Physics Program at Chicago State University has been investigating ways to encourage effective collaboration in our introductory physics classes through the various course components. These classes utilize a guided-inquiry approach to instruction and we often observe students engaging in peer questioning as they work through course material. Analysis of video from the laboratory portion of the course suggests that students' use of questioning may promote effective collaboration. In order to provide additional evidence that this is the case, we have begun to supplement data from the classroom with data from one-on-one interviews. In this talk we discuss how transcriptions from the classroom videos and interviews, as well as results from a survey we developed to assess the value students place in the guided-inquiry approach, will be used to guide instruction and foster better collaboration in the classroom.

*Funding provided by New York City Alliance Bridge Program and the National Science Foundation CCLI grant DUE #0632563

CB06: 5:20–5:30 p.m. A Link Between Physics Experiences and Future Learning*

Joseph Santonacita, Colts Neck High School, Manasquan, NJ 08736; jsantonacita@gmail.com

Erin Siebenmann, Freehold Boro High School

Eugenia Etkina, Rutgers University

Physics Union Mathematics (PUM) is an interactive engagement, guided-inquiry curriculum with an emphasis on mathematical and scientific reasoning and scientific abilities that spans middle school physical science and high school physics. The pilot-year high school students who learned physics through PUM have gone on to their senior year or freshman year in college. The current high school seniors have pursued a variety of interests in AP courses and other electives during their senior year. Those who have gone to college entered a number of fields where physics is not used on a daily basis. Using a questionnaire/survey provided to those volunteer students, we examined how the interactive engagement of the PUM curriculum affected students' learning styles and attitudes toward their current nonphysics and physics coursework. We were interested whether students who pursued science courses (physics, chemistry, environmental science, etc), could utilize the skills that they developed in the PUM curriculum in other science and technical courses.

*Sponsored by NSF grant # DRL-0733140

Session CC: Particle Physics in High Schools

Location: Chemistry 1300
Sponsor: Committee on Physics in High Schools
Date: Monday, July 27
Time: 4:30–6 p.m.

Presider: Deborah Roudebush

Not enough time. Too difficult. No labs. These are refrains often heard when discussing particle physics in the high school classroom. Yet many teachers and students do innovative, exciting work at the high school. Students can and do experience what particle physics is and how it is done. This session shows some of the ways this happens and the tools that are used.

CC01: 4:30–5 p.m. Particle Physics in the Classroom in Practical Terms

Invited – Michael R. Fetsko, Mills E. Godwin High School, Henrico, VA 23238; mrfetsko@henrico.k12.va.us

As a member of QuarkNet for the past nine years, the author has learned about the fascinating world of high-energy physics and he decided many years ago to come up with a way to share this content with students. For the past eight years, the author has taught a two- to three-week unit on particle physics that has involved hands-on activities, video clips, content, and interactive investigations. From participating in real particle physics data analysis to talking about the excitement of the LHC, we need to expose our students to this current and exciting topic. In this talk, the author will provide instructional materials, online resources, and ideas that will help you bring particle physics into your classroom.

CC02: 5–5:30 p.m. E-Labs, Gateways to Data from Professional Experiments

Invited – Thomas A. Jordan, University of Florida, Gainesville, FL 32611-8440; jordant@fnal.gov

Scientists in modern, international collaborations remotely access and analyze data. They also use emerging technologies to communicate and share results. We have created a web-based environment that allows students to do the same.

CC03: 5:30–5:40 p.m. Quantum Electrodynamics, Cartoon Style

Shira K. Eliaser, Chicagoland Jewish High School, Deerfield, IL 60615; seliaser@cjhs.org*

Students are taught that opposite charges attract and similar charges repel, but never why this effect occurs. QED, the exchange of virtual photons, can be explained to high school students in simple and accessible terms. Using cartoons of electric charges—our subatomic connoisseurs—students can examine the charges' insatiable desire to "collect" new photons, then add to their sizeable collection by "trading" photons with other similar charges. Students can use conservation of momentum to predict the outcome of this microscopic game of catch; the same principle can help them explain the motion of opposite charges, who, being unable to pass back and forth, must "share" each others' photon collections. An analogy to teenage DVD collectors tops off this accessible model whereby students can imagine passing their favorite films back and forth, or tossing out unwanted episodes to make way for new ones.

*Sponsored by Ken Ceirce.

CC04: 5:40–5:50 p.m. Correlations Among Extended Air Showers Using the CROP Network

Thomas S. McShane, Creighton University, Omaha, NE 68178; tmcshane@creighton.edu

Yury Gorbunov, Lyle A. Sass, Creighton University

We present the results of a search for extended air showers performed with several independent scintillator arrays. The motivation for this project was based on a theoretical model predicting a long-range correlation between air showers, with a typical separation distance ranging from a few kilometers up to a hundred kilometers. During this project we provided class lectures for high school students in select schools, web-based study materials, instructions for operating and maintaining detector arrays in high schools, and assisted with initial setup and maintenance. Data sharing and analysis tools have been made available on the web which ensures easy access to the collected data and analysis framework for all participating schools. The collaboration consisted of 15 Nebraska high schools, two community colleges, and two universities. High school teachers and students developed a deeper understanding of nuclear physics and became familiar with modern particle detectors as well as data analysis methods.This research project has been supported by a NASA Nebraska Space grant.

CC05: 5:50–6 p.m. Particle Physics Masterclass: Possibility for Teaching the Nature of Science?

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

This study addresses the problem of science literacy, focusing specifically on students' lack of understanding about the nature of science. Research is in progress to determine if QuarkNet's Particle Physics Masterclass provides a fruitful program for students to learn about the nature of science. The Masterclass is a national program in which high school students come to a local area research institute and interact with particle physicists through lectures, informal discussions, and work together to analyze real particle physics data. This presentation highlights the research questions, methodology, and the preliminary results of the study.

CC06: 6–6:10 p.m. Virtual QuarkNet for More Distant Teachers

Dave W. Trapp, Sequim Science.com, Sequim, WA 98382; dtrapp@mac.com

Traditionally QuarkNet had provided for groups of local high school physics teachers to gather under the auspices of a nearby research center under the guidance of several physicist mentors and lead teachers to share ideas, support each other, and gain further understanding of high-energy physics. Despite the large number of institutions serving as QuarkNet centers, many physics teachers live too distant to attend multiple QuarkNet meetings during the school year. Virtual QuarkNet is a small initial effort to investigate whether similar collegial support might be largely provided to more remote teachers via monthly video conferences. Details about the efforts and their success will be presented. QuarkNet and Virtual QuarkNet have been supported in part by the National Science Foundation and the Office of High Energy Physics, Office of Science, U.S. Department of Energy.

Session CD: Recruiting and Retaining Women in Physics: What We Knew Then, What We Know Now

Location: Chemistry 1400
Sponsor: Committee on Women in Physics
Date: Monday, July 27
Time: 4:30–6 p.m.

Presider: Brian A. Pyper

Review and update of issues on Women in Physics

CD01: 4:30–5 p.m. The Current Status of Women in Physics

Invited – Laura McCullough, University of Wisconsin-Stout, Menomonie, WI 54751; McCulloughL@uwstout.edu

Are women still under-represented in physics? Is this a problem? This talk will explore the 2009 status of women in physics: classes, degrees, jobs, and lives. Looking at data from a variety of sources, I will discuss the participation rates of women in our field, and what work has been done on discovering how to make physics more welcoming to women. I will also discuss the gender gap in the physics classroom and the belief that interactive teaching strategies are particularly helpful to women.

CD02: 5–5:30 p.m. APS Gender Equity Conference: Promoting Gender Equity in University Environments*

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

In May 2007 the APS Committee on the Status of Women in Physics (CSWP) received funding from the National Science Foundation and U.S. Department of Energy to bring together chairs of the largest Ph.D.-granting institutions and directors of national laboratories to discuss issues related to promoting gender equity in physics at their institutions with the intent of doubling the participation of women in physics. The report (www.aps.org/programs/women) contained recommendations for physics departments, national labs, and funding agencies to continue the gains realized in the community over the past several decades. Current activities include a set of focused discussions with departments on improving climate, recruiting, and retention of women in physics. I will discuss specific outcomes and look forward to a good discussion of how our community can continue effective and efficient progress on this issue.

*Funding provided by the National Science Foundation, the Department of Energy, and the American Physical Society.

CD03: 5:30–6 p.m. Connecting High School Physics Experiences and Physics Identity Development: A Gender Study

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

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

This study addresses the issue of female under-representation in physics by examining gender differences in high school physics experiences and how these experiences shape students' physics identities. The theoretical framework for this work is based upon the concept of a physics identity that is shaped by performance, competence, recognition by others, and interest. The data is drawn from the Persistence Research in Science & Engineering (PRiSE) project, which surveyed college English students nationally about their backgrounds, high school science experiences, and science attitudes. This study uses multiple regression to examine the responses of 3829 students from 34 randomly selected U.S. colleges. Confirming the importance of identity for young persons' occupational choices, a measure representing students' physics identity is found to be strongly correlated to their intended choice of a career in physics. Physics identity, in turn, is positively predicted by several high school physics experiences with a single factor exhibiting a differential effect for females and males. Additionally, the high school physics experiences that are significantly different for males and females will also be presented. The implications of these finding for gender studies will be discussed in the presentation.

Session CE: Teaching Physics Around the World: Part I

Location: Chemistry 1640
Sponsor: Committee on International Physics Education
Date: Monday, July 27
Time: 4:30–6 p.m.

Presider: Lei Bao

This is an invited and contributed session designed for reports from groups around the world working on physics teaching. The session will focus on perspectives, results, successes and challenges of physics teaching around the world; as well as the effect of the structure of different school systems on physics teaching.

CE01: 4:30–5 p.m. How Systems, Dependencies, and Constraints Affect Our Physics Education Research

Invited – Michael C. Wittmann, University of Maine, Orono, ME 04468-5709; wittmann@umit.maine.edu

Physics education research takes place within an infrastructure dependent on the local culture of instruction, including mandated or culturally expected curricula, quality of student body, and so on. Different countries have different infrastructures and different instructional cultures, creating constraints on the kinds of studies available to researchers. In this talk, I will discuss U.S. research and reform efforts at the college level and compare them to the possible research and reforms of Germany (specifically Bavaria) and Austria. Using information gathered recently during a year lived abroad as well as data gathered through collaborators in Germany and Austria, I will discuss the different kinds of research carried out in each country and how research is affected by the systems, dependencies, and constraints in each location. I will outline a research project to study issues in learning across language and culture and present examples of representative research data.

CE02: 5–5:30 p.m. 111 Degrees Apart: Teaching Physics in Fiji and Venezuela

Invited – Andrew D. Crouse, Ithaca College, Ithaca, NY 14850; acrouse@ithaca.edu

An overview of physics teaching in both Fiji and Venezuela will be presented from the perspective of an outsider looking in. Examples will be gleaned from the speaker's experience teaching for two years in each location. Some unique challenges facing Peace Corps Volunteers teaching physics as well physics teachers in international schools will also be discussed.

CE03: 5:30–6 p.m. PHYSWARE: Teaching Mechanics in Developing Countries

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

Dean Zollman, Kansas State University

Pratibha Jolly, University of Delhi

Elena Sassi, University of Naples

At the World Conference on Physics and Sustainable Development (http://www.wcpsd.org) a key action plan formulated by approximately 100 members of the Conference's Physics Education Planning Group was "To develop model workshops for teacher-trainers in Asia, Latin America, and Africa that exemplify how active learning methods can be adapted to help meet the needs of students in developing countries." To facilitate this action plan the Abdus Salam International Center for Theoretical Physics in Trieste, Italy hosted Physware—a two-week workshop attended by 33 physics faculty and administrators from 26 developing countries. At Physware the participants engaged in exploring the use of both low-cost equipment and appropriate technologies for active learning in mechanics. The participants created projects and established various means of continuing the collaboration through blogs, groups and other Web-based collaborative tools. We report on the workshop and possible follow-up activities.

CE04: 6–6:10 p.m. Learning Microgravity by the Project Method Gives Students More Latitude, Improves Achievement and Develops Skills

Rafal Jakubowski, Wyspianskiego 4, Ostrow Wielkopolski, 63-400, Poland; festiwal@osw.pl

During this school year I explored the Project Method of learning and teaching to improve students' learning experience. My students worked on a project called "Newton in Space." On this project students are learning about microgravity and Newton's law applications in space. Students must navigate their own independent study. The "Newton in Space" project is divided three different ways for exploring microgravity. The first variation is to give students instruction by the teacher, and students must exactly follow the instruction specifics. This helps them reference how well they can think and follow somewhat complicated instruction. The second variation is that a theme is given by the teacher and all of the work including defining their own guidelines as instructions to follow help the students define their own methods to reach a conclusion. The third and last kind of project is done by students' microgravity experiments in the classroom. The three methods allow students at all levels to complete the project with success and allows students to explore using their abilities to complete a project with a variety of degrees of involvement. Both teacher and student benefit from this type of teaching.

(This session is continued as Session HE on Wednesday afternoon.)

Session CF: Advice for the New Physics Teacher

Location: Dana 1040
Sponsor: Detroit Metro Area Physics Teachers, Committee on Physics in High Schools
Date: Monday, July 27
Time: 4:30–6 p.m.

Presenters: Steve Rea, Jim Gell, Plymouth High School and Detroit Metro Area Physics Teachers

Our team of new and veteran teachers will provide advice and tips to help you transition into the classroom. We will offer advice on how to make professional contacts, how to engage students, how to find the best teaching resources, and how to thrive in this exciting profession.

Session CG: Carnival Knowledge

Location: Dennison 170
Sponsor: Committee on Science Education for the Public
Date: Monday, July 27
Time: 4:30–6 p.m.

Presider: Stanley Micklavzina

CG01: 4:30–5 p.m. Carnival Knowledge: The Flying Bernoulli Brother's Stupendous Sideshow of Science – I*

Invited – Gene Easter, 540 S. Ridgecliff Rd., Tallmadge, OH 442787; gleaster@sbcglobal.net

Hurry! Hurry! Hurry! To the Greatest Show and Tell on Earth! Take a stroll down the Magic Midway as the Flying Bernoulli Brothers explore the games of chance—or so they are called. How do they work? Learn how to play using scientific principles. See when to bet and when not. Learn how they gaff a game. What are alibi games? Why are Flat stores flat? Participants will actually try many of the games as we explain how the principles of physics are used against you. Hanky Pank, Group Games, Skill Games, Percentage Games, Buildup, Alibi, Flat Stores and more.

*Funded by Misspent Youth

CG02: 5–5:30 p.m. The Flying Bernoulli Brothers Present Carnival Knowledge Part 1

Invited – Bill Reitz, Hoover High School, Silver Lake, OH 44224; wer1nc@northcanton.sparcc.org

A continuation of The Flying Bernoulli Brothers Present Carnival Knowledge Part I.

Session CH: Innovations in Teaching Astronomy

Location: Dennison 182
Sponsor: Committee on Space Science and Astronomy
Date: Monday, July 27
Time: 4:30–6 p.m.

Presider: Doug Lombardi

This session will focus on innovative teaching methods, strategies, and resources pertaining specifically to astronomy and space science content.

CH01: 4:30–5 p.m. Teaching General Education Astronomy Using SCALE-UP/Studio Physics Models

Invited – Michael Rogers, Ithaca College, Ithaca, NY 14850; mrogers@ithaca.edu

Luke Keller, Matthew Price, Julia Kregenow, Ithaca College

Mark Constas, Cornell University Education Department

The defining characteristics of studio physics classes are integrated lecture/laboratory form, a reduction in lecture time, a technology-enhanced learning environment, collaborative group work, and a high level of faculty-student interaction. SCALE-UP (Student-Centered Activities for Large Enrollment Undergraduate Programs) developed at North Carolina State University expands the Studio Physics model to classrooms of 100 or more students. The Ithaca College Performance-based Physics room contains eleven 6.5-foot-diameter tables with each table seating nine students working in groups of three for a total of 99 students in the room. Each table has an associated 10.5-foot-wide storage cabinet along the walls of the room containing PASCO data-collection equipment and whiteboard doors for solving problems. We are developing curriculum materials for general education astronomy that take advantage of this format, and studying their effectiveness at enhancing student learning. We are particularly focused on enhancing student understanding of the nature of science.

CH02: 5–5:10 p.m. A Spectrum Is Worth a Thousand Pictures

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

We present a sequence of interactive activities that allow every instructor to incorporate spectroscopy as part of introductory astronomy courses and to provide each student with a meaningful understanding and appreciation of spectra as a scientific tool. Hands-on activities have been designed so students will learn how to discover "hidden" diagnostics, such as different sources of light their eyes see as white light. Other activities help students appreciate the evidence for the Doppler redshifted spectra of galaxies leading to the explanation of an expanding universe, the observed spectrum of the cosmic microwave background, and how we can know that theories of primordial nucleosynthesis match the observed elemental composition. Emphasizing spectroscopy also provides the opportunity to stress the story of the "Harvard Women," a tale that bridges gender gaps and often humanizes scientists in the eyes of nonscience majors.

CH03: 5:10–5:20 p.m. It's a Matter Of Scale: Seeing Neil Armstrong's Footprints

Philip E. Kaldon, Western Michigan University, Kalamazoo, MI 49008-5252; philip.kaldon@wmich.edu

While researching a science fiction story I was writing, I got to thinking about being able to see small objects from very far away. The Internet can provide students with some fascinating photos—the International Space Station seen from Earth, Google Earth images of airplanes and ships from space, landslides on Mars from Martian orbit, Earth and Moon seen from the surface of Mars. In addition to the physics and technical difficulties of such magnification, our ability to see increasingly small angles of view also means we are likely to miss small things as well. And TV shows give students the impression that we can see "everything" with unlimited resolution. The real world is much more interesting.

CH04: 5:20–5:30 p.m. Teaching and Learning Physics Through Astronomy

Stanley Greenspoon, Capilano University, North Vancouver, BC V7J 3H5; sgreensp@capilanou.ca

The standard introductory astronomy course normally covers various areas of physics on an as-needed basis. I propose that a course at this level can not only survey astronomy for its inherent interest but also be intentionally designed to serve as a vehicle to provide students with an introduction to physics over a wide range of topics, including mechanics, waves, optics, electricity and magnetism, thermal physics, quantum physics, and relativity. Conversations with students suggest that their interest and understanding of topics in physics is promoted more by learning about them in the context of astronomy than through following a standard non-thematically based course.

CH05: 5:30–5:40 p.m. Graduate Cosmology as Professional Training in Written and Oral Presentation

Eric Gawiser, Rutgers University, Piscataway, NJ 08854-8019; gawiser@physics.rutgers.edu*

Graduate courses often feature lectures heavy on derivations and problem sets laden with algebra. Students emerge unprepared to face the primary career demands of reading the literature, designing research projects to extend on it, and clearly communicating their results in scientific papers and oral presentations. I will describe a novel approach to the teaching of graduate cosmology implemented successfully at Rutgers University that features: 1) a simplified curriculum focused on concepts rather than derivations, 2) problem sets written in the style of refereed articles that place equal emphasis on calculation and explanation, 3) reading published papers from the literature, both historical and modern, 4) design, research, and writing of an individual term paper in the style of a publishable article with a draft refereed by the instructor, and 5) oral presentations of the literature papers and term project papers to the rest of the class.

*Sponsor: David Maiullo (Rutgers University)

Session CI: Physics Bazaar – Posters

Location: CC Little 1528
Sponsor: Committee on Apparatus
Date: Monday, July 27
Time: 4:30–6 p.m.

Presider: Tom Senior

Participants will display Inexpensive physics demonstration and laboratory equipment and offer samples for sale.

CI01: 4:30–6 p.m. Music in Motion: Activities Using Musical Instrument Design to Teach Freshman Science and Mathematics*

Poster – Robert J. Culbertson, Arizona State University, Tempe, AZ 85287-1504; robert.culbertson@asu.edu

A project to integrate science, mathematics, and English for incoming university freshmen was begun in fall 2008 by an interdisciplinary team consisting of physics, mathematics, education, engineering, and music faculty. A physical science course, the lead course in this project that consisted of an 11-credit block of connected science, math, and English composition courses called a Learning Community (LC) included a laboratory component where students carried out construction projects on the theme of sound and musical instruments. Initially, the course cluster was offered to non-STEM freshmen in liberal arts and science majors, but in fall 2009 pre-service education majors will be recruited. Beginning with simple harmonic motion, the projects quickly progressed into wave motion, standing waves, and applications to musical instruments. Several working instruments were constructed from inexpensive and readily available materials, and the final project involved the design, construction, and demonstration of a unique musical instrument. Several examples of projects that can be used in a wide range of classroom environments will be given.

*Sponsored by NSF No. 07118937

CI02: 4:30–6 p.m. New Ways of Improvising for Demonstrating Two Physics Concepts

Poster – Liang Zeng, The University of Texas-Pan American, Edinburg, TX 78539; zengl@utpa.edu

The two experiments will show how to improvise for demonstrating the phenomena of atmospheric pressure and electrostatic induction: (1) for the atmospheric pressure demo, the materials include a PASCO cap (with a hole), two regular plastic drinking water bottles, and a straw; (2) for the electro-static induction, the materials include two rods, a piece of fur, a stand, a wood block, and any other ordinary materials such as a tape case, an envelope, a book, and a piece of aluminum foil. My teaching experience shows that students do not expect the results and it is a lot of fun for them to be involved in the explanations.

Session TYC: Favorite Activities in the Two-Year College Classroom – Posters

Location: Michigan League Room 4
Sponsor: Committee on Physics in Two-Year Colleges

(Note: These posters will be on display in the TYC Resource Room, ML 4, for the whole meeting, Sunday through Wednesday)

TYC01: Pinhole Clarifiers

Rhoda Berenson, New York University Liberal Studies Program, New York, NY 10003; rb143@nyu.edu

This poster will describe a simple, hands-on student activity that can be performed even in a large lecture. It quickly demonstrates how pinholes clarify (rather than magnify) vision and also illustrates "near point." It is a great start to a discussion of vision, pinhole cameras or lenses.

TYC02: Color as a Tool in the College Classroom

Michael C. Faleski, Delta College, University Center, MI 48710; michaelfaleski@delta.edu

Determining the connectedness in circuits is often a challenge to teach. Simple circuits with obvious connections of resistors/capacitors in series/parallel are not too troublesome, but when shorting wires are added or the circuit is connected in an unusually drawn way, students struggle. One way to combat the misunderstandings is through the use of color. After finishing a professional presentation during which I described how color can clarify circuits, it was pointed out that the CASTLE Project already had high school curriculum using color for this purpose. Largely, the college and university teachers with whom I have spoken subsequently are not aware of these techniques. Examples of the utility of using color with an introductory calculus-based college class in electricity and magnetism will be presented.

TYC03: Newtonian Tasks Inspired by Physics Education Research (nTIPERs) Project

Curtis J. Hieggelke, Joliet Junior College, Joliet, IL 60431; curth@comcast.net

Steve Kanim, New Mexico State Universit, *David Maloney, Indiana University – Purdue University Fort Wayne,*

This poster will describe the 2009 status and provide samples from a project that is aimed at developing innovative tasks in a variety of formats designed to improve student learning and understanding of Newtonian mechanics. These tasks are based, in part, on efforts in Physics Education Research and thus are called nTIPERs (Newtonian Tasks Inspired by Physics Education Research). These tasks readily support active learning approaches and provide an easy way of updating traditional lecture formats. This project includes paper and pencil activities as well as "clicker" tasks. This is a collaborative project between Joliet Junior College, New Mexico State University, and Indiana University-Purdue University Fort Wayne that is supported in part by CCLI grants from the Division of Undergraduate Education of the National Science Foundation (0632963 and 0633010).

TYC04: Changing How I Cover Lenz's Law

William P. Hogan, Joliet Junior College, Joliet, IL 60431; whoganjjc@gmail.com

I've recently made some changes to how I approach Lenz's Law in my algebra/trig based introductory course. I will discuss the changes I have made and how my students have responded. I hope this poster will lead to a discussion with those in attendance about how others approach this topic.

TYC05: Motion Diagrams in the Introductory Physics Class

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

I have been using and modifying motion diagrams since being introduced to them by Alan Van Heuvelen. In the nearly two decades since that indoctrination, I and colleagues have used motion diagrams in a wide variety of ways. In this poster, I will illustrate a number of ways we have used motion diagrams and will have examples to share.

TYC06: Having Fun with Spiral Physics

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

During this past year, I have used the Spiral Physics curriculum (developed originally by Paul D'Alessandris at Monroe Community College) for my calculus-based physics class. In this poster, I will illustrate how I used the curriculum, point out some benefits and challenges of this curriculum, and share some of the highlights from my class.

TYC07: Exploring How Waves Behave at Boundaries

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

Understanding how waves behave at boundaries is critical for ultrasound technicians trying to obtain the best possible image to examine a patient's internal pathology. In my class, students use a LASER and an acrylic block to examine the concepts of reflection and refraction and Intensity Reflection Coefficients and Intensity Transmission Coefficients. This gives them a visual to relate the theory of ultrasound wave transmission with. It also leads them to an understanding of why reflection plays a role in the attenuation of the beam making it challenging for the transducer to record the returning echo.

TYC08: Failing the Test

David Weaver, Chandler-Gilbert Community College, Chandler, AZ 85225; david.weaver@cgcmail.maricopa.edu

I am a testing heretic. I believe that grades (and, therefore, tests) are anachronistic and do not truly measure learning. Furthermore, tests exist primarily in the world of education and also in certification exams. My 3.71 GPA (derived mostly from exams) did not indicate how good of a physicist I might be. Good scores on MCAT or LSAT don't assure excellent doctors and lawyers. I passed both Cisco and Novell certification exams and I assert that my passing scores did not measure my ability to be a good network administrator. If tests don't measure authentic learning and don't reflect real life (can't cram for a paycheck), why use them? I don't, should you?

TYC09: Project-Based Physics Potpourri

David Weaver, Chandler-Gilbert Community College, Chandler, AZ 85225; david.weaver@cgcmail.maricopa.edu

I've presented numerous posters as well as a number of contributed and invited talks at national AAPT meetings about my use of Project Based Physics (PBP) in the physics classroom. This poster will consist of project descriptions for most of the projects I've used over the last 15 semesters along (with a collection on USB drive for you to copy to your computer if you wish, and you can leave me files for your projects that I might be able to use). I will, of course, be happy to explain why and how I do PBP, but this poster is focused on the "what."

TYC10: Does this Compute?

David Weaver, Chandler-Gilbert Community College, Chandler, AZ 85225; david.weaver@cgcmail.maricopa.edu

I've long been intrigued by the various presentations on Computational Physics. Even when TYC colleagues (such as Martin Mason from Mt. SAC) talk about it, there has been an impedance mismatch for me and my students... I only teach the algebra-based course and most of the other examples are at a higher level. I decided to attempt to use Excel and VPython at a level approachable to high school and introductory college courses. Come by to see how I did.

Award: AIP's Andrew W. Gemant Award to John Rigden

Location: Mendelssohn Theater
Sponsor: American Institute of Physics
Date: Monday, July 27
Time: 7:30–8:30 p.m.

Presider: Catherine O'Riordan

John S. Rigden Washington University at St. Louis

Physics and the Public: Why? Who? What? How? When?

Members of the physics community recognize the need to nurture the public's interest in science. Often, however, the activities prompted by this recognition are clearly driven by self interest. Physicists can do better. There are noble reasons for bringing physics to the attention of the public not only because the people have an inbred interest in the ideas of physics, but also because they will be the beneficiary. Some physicists are diligent in reaching out to the public, but the occasional lecture is, at best, an ad-hoc approach. A long-range strategy is needed.

Tuesday, July 28

Registration *Michigan League Concourse*	7 a.m.–4:30 p.m.
Poster Session *Dana Hall*	8:30 a.m.–10 p.m. (authors present 8:30 p.m.-10 p.m.)
Klopsteg Award *Mendelssohn Theater*	10:30–11:30 a.m
"400 Years of the Telescope" *Dennison 182 — brown bag*	11:50 a.m.–1 p.m
Exhibit Show *Michigan League 2nd Floor*	10 a.m.–6 p.m
AAPT Awards Ceremony *Mendelssohn Theater*	2:30–4:15 p.m

Session DDD: Crackerbarrel – National Task Force on Physics Teacher Preparation: An Update

Location: CC Little 1505
Sponsor: Committee on Teacher Preparation
Date: Tuesday, July 28
Time: 7–8:30 a.m.

Presider: Stamatis Vokos

There is a well-established and documented need for major improvements in physics and physical science education in the United States, in order to prepare today's students for tomorrow's increasingly technical workplace. To lead the physics community in a response to national and international pressure for a drastic improvement in pre-college science education, and to the national debate on accountability in pre-college education, the American Association of Physics Teachers, the American Physical Society, and the American Institute of Physics have formed a National Task Force on Physics Teacher Education. The Task Force is investigating best practices that institutions (and in particular, physics departments and schools or colleges) can employ to increase the number of well-prepared secondary teachers of physics. The Task Force is performing site visits and collecting national data. It will author a report of its findings, which it will distribute to all physics departments in the United States, and disseminate through presentations, workshops, and other mechanisms, under the auspices of the sponsoring professional organizations. This crackerbarrel will provide an opportunity for participants to learn more about the work of the Task Force and provide input to it.

Session DA: Pre-College Physics Potpourri

Location: Chemistry 1200
Sponsor: Committee on Physics in Pre-High School Education
Date: Tuesday, July 28
Time: 8:30–10:30 a.m.

Presider: Julia Olsen

DA01: 8:30–8:40 a.m. A Quantitative Demonstration of the Momentum and Kinetic Energy in an Entire Collision

Nattakit Sawadthaisong, Center for Science and Mathematics Education, The University of Texas at Austin, Austin, TX 78712-0382; nsawad@hotmail.com

James P. Barufaldi, The University of Texas at Austin

A collision is a physical phenomenon commonly occurring in our daily life. In the classroom, the instructor usually demonstrates collision to enhance students' conceptual understanding of momentum conservation and kinetic energy conservation in collisions or explosions. The results of such demonstrations illustrate that the total linear momentum and the kinetic energy for elastic collisions in a system are similar both before and after the collision. Demonstrating the momentum and kinetic energy while the two objects are in the process of colliding can provide greater insight into these concepts. Such demonstration results during the collision are rarely described, however, because the time during the collision process is very short making the determination of the velocity or momentum of each object very difficult. In this paper, a quantitative demonstration is proposed to illustrate the results of momentum conservation and kinetic energy conservation simultaneously for the entire collision.

DA02: 8:40–8:50 a.m. Kinematics of the Assembly Line to Teach the Doppler Shift

Joseph M. Mosca, Embry-Riddle Aeronautical University, Daytona Beach, FL 32114; moscaj@erau.edu

Bereket Berhane, Micheal Hickey, Embry-Riddle Aeronautical University

Most students in their first physics course find the general Doppler shift formulas confusing despite the abundant and relatively subtle role of the velocity of the source. We propose a set of analog-kinematics problems that allows the students to discover for themselves the general Doppler shift formulas and allows them to gain a better understanding of the relationships between frequency, wavelength, and speed of traveling sinusoidal waves.

DA03: 8:50–9 a.m. Spreadsheet Analysis and Model of a Big Yellow Bus

Richard K. Cole, Evansville High School, Evansville, WI 53536; coler@evansville.k12.wi.us

Modeling of real-world experiences can bring relevance and enhanced retention to introductory-level physics students. This culminating kinematics exercise brings together relevant personal experiences (riding the school bus), computational skills (spreadsheet calculations), kinematics topics (speed, acceleration, kinetic energy, power, friction, wind resistance, efficiency), and the capabilities and limitations of a predictive model, all infused with the timely relevance of fuel consumption and greenhouse gas emissions. Students begin by timing the deceleration of a school bus on a level road, finding its mass at a nearby truck scale, and measuring the rolling friction by pushing it with the use of bathroom scales! The numbers are entered into a spreadsheet and factors for wind resistance and engine friction are introduced into the calculations. The model is used to predict the power expended against drag, and to predict the top speed of the bus, its fuel consumption and its overall efficiency.

DA04: 9–9:10 a.m. Using Dark Matter to Teach Physics Topics in the Classroom

Nancy Bynum, Elk River High School, Elk River, MN 55330; nancy.bynum@elkriver.k12.mn.us

Abstract not available.

DA05: 9:10–9:20 a.m. Physics and Lyrics: Storytelling in Teaching Physics

Mikhail M. Agrest, College of Charleston, Charleston, SC 29424; agrestm@cofc.edu

Whether you are a "traditional lecturer" communicating physics to numerous listeners in an auditorium, a "studio coach" exposing your students to the hands-on experience, or an "online instructor" teaching via the Internet, it will help your students to learn if you employ storytelling as a carrier of the provided knowledge. The associative thinking and imagination are effective tools of scientists in creating physical models while studying the laws of the Universe, they are also essential in relating new knowledge to previously obtained information. Storytelling can be used to create images and mnemonic rules and enhance students' memories. The persuasive speakers' slogan "Tell a story, make a point" became an effective tool in the author's teaching practice[1-4] creating the emotional component of the cognition process.

1-4. M. Agrest. *Lectures on Introductory Physics I&II. Revised; General Physics I&II* (Calculus Based).

*Supported by the College of Charleston Center for Faculty Development Grant"

DA06: 9:20–9:30 a.m. Physics Class – It's All Greek to Me

William E. Semrau, Van Buren ISD, Lawrence, MI 49071; techscienceguy@yahoo.com

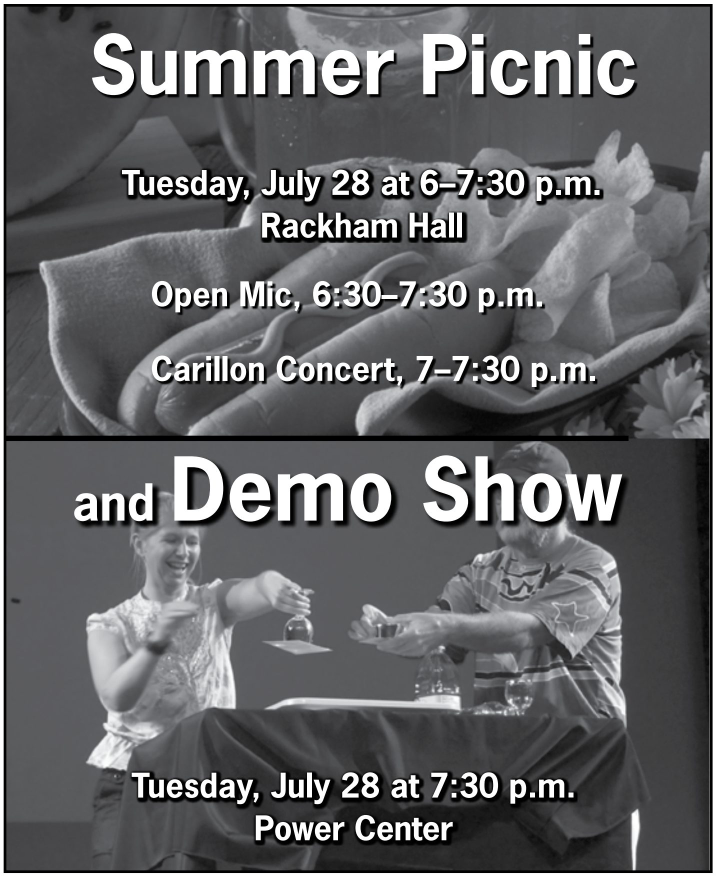
As I've taught high school physics courses and talked with non-science major teachers, it has become apparent that we are not only teaching physics concepts in addition to reinforcing algebra skills and applications, but we are also opening up an entire new world of vocabulary to our students. From our alphabet soup of letters, abbreviations, and terms the question is asked if we are remembering to address the vocabulary that is adherent within our discipline. A firm grasp on the language of physics may help improve student learning. This talk will present specific examples from current electricity as well as student definitions and invites other teachers to share their experiences on how to help students master the vocabulary within our discipline.

DA07: 9:30–9:40 a.m. Physics First Textbook Discussion

John L. Hubisz, North Carolina State University, Raleigh, NC 27695; hubisz@mindspring.com

Barry H. Feierman, Westtown School

Suggestions are made for a variety of textbooks suitable for a first course in high school physics. Physics First is a style of course where physics is taught in ninth-10th grade prior to a full-year course in chemistry and biology. The kind of textbook most successful for this younger age group depends on the goals of the course, varying from a mostly conceptual text using only basic algebra to a more analytical style text relying on traditional mathematical derivations and problem solving. Textbooks to meet this wide range of interests are reviewed.



DA08: 9:40–9:50 a.m. Unraveling Bias from Student Evaluations of High School Science Teachers

Geoff Potvin, Dept. of Engineering & Science Education and Dept. of Mathematical Sciences, Clemson University, Clemson, SC 29634; gpotvin@clemson.edu

Zahra Hazari, Clemson University

Robert H. Tai, University of Virginia

Philip M. Sadler, Harvard Smithsonian Center for Astrophysics

In this talk, recent work examining the evaluation of high school biology, chemistry, and physics teachers by their students will be reported. While male students in all three disciplines rate female teachers significantly lower than male teachers, even female students underrate female teachers in physics. The gender bias in teacher ratings persists even when accounting for academic performance, classroom experiences, and family support. Moreover, male and female teachers in each discipline appear equally effective at preparing their students for future science study in college, suggesting that students have a discipline-specific gender bias. The possible negative impacts of this bias on female students, particularly in physics, will be discussed.

DA09: 9:50–10 a.m. Raising the Bar: Middle School Students Learn Through the Physics Union Mathematics Curriculum*

James Finley, New Providence Middle School, Berkeley Heights, NJ 07922; finleyjames@mac.com

Susanne Brahmia, Hector Lopez, Tara Bartiromo, Eugenia Etkina, Rutgers University

The Physics Union Mathematics (PUM) project is a research-based curriculum that utilizes observations, concept development, testing, and questioning to help middle and high school students develop physics and mathematics conceptual understanding and scientific abilities. Over the past two years pilot- and field-testing has occurred in both middle and high school classes. We tracked the conceptual development of two years of 8th grade students in a North Jersey middle school using a series of assessments. In the pilot year, students in this class showed impressive scores on the post-assessments, some of which even rivaled those of high school students. In the field test year, an additional pre- and post-assessment was given using the Force and Motion Conceptual Evaluation. We report the students' assessment scores and discuss how the curriculum helped increase student understanding of force and motion concepts.

*Sponsored by the NSF grant # DRL-0733140

DA10: 10–10:10 a.m. Reformed Instruction and Experience: Is there a Link?

Tara M. Bartiromo, Rutgers University, New Brunswick, NJ 08901; tmfinley1@yahoo.com

Suzanne Brahmia, Hector Lopez, Eugenia Etkina, Rutgers University

The Physics union Mathematics (PUM) project is an interactive engagement, guided inquiry curriculum with an emphasis on mathematical and scientific reasoning that spans middle school physical science and high school physics. During the pilot and field-testing phases for the first six modules, we conducted more than 30 observations in more than 15 classrooms of middle and high school teachers with various levels of experience of using interactive engagement materials, and specifically PUM. We took extensive field notes, created transcripts, and determined Reformed Teaching Observation Protocol (RTOP) scores. We found that the RTOP scores for more experienced PUM teachers were consistently higher than those of inexperienced PUM teachers and that the more experienced teachers' scores in the second year increased from their first year of using PUM.

DA11: 10:10–10:20 a.m. BEST Robotics: For High Schools and Middle Schools

Steven J. Maier, NWOSU, 709 Oklahoma Blvd., Alva, OK 73717; sjmaier@nwosu.edu

Since 2002, NWOSU has sponsored Heartland BEST,[1] a local feeder "hub" for the growing national BEST Robotics program.[2] BEST (Boosting Engineering, Science & Technology) is a venue that makes available to students a six-week challenge that culminates in a friendly robotics competition. The final competition is a sports-like event complete with cheerleaders, pep bands, and fanfare one would expect at an athletic tournament. This presentation will begin with a brief history and basic outline of the BEST program. I will then discuss the logistics of hosting the annual competition highlighting our challenges, the perceived worth of the program and research opportunities. Middle and high school teachers interested in finding out more about the program are welcome to attend, as are institutions that may be looking for outreach or service learning program opportunities.

1. www.nwosu.edu/BEST
2. www.bestinc.org

DA12: 10:20–10:30 a.m. Unexpected Findings from Fourth Graders' Work with Batteries and Bulbs*

Victoria Winters, San Diego State University/University of California, San Diego, San Diego, CA 92122; vwinters@rohan.sdsu.edu

David Hammer, University of Maryland, College Park

Previous work suggests college students have more difficulty lighting a bulb with a single wire and a battery than with two wires (Slater et al., 2000), results that have informed the design of activities (Schaffer & McDermott, 1992). I present some unexpected findings from two fourth-grade classes engaged in a 15-hour inquiry module on electric circuits. Students successfully lit the bulb with a single wire in a variety of ways, including configurations with multiple bulbs and multiple batteries. Starting with the first day of experimentation, however, students from both classes showed and expressed the view that the bulb had to be in direct contact with a battery in order for it to light. I offer an interpretation of this outcome in terms of a resources perspective (diSessa, 1993; Hammer et al., 2005), where spontaneously generated explanations and actions are contextually sensitive to features of the task.

*Supported by NSF grant #0732233

Session DB: Student Conceptual Difficulties: Introductory and Upper-Level Topics

Location: Chemistry 1210
Sponsor: Committee on Research in Physics Education
Date: Tuesday, July 28
Time: 8:30–10:30 a.m.

Presider: Paula Heron

DB01: 8:30–8:40 a.m. Investigation of Student Understanding of Vector Direction Concept in a Mexican University

Genaro Zavala, Tecnologico de Monterrey, Monterrey, NL Mexico 64849; genaro.zavala@itesm.mx

Pablo J. Barniol, Tecnologico de Monterrey

The vector concept is used to model almost all physical phenomena; therefore, its understanding should be a key objective of university introductory physics courses. However, it has been shown that students don't have a clear understanding of concepts such as magnitude, direction, and addition of vectors.[1] In a previous contribution,[2] we showed that Mexican students have similar difficulties compared to American students. However, we have noticed that in the concept of direction of a vector, in particular, the results are different. In this contribution we are presenting results of a study in which the objective was to investigate Mexican students' understanding of the concept of direction. We will show that the understanding of this concept is related to language and cultural issues.

1. Ngoc-Loan Nguyen and David E. Meltzner, "Initial understanding of vector concepts among students in introductory physics courses," *Am. J. Phys.* **71**, 630-638 (2003).
2. Christian Moran and Genaro Zavala, "An investigation of the concept of vectors with college students in Mexico," PERC Conference, Edmonton, Canada (2008).

DB02: 8:40–8:50 a.m. Exploring the Effect of Presentation on Student Vector Addition Methods*

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

John R. Thompson, Michael C. Wittmann, University of Maine

The mathematical operation of two-dimensional vector addition arises in multiple physics contexts. The vectors are often presented with different features (axes, grids, etc.) depending on the quantities represented and the physical contexts given. To determine if these changes in presentation have an effect on the methods students use to solve these problems, we asked four two-dimensional vector addition questions as part of a larger survey developed by Van Deventer in 2007, with different contextual features, in both a math and a physics context. We also conducted interviews consisting of two sets of five different two-dimensional vector addition questions with a distracter task between sets. In this talk, we present the questions, examples of student work from interviews, and a brief summary of results. More detailed analysis can be found in a related poster.

*Supported in part by NSF grant DRL-0633951

DB03: 8:50–9 a.m. Student Understanding Difficulties with Vectors in Contexts Related to Mechanics

Sergio Flores, University of Juarez, El Paso, TX 79912; sergiflo@hotmail.com

Maria Dolores Gonzalez, New Mexico State University

Juan Ernesto Chavez, Luis Leobardo Alfaro, Jose valente Barron, University of Juarez

A functional understanding of Newton's second law as a vector equation requires that students be able to reason about vectors. In this presentation, we present data describing students' conceptual difficulties with vector addition and subtraction, and with vector quantities such as force, acceleration and tension. These data suggest that after traditional instruction in introductory physics, some students do not recognize the vector nature of these quantities. Other students who do not have the requisite procedural knowledge to determine net force or acceleration, and are therefore unable to reason qualitatively about Newton's second law. We describe some specific procedural and reasoning difficulties we have observed in students' use of vectors. In addition, we describe modifications to laboratory instruction in mechanics that we designed on the basis of our research into student understanding. These modifications were intended to improve students' understanding of vector addition and subtraction and to promote student use of vectors when solving mechanics problems.

DB04: 9–9:10 a.m. A Closer Look at Full-Length Mirror Image Predictions

Joel A. Bryan, Ball State University, Muncie, IN 47306-0505; jabryan@bsu.edu

Barbara D. Fennell, Ball State University

It has been widely reported that most people believe that a person can see more of himself/herself as he/she moves farther away from a plane mirror. Such a belief, which remains strongly held even after formal instruction and laboratory investigations of reflection of light, implies that the minimum size of a plane mirror needed for full-length image viewing should decrease as a person moves further from the mirror. To more fully investigate this belief, pre-service elementary teachers were asked to illustrate the size and location of the smallest mirror necessary for viewing one's full-length image from varying distances. Results indicated that although an overwhelming majority of students do believe that the mirror size should decrease, their diagrams revealed different patterns of thought not previously uncovered by research, and not affected by traditional ray tracing activities.

DB05: 9:10–9:20 a.m. Student Difficulties with the Sign of Magnetic Force on a Charged Particle

Thomas M. Scaife, The Ohio State University, Columbus, OH 43210; scaife.7@osu.edu

Andrew F. Heckler, The Ohio State University

In a series of tests administered to introductory physics students, we examine how students answer questions about the direction of the magnetic force on a charged particle. Data were taken over a period of 17 weeks using both field line and magnetic pole representations of the magnetic field. Following instruction, approximately 30% of the responses to the magnetic pole representation coincided with an overall sign error. Potential sources of sign error (e.g. "left-hand-rule," physical discomfort, non-commutativity of crossproducts) were investigated by means of additional test questions and student interviews. Evidence from these additional tasks suggests that the sign errors are not systematic within students, but vary randomly. For example, students who believe the cross product is commutative could answer either with the correct force or an overall sign error.

DB06: 9:20–9:30 a.m. Development of a Conceptual Post-Test for Upper-Division Quantum Mechanics*

Steve N. Goldhaber, University of Colorado at Boulder CO 80309-0390; goldy@colorado.edu

Steven J. Pollock, Katherine K. Perkins, Paul D. Beale, University of Colorado at Boulder

Previous research has shown that students finish their undergraduate quantum mechanics training with common conceptual difficulties such as time dependence or the effect of measurement on a system. At the University of Colorado at Boulder, we are transforming our upper-division quantum mechanics course using interactive engagement techniques, homework problems that emphasize conceptual as well as computational proficiency, interactive problem-solving sessions, and University of Washington Tutorials in quantum mechanics. To assess the effectiveness of these transformations, we are developing a conceptual post-test that we are using to measure student learning in areas of known student difficulty. We report on the initial development of the test and discuss two semesters worth of student results.

*This work was funded by the University of Colorado's Science Education Initiative and by National Science Foundation.

DB07: 9:30–9:40 a.m. Exploring Student Difficulties with Multiplicity and Probability in Statistical Physics*

Donald B. Mountcastle, University of Maine, Orono, ME 04469-5709; mtcastle@umit.maine.edu

John R. Thompson, Trevor I. Smith, University of Maine

We continue our research program on the teaching and learning of concepts in upper-division thermal physics at the University of Maine. Typical statistical physics textbooks introduce entropy (S) and multiplicity (w) [S = kln(w)] with binary events such as flipping coins N times. Inherent confusion with probability and statistics, macrostates and microstates, and the varying dependence of each on N lead to student conceptual difficulties reported both by us and others. We have developed and implemented a guided-inquiry tutorial on the binomial distribution with student use of computational software to produce calculations of multiplicities, outcome probabilities, and graphs of the distributions of each as functions of N. This allows convenient exploration of relevant statistics over more than six orders of magnitude in N. Comparing student answers to pre- and post-tutorial questions, we find some, but not all of the intended learning results are achieved.

*Supported in part by NSF Grants #PHY-0406764, DRL-0633951 and DUE-0817282

DB08: 9:40–9:50 a.m. Student Understanding in Upper-Division Physics and Chemistry Courses Covering Thermodynamics*

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

As part of a continuing project of research and curriculum development in the context of upper-division courses in thermal physics, we have performed extensive studies of student understanding in the context of an upper-division course in thermodynamics and statistical physics at CSUF. Recently, we extended this work to include an upper-division course in physical chemistry. The first semester of the two-semester physical chemistry course at CSUF focuses on thermodynamics and is similar in structure and enrollment to the corresponding course in the physics department. While the topics of the two courses overlap considerably, student populations and disciplinary focus can be quite different. For this presentation, we examine responses to questions posed to students in the two courses.

*Supported in part by NSF grant DUE-0817335.

DB09: 9:50–10 a.m. Preliminary Results of Curriculum Development in Upper-Level Thermodynamics: Heat Engines*

Trevor I. Smith, University of Maine, Orono, ME 04469; Trevor.I.Smith@umit.maine.edu

Warren M. Christensen, John R. Thompson,Donald B Mountcastle, University of Maine

Members of the UMaine Physics Education Research Laboratory are conducting an ongoing investigation of student understanding of thermodynamics and statistical mechanics concepts in upper-level undergraduate thermal physics courses. Based on the results of our research, we have designed and implemented a sequence of guided-inquiry instructional materials (tutorials) to address student difficulties with thermal physics topics. We present pre- and post-instruction data from the first implementation of a tutorial focusing on heat engines in a classical thermodynamics course. We make comparisons to results reported by Cochran and Heron (2006) from lecture-based instruction. Results from post-instruction data show that the tutorial addressed the difficulties observed after lecture-based instruction and guided students toward patterns of reasoning that are not typically observed.

*Supported in part by NSF Grants REC-0633951 and DUE-0817282.

DB10: 10–10:10 a.m. Curriculum Adaptation in Upper-Level Thermodynamics: Entropy and the Second Law

Warren M. Christensen, University of Maine, Orono, ME 04468; warnpeace1414@hotmail.com

Trevor I. Smith, John R. Thompson, University of Maine

As part of our ongoing research into student learning of thermodynamics in the introductory and upper-level courses, we report on curriculum that targets student ideas about entropy during processes with spontaneous heat transfer. Early work at the introductory level showed students tended to rely on "conservation"-like ideas concerning questions about total entropy change. Developed curriculum that directly addressed these student ideas showed dramatic improvement in student performance on post-instruction testing. Because we subsequently observed many of these same difficulties among upper-level students, the curriculum was adapted for use at the upper level by removing some of the fine-grained scaffolding that was necessary for the introductory students. Initial results show that learning gains after instruction are high and may lay the groundwork for improved understanding of future topics in thermodynamics such as heat engines.

Session DC: What to Teach After Newtonian Mechanics

Location: Chemistry 1300
Sponsor: Committee on Physics in High Schools
Date: Tuesday, July 28
Time: 8:30–10:30 a.m.

Presider: Dale Freeland

Given limited time, 40 chapter textbooks, and a heavy emphasis already on Newton's laws, this session attempts to look at the critical content and concepts that students should learn in high school—beyond Newton's laws—to be successful in a first-year physics course in college.

DC01: 8:30–9 a.m. Re-Thinking High School Physics

Invited – Vincent P. Coletta, Loyola Marymount University, Los Angeles, CA 90045; vcoletta@lmu.edu

Paul Hsu, Animo Venice Charter High School

Anna F. Karelina, Rutgers University

Research has shown a strong correlation between individual students' scientific reasoning ability and their conceptual learning in interactive engagement physics courses. Our Thinking in Physics (TIP) high school project will develop materials and methods intended to improve learning, especially among students from lower socioeconomic backgrounds, students whose reasoning skills are often weak, preventing them from fully benefiting from even the most effective interactive engagement instruction in practice today. TIP aims to improve students' scientific reasoning abilities within the standard high school physics course, creating a new focused curriculum, including pedagogy and materials, such as computer games targeting specific skill development. TIP also uses interesting, unifying projects to increase student interest. Extensive pre- and post-instruction testing will be used both to identify individual students' needs and to measure the effectiveness of the program. We will describe the coverage of physics topics, and some of the pedagogy and preliminary materials.

DC02: 9–9:10 a.m. Orbiting Satellites – Both Around and Through the Center of Earth

Paul Robinson, San Mateo High School, Redwood City, CA 94062; laserpablo@aol.com

Suppose you could bore a tunnel through the center of the Earth. Further suppose you could pump all the air out of this tunnel to eliminate air friction. What would happen if you devised an elevator that dropped all the way through to the other side? This would be one heck of ride. Such an elevator would be like an 8000-mile Drop Zone at Great America! How long would it take for you to reach the other side of the Earth? How long would a round trip be? And how fast would you end up going at the center of the Earth? It turns out the round trip time of the elevator is exactly the same time it takes a satellite to orbit the Earth—about 90 minutes! This paper will show why this is not a coincidence and also will incorporate a lot of interesting physics in doing so.

DC03: 9:10–9:20 a.m. What Else Should Students Learn in Introductory Physics?

Analia Barrantes, Physics Dept., MIT, Cambridge, MA 02139; analiab@mit.edu

David E. Pritchard, MIT

Brian Belland, Utah State University

Starting with interviews, we developed relatively orthogonal responses to the question "what should we teach besides the current syllabus topics for nonphysics majors?" Teachers at AAPT meetings, researchers at an Atomic Physics Gordon conference and at PERC08 were polled as to which responses they would select for their course. All instructors rated "sense-making of the answer" very highly and expert problem solving highly. PER'ers favored epistemology over problem solving, and atomic researchers "physics comes from a few principles." All students at three colleges had preferences anti-aligned with their teachers, preferring more modern topics, and the relationship of physics to everyday life and to society (the only choice with instructor agreement), but not problem solving or sense-making. Conclusion #1: we must show students how 17th-century physics is relevant to their world. Conclusion #2: significant course reform must start by reaching department-wide consensus on what to teach and how to hold students' interest.

DC04: 9:20–9:30 a.m. High School Magnetism at the Nano-scale

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

Lynn A. Bryan, David Sederberg, Purdue University

For matter at such a small scale, the applications of nanotechnology and nanoscience are huge forces in physics research today. The National Center for Learning and Teaching in Nanoscale Science and Engineering offers professional development to enable middle and high school teachers to build their personal knowledge about nanoscience and to smoothly introduce lessons, based on the nine "Big Ideas of Nanoscience," into the classroom. Nearly 100 of my Honors Physics I students worked through a three-day inquiry-based magnetism unit developed during a two-week summer institute at Purdue University. Magnetism, already part of many introductory physics classes, offers a natural fit for the Big Idea that size and scale impact the property of materials. The unit was structured to help students understand that the paramagnetic properties of ferrofluid arise from its nano-sized iron oxide clusters. Successes and limitations of the lesson as well as evidence of student learning will be presented.

DC05: 9:30–9:40 a.m. System and Object Potential Energies

David Keeports, Mills College, Oakland, CA 94613; dave@mills.edu

When two mutually attracting objects are separated, it is most correct to speak of potential energy as being a property of the system. Nevertheless, it is a common practice in problem solving to consider only the potential energy of a single object. For example, when a ball rises through the air without drag, the ball's maximum height is routinely found using mechanical energy conservation without including a potential energy term for the Earth. But is this exclusion justifiable? By using an argument based upon impulse, momentum, kinetic energy, and potential energy, I will demonstrate that the answer to my question is strongly affirmative.

DC06: 9:40–9:50 a.m. Teaching Introductory Quantum Mechanics

Marc Mayntz, Provo High School, Provo, UT 84604; mayntzm@gmail.com

Despite its importance in modern technology, quantum mechanics is often overlooked in the typical high school curriculum due to constraints in time and budget. I will demonstrate several lab exercises that can be used to teach introductory quantum concepts for little to no financial outlay. Labs will cover the nature of the quanta, the Photoelectric Effect, the de Broglie Hypothesis, atomic transitions using the Bohr Hydrogen atom and the Rutherford Gold Foil Experiment.

DC07: 9:50–10 a.m. The Limits of Prediction: Students' Conceptions of Chaotic Behavior in Nonlinear Systems

Edward J. Stamas, University of California, Berkeley, 52 Pierce St, Hyde Park, MA 02136; ejstamas@gmail.com

CANCELED

A design experiment utilizing multiple representations of linear and nonlinear phenomena to facilitate students' understandings of classical and modern physics concepts was conducted. Over the course of nine 50-minute instructional periods in January 2006, an enthusiastic, ethnically diverse group of 33 high school students in the San Francisco Bay area participated in a curriculum designed by this author. All students were finishing their first semester of physics with the author as their teacher. Prior to the educational intervention, students were surveyed about their epistemological views on predictability in physics, the limitations of measurement, sensitivity to initial conditions, and holism versus reductionism. Students engaged in multiple inquiry-based investigations in the physics of systems, which included hypothesis generation, experimental design, graphical representations, and using calculators and Boxer-based computer simulations as experimental tools (diSessa, 1995, 2000).

Calculators were utilized to employ iteration algorithms demonstrating sensitivity to initial conditions (Burger and Starbird, 2000). After experimenting with simple pendulums, students constructed nonlinear, magnetic chaotic pendulums and used them in experiments investigating the dynamics of chaotic systems. In the final week of the intervention, small groups of students engaged in scaffolded inquiry with Boxer providing a computer representation of the chaotic pendulum. Throughout the curriculum, qualitative data was obtained through student interviews and written responses on worksheets.

DC08: 10–10:10 a.m. The Ubiquitous Lorentz Force

Clinton L. Lewis, West Valley Community College, Saratoga, Palo Alto, CA 94303; clewis@speakeasy.net

A novel point of view leads to a derivation of conservation laws using Lagrangian formalism which is entirely differential and local, in contrast to Noether's theorem, which minimizes a global action integral. A local or differential covariant technique implies charge conservation and the expected non-conservation of energy in the presence of external fields. The teaching of these concepts is simplified by combining two deeply related concepts, gauge covariance in quantum mechanics, and coordinate covariance in General Relativity into a single covariant derivative.

DC09: 10:10–10:20 a.m. Consider Integrating Engineering Design in Support of Physics

Douglas L. Oliver, University of Toledo–Mechanical Engineering, Toledo, OH 43606; doliver@nsf.gov

Jackie Kane, St. Ursula Academy, Toledo, Ohio

The proportion of college graduates with engineering majors has declined dramatically from its peak in 1986. This has led to calls for teaching pre-engineering courses in high schools. The heart of engineering is creatively integrating science, technology, and mathematics to design a novel device or method. High school physics courses are an ideal venue for combining physics, technology, and math to solve open-ended design problems. This paper introduces two open-ended design activities that integrate physics, math, and technology. The first involves the design and construction of a voltage divider given real-world constraints. The second uses the skills developed in the first activity to design and construct a light-emitting diode (LED) circuit that switches on and off with changes in light intensity. These two design activities are inexpensive to implement and were successfully tested on a junior/senior level physics class at St. Ursula in Toledo, OH.

Session DD: Assessment of Effectiveness of Educational Technology in Instruction

Location: Chemistry 1400
Sponsors: Committee on Educational Technologies, Committee on Research in Physics Education
Date: Tuesday, July 28
Time: 8:30–10:30 a.m.

Presider: Vern Lindberg

The use of educational technology is pervasive in today's classroom, but how do we know how effective it is? This session will highlight research into the effectiveness of the use of technology in the classroom.

DD01: 8:30–8:40 a.m. Comparing Student Gains With and Without Clickers in Introductory Physics

Jason Kahn, Tufts University, Medford, MA 02155; jason.kahn@tufts.edu

David R. Sokoloff, University of Oregon

In this study, we compared student gains with and without clickers while using the Interactive Lecture Demonstration (ILD) format. We chose to look specifically at learning for Newton's Third Law, an ILD that does not require students to make graphical predictions. Students in the same class either used a clicker (N=28) or did not (N=41; group pre-test results are not significantly different). Other than the presence of a clicker, the students received identical instruction, providing a built-in control. Both groups showed strong gains on the Force and Motion Conceptual Evaluation (FMCE), but the students without clickers had higher gains (0.82 without clickers vs. 0.66 with). One conclusion is that the act of making an open-ended prediction has some benefit to the student, but it is not without flaws. Students without clickers were free to look at the same options presented to students with clickers, and Newton's Third Law ILD leads to fairly straightforward, nongraphical predictions. This result merits further study to better understand how a clicker affects instructional techniques such as ILDs, and if the sequence can be modified to be augmented by the clicker.

1. David R. Sokoloff and Ronald K. Thornton, "Using interactive lecture demonstrations to create an active learning environment," *Phys. Teach*. **35,** 340 (1997).

DD02: 8:40–8:50 a.m. PhET Simulations: Should We Show the invisible?

Archie M. Paulson, University of Colorado at Boulder, Boulder, CO 80302; archie.paulson@colorado.edu

Katherine K. Perkins, Wendy K. Adams, University of Colorado

The PhET Interactive Simulations project develops interactive, research-based simulations of physical phenomena that emphasize interactivity, animation, and real-world connections. We are seeking a better understanding of how students learn from simulations (sims) in order to inform both sim design and use. We compare differences in student learning and sim investigation when the sim either shows or hides representations of abstract or invisible phenomena such as a magnetic field or electron flow in a current. The study is based on interviews with introductory-level university physics students while using the sims. Results of this study are expected to improve our understanding of how students learn complex physical concepts using sims, and have implications for designing effective sim-based in-class activities, homework and labs.

DD03: 8:50–9 a.m. Assessing the Effectiveness of Multimedia Pre-lectures in Introductory Physics

Tim Stelzer, University of Illinois, Urbana, IL 61801; tstelzer@illinois.edu

Gary E. Gladding, Zhongzhou Chen, University of Illinois

We have developed 28 multimedia learning modules for an introductory calculus-based electricity and magnetism course. These modules have now been used for three semesters at the University of Illinois, and are beginning to be used at other institutions. This talk will describe the pre-lectures and their impact on the courses.

DD04: 9–9:10 a.m. Using Multimedia Learning Modules (MLM) as Part of a Hybrid Course in Electricity and Magnetism

Homeyra R. Sadaghiani, California State Polytechnic University, Pomona, CA 91768; hrsadaghiani@csupomona.edu

Timothy J. Stelzer, Gary E. Gladding, University of Illinois at Urbana-Champaign

As part of a hybrid course in a calculus-based introductory E&M at California State Polytechnic University, Pomona, we have implemented Multimedia Learning Modules through the blackboard learning management system. The integration of the web-based Multimedia Learning Modules introduces students to basic physics content prior to class and allows instructors to focus on more in-depth application of the concepts. We will describe the research project and discuss the impact it had on student preparation, exam performance, and their attitude toward online material.

DD05: 9:10–9:20 a.m. Assessing the Effectiveness of Multimedia Pre-lectures at a Two-Year College

Tom Carter, College of DuPage, Glen Ellyn, IL 60137; cartert@cod.edu

Tim Stelzer, University of Illinois

This talk will review the initial data from the use of the multimedia learning pre-lecture modules from the University of Illinois (UIUC) at a two-year college. These modules were used for one semester at the College of DuPage in an introductory calculus-based electricity and magnetism course. I will discuss both qualitative student feedback and the effect on student knowledge as measured by scores on standardized tests.

DD06: 9:20–9:30 a.m. Using Multimedia Pre-lectures to Improve Students' Understanding of Physics Concepts

Zhongzhou Chen, University of Illinois, Urbana, Il 61801; zchen22@illinois.edu

Tim Steltzer, Gary E. Gladding, University of Illinois ,

We performed a detailed analysis on how students interact with online multimedia learning modules (MLM), based on data collected from a calculus-based electricity and magnetism course with more than 1000 students. Through our analysis we're able to show the effectiveness of MLMs on improving students' basic understanding of physics concepts.

DD07: 9:30–9:40 a.m. LON-CAPA: An Affordable Educational Tool for Teachers and Students

Stuart P. Raeburn, Michigan State University, East Lansing, MI 48824; raeburn@msu.edu

Gerd Kortemeyer, Felicia V. Berryman, Ed Kashy, Michigan State University

The Learning Online Network with CAPA (LON-CAPA) incorporates both a powerful assessment engine and also access to a cross-institutional content library containing abundant online resources for learning physics. Currently the LON-CAPA network is composed of a consortium of more than 130 schools, colleges, and universities, which share online content materials in introductory science, math, and engineering. One use of the web-based system is to promote collaborative learning by providing students with individualized versions of homework problems, as well as immediate feedback. Formative assessment via LON-CAPA can also be used to identify deficiencies in understanding, which can be addressed by just-in-time teaching. Another use is for summative assessment, either via online exams or paper-based bubble sheet exams. We summarize published findings obtained over the years regarding its content sharing and online assessment features, and discuss some recent findings regarding gender differences and content sharing.

DD08: 9:40–9:50 a.m. ALT-Pathway: Synthetic Tutors for Probing Student Learning*

Chris M. Nakamura, Kansas State University, Manhattan, KS 66506; cnakamur@ksu.edu

Sytil K. Murphy, Nasser M. Juma, N. Sanjay Rebello, Dean A. Zollman, Kansas State University

Mike Christel, Scott Stevens, Carnegie Mellon University

A new web- and research-based synthetic tutoring system addresses students' questions about physics content and also presents relevant questions to students, using pre-recorded video and a natural language interface. In this manner we create a quasi-Socratic interaction. Combining subjective and objective questions allows us to observe student performance on two time scales. A computer can monitor student responses to objective questions and provide immediate feedback and scaffolding. A more detailed analysis of student understanding can be done later using responses to the subjective questions. The system employs various multimedia including static images, video clips, and java applets. Our research focuses on the impact of each medium on student learning. Complete logging of students' interactions facilitates this research by allowing us to observe how students interact with the system, and when that interaction produces effective learning.

*This work is supported by the U.S. National Science Foundation under grants REC-0632587 and REC-0632657.

DD09: 9:50–10 a.m. Why Use Clickers When They Don't Help Instruction?

Matt Evans, University of Wisconsin – Eau Claire, Eau Claire, WI 54701; evansmm@uwec.edu

Amy Raplinger, University of Wisconsin – Eau Claire

Student Response Systems have been hailed as a novel way of engaging students in large classrooms. While our previous research has upheld this argument, we recently conducted an experiment comparing two classes; one used clickers and one asked the same multiple-choice questions but without clickers. Our results show, along with others,[1] that, with equal presentation, and preparation opportunities for students, the two classes performed similarly on exams regardless of feedback method. This leads us to conclude that clickers are not necessary for engaged learning. Combining this result with our previous studies shows how clickers, although not needed by students, are critically important for implementing engaged learning/peer-instruction techniques for instructors not trained in these teaching teaching methods.

1. N. Lasry, "Clickers or flashcards: Is there really a difference," *Phys. Teach.* **46**, 242–244 (2008)

DD10: 10–10:10 a.m. Googling for Physics Homework

Zbigniew Dziembowski, Temple University, Philadelphia, PA 19122-6082; dzie3emple.edu

Christina Martin, Mia Luehrmann, Temple University

Technology use for physics courses has broadened communication between professors and students, which includes professors posting answers to practice problems. Although such a practice should foster a positive outcome, we have found evidence for students misusing this by Googling for their homework answers with the search engine www.google.com. Indication of blatant homework copying consisted of two assessments with 10 identical problems. One assessment was given as an online homework assignment of "googlable" problems (i.e. word-for-word problems found on www.google.com with an exact answer shown.) The other assessment was an in-class exam consisting of exactly the same problems where students needed to show their derivation of the answer. Based on the data from an introductory physics class at a large urban university, we discuss the size and correlates of online homework copying.

Session DE: Panel – Overcoming Barriers: Establishing and Improving Teacher Preparation Programs

Location: Chemistry 1640
Sponsor: Committee on Teacher Preparation
Date: Tuesday, July 28
Time: 8:30–10:30 a.m.

Presider: Theodore W. Hodapp

This panel will discuss their experiences in establishing and improving teacher education programs. Experiences range from environments at the community college to research universities, and with individuals from faculty through senior administration. Panelists will discuss some of the challenges they faced—and overcame; and invite questions from the audience to help spark an informative discussion on improving the nation's physics teacher education enterprise. Although we will discuss barriers during this session, our main focus is on creative solutions to these problems. Please join us with your own creative solutions and interesting challenges.

Invited Speakers:

Jerry R. O'Connor, San Antonio College, San Antonio, TX

Jill Marshall, University of Texas, Austin

John Frederick, University of Texas, San Antonio

Deborah Gardner, City University of New York, Hunter College

Session DF: Introductory College-Level Courses

Location: Dana 1040
Sponsor: Committee on Physics in Undergraduate Education
Date: Tuesday, July 28
Time: 8:30–10:30 a.m.

Presider: Lili Cui

DF01: 8:30–8:40 a.m. Documenting the Development of Pedagogical Content Knowledge

Dedra Demaree, Oregon State University, Corvallis, OR 97331; demareed@physics.oregonstate.edu

Sissi Li, Lin Li, Oregon State University

At Oregon State University, we are undergoing curriculum reform in our large-enrollment introductory calculus-based physics sequence. As part of this reform, we are integrating course goals and materials borrowed from the ISLE (Investigative Science Learning Environment) curriculum at Rutgers and California State University, Chico. To prepare each lecture, the instructor makes a set of lecture notes including the goals for the day and for specific activities. These notes are given to an observer who is present and manages audio and video recording of all lectures. After each lecture period, the instructor journals about the implementation of the day's activities and how the students engaged with them. The instructor and the observer also discuss their observations on a daily basis. This talk will share examples of how this process promotes the development of pedagogical content knowledge which improves the implementation of new activities in our introductory courses.

DF02: 8:40–8:50 a.m. Physics Applications from The New York Times

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

The New York Times tends to have more articles using physics concepts with useful variables than local Metro region newspapers. For three years I have been finding and extracting excellent articles with vivid graphics. The articles are reduced to one page and placed into a word document. I add graphics, introduction and questions (with answers) to the page. *The New York Times* application is placed on a page containing 40 such applications. Eight pages of applications exist. Three hundred applications exist. The applications are mostly in: mechanics, properities of matter, heat and waves. I use the pages as introductions to new concepts in class, web extra credit, and quiz questions. The site containing all the pages is: http://cisephysics.homestead.com/files/NYT.htm.

DF03: 8:50–9 a.m. An Introductory Mechanics Approach to Cells and Molecules

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

Robert P. Donaldson, Rahul Simha, Carl Pearson, George Washington University

National reports such as Bio2010 have made a convincing case for engaging life-science and biomedical students inquantitative reasoning and problem solving. In a collaboration between the departments of physics, biology, and computer science, we have developed and implemented a calculus-based introductory physics course that uses microbial motion and molecular dynamics as central motivating examples, while simultaneously introducing students to grand challenge problems in biology. The physics concepts are introduced as needed to quantitatively understand the particular biology problem. By building upon and extending the materials of the successful SCALE-UP pedagogy, we have produced in-class activities, problems sets, and computational exercises using biologically inspired themes. Student performance and attitudes are compared with life-science majors in conventional physics courses using pre- and post-FCI and CLASS surveys.

DF04: 9–9:10 a.m. Strength of Student Models in Force and Motion*

C. Trecia Markes, University of Nebraska at Kearney, Kearney, NE 68849; markest@unk.edu

With a FIPSE grant, it has been possible to develop and implement activity-based algebra-level introductory physics. Pre-test and post-test responses on the Force and Motion Conceptual Evaluation are analyzed to determine the models that students use. The questions are separated into eight groups. Responses are divided into expert model, student model, and null model. Students are categorized as being in an expert state, a mixed state, or a student state. Previous work assumes a particular model if the answers to 75 percent or more of the questions in a group fit that model. To determine the strength of the models, the analysis will be repeated assuming 90 percent and then 100 percent. The results will be analyzed to determine if there is a significant difference from 75 percent to 90 percent to 100 percent. This will indicate the strength of the models in each group of questions.

*Supported by a FIPSE Grant.

DF05: 9:10–9:20 a.m. Modeling Applied to Problem Solving

Andrew Pawl, Physics Dept., MIT, Cambridge, MA 02139; aepawl@mit.edu

Analia Barrantes, David E. Pritchard, MIT

Modeling[1] Applied to Problem Solving (MAPS) is a pedagogy that helps students transfer instruction to problem solving in an expert-like manner. Declarative and Procedural syllabus content is organized and learned (not discovered) as a hierarchy of General Models (a WIKI is under development to serve as a textbook for this). Students solve problems using an explicit Problem Modeling Rubric that begins with System, Interactions, and Model (S.I.M.). Interactions are emphasized as the key to a strategic description of the system and to the identification of the appropriate General Model to apply to the problem. MAPS is designed to be added into an existing course with minimal impact on the syllabus. We have employed the approach in a three-week review course for MIT freshmen who received a D in the fall mechanics course with very encouraging results.

1. M. Wells, D. Hestenes, and G. Swakhamer

DF06: 9:20–9:30 a.m. Do Good Students Have Good Homework Habits?

Michael A. Dubson, University of Colorado at Boulder, Boulder, CO 80309; michael.dubson@colorado.edu

Bryan L. Kaufman, University of Colorado at Boulder

In our large freshmen physics courses, we use the online homework system CAPA (developed at Michigan State). Each weekly assignment consists of several questions, and students are given up to 6 tries for each question. The CAPA system records every submission, giving a complete work record for every student. Do "A" students start and finish their assignments earlier with fewer tries than the "C" students? In our algebra-based courses for life-science majors, the answer is no. The high-performing students procrastinate just as long and use as many tries as the low-performing students. In our calc-based courses for engineering majors, we see a small (but statistically significant) correlation between exam performance and homework habits. High-performing students use just slightly fewer tries than low-performing students. We will discuss possible reasons for this surprising lack of correlation between exam performance and homework habits.

DF07: 9:30–9:40 a.m. Building Up-to-Date Syllabi for IPLS Courses

Donald F. Holcomb, Cornell University, Ithaca, NY 14853; dfh1@cornell.edu

The typical syllabus for a course taken by students in the life sciences has been changed only by modest accretions over the last 50 years. Physics in general, and the needs of students in other sciences in particular, have changed dramatically in that period. I'll outline some ideas about a new set of syllabic desiderata for life science students. A new syllabus might include, e.g., 1) A strong emphasis on the "take-away transferable skills," or "habits of mind" that characterize physics. 2) Early consolidation of knowledge about electrons, atoms, and molecules that IPLS students bring from previous chemistry courses, 3) Early development of the Principle of Conservation of Energy—using it as a striking example of the power of a conservation law, as applied to the physics of fluids, thermal physics, nuclear reactions, electromagnetics and quantum phenomena. 4) A recognition that a focus on "take-away capabilities" requires streamlining of the standard model's emphasis on Newtonian mechanics.

DF08: 9:40–9:50 a.m. Teaching by "Cycling" at CWRU and YSU

James H. Andrews, Youngstown State University, Youngstown, OH 44555; jandrews@ysu.edu

Robert Brown, Gavin Buxton, Corbin Covault, Peter Kernan, Walter Lambrecht, Case Western Reserve University

Six years ago we began to reorganize our introductory physics courses to introduce major concepts in a simple context in the first third (or first half) of the course, and then to revisit them in two (or one) more increasingly sophisticated and interconnected cycles, each followed by hour exams. This approach allows an early overview of the whole course, addresses midterm exam difficulties and improves retention through revisiting, eliminates the long gap between early material and the final exam, provides time for students to assimilate harder concepts previously introduced only at the end of the course, and provides increased opportunities for using multi-concept problems. Challenges include pace, level, and the role of the textbook. We describe experiences and feedback over 20 semesters with seven different lecturers at two universities, the development of a mechanics text for three-cycle use, and a first application of revisiting to an upper-division physics course.

DF09: 9:50–10 a.m. Identifying Intellectually Similar Groups of Students

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

Mayo Miller, University of Arkansas

Research on context sensitivity suggests that many students are left in a mixed state of knowledge after an introductory science class. Some students will answer contextually related questions in the same way and some will answer differently based on the context. The efficacy of statistical methods to form groups of these students is investigated both using artificial computer-generated data and classroom data. The requirements of the underlying population of students for successful grouping are quantified. The effect on grouping algorithms of the low number of contextually related problems that can be given in a single exam is also investigated.

DF10: 10–10:10 a.m. Transfer of Physics Education Research Principles and Methods to Honors Science

Larry Medsker, The George Washington University, Washington, DC 20052; lrm@gwu.edu

Cornelius Bennhold, The George Washington University

Key objectives in our University Honors science course are that students be able to critique scientific claims, use scientific techniques to solve realistic problems, and analyze social, ethical, and policy contexts of science and technology. The theme for this freshman proseminar is "Energy, Environment, and Climate Change." A joint project with the Physics Department applies ideas from physics education research to the honors proseminar in our SCALE-UP environment. Important aspects of this project include extensive use of rubrics, assessments with the Lawson CTSR and frequent self-assessments, private student-professor blogs for rapid dual feedback, communications training based on the analysis of scientific articles, and use of individual wikis for information gathering. The students in this honors course provide unique opportunities and challenges to the use of PER principles. We will report on current results and discuss implications for PER and the current movement to transform general education science curricula.

DF11: 10:10–10:20 a.m. Examining Change Strategies in University STEM Education

Yuhfen Lin, Western Michigan University, Champaign, IL 61820; lin.490@osu.edu

Charles R. Henderson, Andrea L. Beach, Western Michigan University

Noah Finkelstein, University of Colorado at Boulder

R. Sam Larson, Kaiser-Permanente and Regis University

Calls for change in Science, Technology, Engineering, and Mathematics (STEM) education have been made for over a decade. Yet change is hard to initiate and difficult to sustain. In order to gain a better understanding of the mechanisms that facilitate change in instruction in higher education, we surveyed existing literature that describes reform in STEM education. Through examining the strategies that researchers adopted, two dimensions of change strategies emerged: 1) change strategies either seek to impact individuals or the environments and structures; 2) the intended change outcome is either prescribed or emergent. With the aid of extra coding categories, we were able to better study the differences and similarities of the approaches adopted by researchers in three different fields: STEM education, higher education, and faculty development. In this talk we will present some of the results and discuss some implications for how to effectively promote change in STEM education.

*Supported, in part, by NSF #0623009 and #0723699.

1. Henderson, C., Beach, A., Finkelstein, N., & Larson, R. S., (2008, June). Preliminary Categorization of Literature on Promoting Change in Undergraduate STEM.

DF12: 10:20–10:30 a.m. Challenges and Successes in Using Discourse Management

Adrienne Battle, Seminole Community College, Sanford, FL 32773; battlea@scc-fl.edu

Getting students to participate in the learning process is a difficult and important thing to do. Discourse management offers several techniques for engaging students in classroom discussion and problem solving. My talk will focus on the challenges and successes faced when implementing discourse management in a small classroom setting.

Session DG1: New Demos in E & M

Location: Dennison 170
Sponsors: Detroit Metro Area Physics Teachers, Committee on Physics in High Schools
Date: Tuesday, July 28
Time: 8:30–9:30 a.m.

Presenters: Steve Dickie, Dearborn Divine Child HS; Nicole Murawski, Royal Oak HS; and DMAPT colleagues

We will show you some new and amazing demos that can be done with inexpensive equipment. Our team will show you how to 1) Build a homemade smart board for $75, 2) Introduce the principles of digital communications using laser pointers, solar cells, etc. 3) Hear and see the infra-red digital signals produced by IR devices, 4) make your own personal radio transmitter and receiver, and many others. Handouts will be available for all.

Session DG2: Discrepant Events

Location: Dennison 170
Sponsors: Detroit Metro Area Physics Teachers, Committee on Physics in High Schools
Date: Tuesday, July 28
Time: 9:30–10:30 a.m.

Presenter: Don Pata, Grosse Pointe North High School

Engaging students is key to their learning. Discrepant event demonstrations are fun and exciting. The session will present 10 demonstrations where the outcomes are not exactly obvious. All are easy to perform with simple apparatus and show one or more concepts from introductory physics. Also, each demonstration will be explained fully in the context of student learning. The demonstrations will be presented using a style that is geared toward stimulating student interactions. These challenges can be used at the beginning of a unit as an anticipatory set, in the middle of the unit as a formative assessment, or at the end as a summative assessment. Most importantly they are fun and easy to perform.

Session DH: Successful Strategies for Dissemination and Implementation of PER-Based Materials and Research Findings Beyond the "Traditional PER Faculty"

Location: Dennison 182
Sponsor: Committee on Research in Physics Educationn
Date: Tuesday, July 28
Time: 8:30–10:30 a.m.

Presider: Marina Milner-Bolotin

One of the main problems in physics teaching today is that even though a substantial amount of of PER-based and widely tested materials and physics teaching strategies have been developed during the past 40 years, they are largely under used by the wider physics teaching community. The goal of this session is to showcase successful strategies for disseminating PER-based physics teaching methods and materials to the wider community at the high school, college, and university levels. The session will also focus on common challenges experienced by the faculty in this process and successful ways of addressing them.

DH01: 8:30–9 a.m. Beyond Traditional Faculty: Creative Human Resource Solutions for Sustaining Reform

Invited – Suzanne White Brahmia, Rutgers University, Piscataway, NJ 08854; brahmia@physics.rutgers.edu

Eugenia Etkina, Rutgers University

A variety of PER reforms have been developed at Rutgers over the past two decades. In this talk we will describe how we implement the reforms in large-enrollment introductory physics courses for engineers and for science majors, many of whom are underrepresented in STEM. Because of the delicate nature of the teaching challenges related to these populations, student needs are not well met by the frequent change-of-staff common in large university courses. In 1992 our first university staff line was secured to provide expertise and the year-to-year continuity necessary to create new knowledge in this area and thereby improve the structure of the program to meet the students' needs. We have since added other staff lines, and more recently have added pre-service teachers from the Graduate School of Education as instructors into our team of teaching specialists responsible for implementing and sustaining reforms. Simultaneously these courses serve as laboratories for PER research that in turn leads to the improvement of the courses following the action based research paradigm.

DH02: 9–9:30 a.m. When Top Down Meets Bottom Up: Supporting Educational Transformation in a Physics Department*

Invited – Steven Pollock, University of Colorado at Boulder, Boulder, CO 80309; steven.pollock@colorado.edu

Noah Finkelstein, Katherine Perkins, Stephanie Chasteen, Michael Dubson, Steven Goldhaber, Chandra Turpen, CU Boulder

The University of Colorado at Boulder Physics Department has been engaged in the systematic transformation and study of many of its physics courses for the last five years. Drawing from interrelated research on 1) lower-division course transformation, 2) upper- division course transformation, and 3) faculty choices in the adoption of reformed pedagogies, we study the processes of implementing, sustaining, and disseminating course transformation. In the introductory sequence, we have implemented the use of Peer Instruction and Tutorials in Introductory Physics. In the upper division, we have begun course transformation of Quantum Mechanics and Electricity & Magnetism. In each of these environments, we have studied faculty choices surrounding (i) which materials and approaches to adopt, and (ii) what specific practices to use in the classroom. In addition to describing the research and evaluation of each of these lines of inquiry (introductory, upper division, and faculty adoption), we identify some critical components of success, including: resources (such as materials, support staff, or class space) faculty buy-in and inclusion (from the earliest stages), and institutional support.

*Supported by grants from NSF (CCLI, REESE, STEM-TP, and TPC), the Nat'l Math and Science Initiative, and Science Education Initiative at Colorado.

DH03: 9:30–10 a.m. Promoting Instructional Change in New Faculty

Invited – Charles R. Henderson, Western Michigan University, Kalamazoo, MI 49008-5252; charles.henderson@wmich.edu

Roughly 300 new physics faculty are hired each year into tenure-track positions at degree-granting physics departments. These new faculty often have little preparation for their teaching roles and frequently struggle with their teaching responsibilities. Thus, an opportunity exists for the physics education research (PER) community to help new faculty in their teaching and promote the spread of instructional strategies and materials based on PER. This talk will discuss the rationale, outcomes, and costs of two strategies for promoting instructional change in new faculty: 1) the Physics and Astronomy New Faculty Workshop and 2) co-teaching.

DH04: 10–10:10 a.m. Comparing Performance in Two Mechanics Curricula (A 6000 Student Study)

Marcos D. Caballero, Georgia Institute of Technology, GA 30071; danny.caballero@physics.gatech.edu

Michael F. Schatz, Richard Catrambone, Keith R. Bujak, Georgia Institute of Technology

Matthew A. Kohlmyer, North Carolina State University

The Force Concept Inventory (FCI) was used to measure the performance of nearly 6000 students in two different introductory mechanics curricula; a traditional course based on "Physics for Scientists and Engineers" by Knight and a reform course based on "Matter and Interactions" (M&I) by Chabay and Sherwood. We find poorer performance for students who have taken the M&I course as compared to students taking the traditional course. We offer explanations for this consistent under-performance in the realm of force and motion as well as some results from recent work to address force and motion misconceptions in the M&I course.

DH05: 10:10–10:20 a.m. Collaborative Group Learning Using the SCALE-UP Approach

Gerald Feldman, George Washington University, Washington, DC 20052; feldman@gwu.edu

Cornelius Bennhold, Barry Berman, Carol O'Donnell, Mark Reeves, George Washington University

The SCALE-UP student-centered active learning environment was developed by Beichner at NC State to extend the "studio physics" approach to large-enrollment classes. We have implemented SCALE-UP in the spring 2008 semester at GW for two sections of our first-semester calculus-based introductory physics class. One of these sections had an integrated science character (physics, biology, computer science) with a distinct biological focus. Comparisons between these sections and a large (concurrent) regular lecture section were based on FCI pre- and post-tests, identical classroom exams, and the Colorado Learning Attitudes about Science Survey (CLASS). In fall 2008, we also added an introductory astronomy section for nonscience majors as a trial for SCALE-UP, and in spring 2009, we expanded SCALE-UP to the second semester of the calculus-based physics sequence. The results of our SCALE-UP experience so far will be summarized, and our future plans for SCALE-UP at GW, including its expansion to other disciplines, will be discussed.

DH06: 10:20–10:30 a.m. CU Science Education Initiative: Factors that Facilitate or Hinder Sustainable Change*

Katherine Perkins, University of Colorado at Boulder, Boulder, CO 80309; Katherine.Perkins@colorado.edu

Carl Wieman, University of Colorado and University of British Columbia

Stephanie Chasteen, Steve Goldhaber, Paul Beale, University of Colorado

The University of Colorado's Science Education Initiative (SEI) and its sister program at the University of British Columbia aim to achieve sustainable, institutional change toward effective, evidence-based science education. Over the past three years, the project has seen substantial adoption and adaptation of PER-based teaching approaches within physics courses that were previously taught in a traditional style. Similar changes have been achieved broadly across the other four departments participating in this campus initiative. In this talk, we describe the key elements of the change model used by the SEI, including the use of department-based, post-doc level, science education specialists as agents of change. We compare experiences across departments to identify common factors that have facilitated or hindered faculty involvement, course transformations, and departmental cultural change.

*All physics 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.

Session PST2: Posters –

High School Physics, Particle Physics for High School, Physics & Society Education, Physics & Life Science, Introductory Physics, Upper Division, Technology in the Into Course, ComPADRE, Teaching with Technology, Evaluation of Technology, Innovations in Teaching Astronomy, Problem Solving, General Topics of Interest in PER, Scientifc Reasoning, Expectations & Gender Issues

Location: Dana Hall Atrium, 1024, 1028, 1046
Sponsor: Committee on Research in Physics Educationn
Date: Tuesday, July 28
Time: 8:30 a.m–10 p.m.

Award: Klopsteg Memorial Award to Lee Smolin

Lee Smolin

Location: Mendelssohn Theater
Sponsor: AAPT
Date: Tuesday, July 28
Time: 10:30–11:30 a.m.

Presider: Lila Adair

Lee Smolin, Perimeter Institute for Theoretical Physics, Waterloo, Canada

The Role of the Scientist as Public Intellectual

Scientists communicate with the public through a variety of means including books, magazine articles, blogs, shows on television, and other media. Much of this is straight publicity or public relations for particular scientific results, fields, or institutions. Scientists, however, have the chance to play a more interesting role as a public intellectual when they go beyond "science outreach" and address issues of wider concern and deeper import. These issues range from philosophical reflections, perhaps concerning the current state or methodology of science, to commentary on nonscientific matters, to politics. I will discuss some conceptions of effective roles for scientists as public intellectuals, such as reviving the genre of "natural philosophy" and the idea of bridging C.P. Snow's two cultures gap, by the identification of a "third culture" which encompasses scientists, artists, and the digerati, who communicate with each other and the public. I will suggest that the main subject of third culture intellectuals is the future, a subject that gets remarkably little attention from more traditional public intellectuals whose training is scholarly rather than creative.

(Posters will be displayed beginning at 8:30 a.m., but authors will be present at the times listed below with their abstracts. Refreshments will be provided at 8:30 p.m..)

(A) High School Physics

PST2A-01: 8:30–9:15 p.m. Concept Mapping Software in a High School Physics Class

Lee S. Trampleasure, Carondelet High School, Berkeley, CA 94709; lee@trampleasure.net

Concept maps, or graphic organizers, are a means to organize concepts to form a visual representation of the relationships between these concepts. Research shows that some students gain a better understanding by mapping concepts in a spatial manner rather than the more traditional outline format. In my academically diverse high school physics class, many students struggle to grasp the relationships between the words we use. My poster presents the software CmapTools, examples of concept maps created by my students (including hand-drawn maps), and results of a survey of these students on their perception of the value of CmapTools. CmapTools is free software that runs on Windows, Macs, and Linux. It is both robust and easy to learn. CmapTools was developed by the Institute for Machine and Human Cognition (of which I am not affiliated). IMHC also provides CmapServer, a free program that allows people to share maps over the Internet.

PST2A-02: 9:15–10 p.m. Modeling for Physics and Understanding Mechanics Concepts

Steven L. Pullar, Math and Science Academy, Woodbury, MN 55125; spullar@mnmsa.org

Since the 2003/2004 school year I have used the Force Concept Inventory (FCI) as a pre-/post- test for my lab-based high school physics course. Typically classes would have a 20-plus percentage point increase in the class average, which is quite good. However, they were only going from horrible to awful. No class ever achieved an average of 60 percent. In the 2007/2008 school year I completely changed over to Modeling for Physics created by the University of Arizona. The results were fantastic. That year's class average was 77 percent! This poster will fully explain what methods I was using before modeling and just how Modeling for Physics works.

PST2A-03: 8:30–9:15 a.m. Mining the Internet for Introductory Physics Data: Sports

Andrew Pawl, Physics Department, MIT, Cambridge, MA 02139; aepawl@mit.edu

An example illustrating how Internet research using the readily available commercial websites of sports equipment manufacturers can enrich introductory physics problems and spark interesting follow-up questions.

PST2A-04: 9:15–10 p.m. Tell a Story, Make a Point: Storytelling in Teaching Physics*

Mikhail M. Agrest, College of Charleston, Charleston, SC 29424; agrestm@cofc.edu

Engaging the emotional component into the cognition process excites students and activates their memory. The persuasive speakers' slogan "Tell a story, make a point" is a widely used teaching tool in many disciplines. Physics is not an exemption. Storytelling can also be used to create images for mnemonic rules and so enhance students' memories. Storytelling helps to relate new knowledge to previously obtained information; it develops the associative thinking and imagination and employs them into the teaching-learning process. Being effective tools of scientists in creating physical models while studying the laws of the universe, they are also essential for students to comprehend new knowledge. In my stories electrons, protons, photons, and other inhabitants of the physics world become personalized; they communicate and interact like people translating the physics message into the language of nonphysics majors of the Liberal Arts and Sciences institutions, H.S. and public; also useful for physics majors.

*Supported by the College of Charleston Center for Faculty Development Grant"

PST2A-05: 8:30–9:15 p.m. Girls' Gateways to Physics Education in Cameroon

Anne E. Emerson, UC Santa Barbara, South Pasadena, CA 91030; emeran02@gmail.com*

Very few girls study physics in secondary school in Cameroon, West Africa. This qualitative study explores the pipeline leading up to students' entering science-based tracks in secondary school. I have found that the number of girls pursuing math and science decreases after the third year of secondary school. Observations in several Cameroonian schools show that, in primary school, boys and girls are equally interested in math and science and participate in class at similar levels; however, there are significant gender differences in math performance and attitudes after algebra is introduced. Interviews with girls in these classes suggest that most difficulties in math have to do with learning abstract concepts. Scores on a test emphasizing algebra taken after the third year of secondary school determine whether or not a student can be placed in a math and science track in school. This research indicates that algebra may be a significant gatekeeper for pursuing math and science in Cameroon.

*Sponsor: Danielle Harlow

PST2A-06: 9:15–10 p.m. Misconception in Understanding Circular Motion

Ashok B. Mody, Kansas State University, Manhattan, KS 66506; modyashok@yahoo.com

In India, Mechanics is always considered as one of the easiest topics to teach at school. The topics like Newton's laws of motion, motion of a body along a straight line, motion in a plane, etc. are there in the curriculum but emphasis is given to the tricks required to solve the problem and to prepare the students from the entrance exam point of view. Importance is never given to the conceptual understanding of those topics. As a result, students have difficulty in understanding motions like circular motion, simple harmonic motion. In this paper, we tried to explain the circular motion of a body in a horizontal plane, circular motion in a vertical plane and conical pendulum with the help of a simple instrument such as a string (inextensible) and pendulum bob as point mass. For a body that describes circular motion, an unbalanced force is required, and how this unbalanced force comes into the picture is explained. These simple experiments with string and point mass may clear the conceptual misunderstanding in learning circular motion.

PST2A-07: 8:30–9:15 p.m. Improving Learning Strategy Makes Physics Students More Successful

Alice Cottaar, Eindhoven University of Technology, Postbus 513, Eindhoven, 5600 MB, The Netherlands; a.cottaar@tue.nl

The aim of my research is to determine how didactical aspects of physics teaching in secondary school influence the physics (national) exam grades and eventually academic success of students in the Netherlands. Survey data of 3230 Dutch university freshman students in science-related fields of study (September 2008) have been obtained and analyzed. With dimension reduction techniques, components are extracted that characterize the typical physics student, teacher, and classroom. Physics teachers and actions in the classroom influence the reported liking and understanding of lessons, but have little or no influence on exam grades. Learning strategies of the pupils are essential and where necessary should change from learning by heart to learning through insight. Different tactics are needed to change student learning strategies depending on the student characteristics.

PST2A-08: 9:15–10 p.m. Status Report: Teaching High School Physics in Oklahoma

Steven J. Maier, Northwestern Oklahoma State University, Alva, OK 73717; sjmaier@nwosu.edu

There are 909 high schools in the state of Oklahoma (including charter schools). During the 2008-2009 academic year, 190 of these offered high school physics. Currently, there are 195 active teachers in Oklahoma certified by the state to teach high school physics. 18% of Oklahoma's active certified physics teachers have been certified via alternative means and 1.5% of Oklahoma's physics teachers are certified solely in physics. Descriptive in nature, material presented during this poster session will consist of data reporting a snapshot of the "current status" of high school physics teaching in the state of Oklahoma. Demographical information and graphical representations of these data will be presented. The purpose of assembling these data is to generate discussion of the current and future conditions of high school physics teaching by region. Therefore, proposed research questions will be posed and suggestions sought for long-term data collection for reporting trends over time.

PST2A-09: 8:30–9:15 p.m. AAPT's PhysicsBowl: A Contest for High School Students

Michael C. Faleski, Delta College, University Center, MI 48710; michaelfaleski@delta.edu

The PhysicsBowl is an annual multiple choice contest for high school students. This past year, more than 200 schools and 4500 students participated, including a school from China. Prizes are awarded to both students and schools for highest performance in each division (2) and region (15). Questions range from introductory topics covered in all physics classes through the AP Physics sequence. This informational poster hopes to increase the interest and awareness of the contest (given every April).

(B) Particle Physics in High Schools

PST2B-01: 8:30–9:15 p.m. QuarkNet as a Model for Sustained Professional Development

Jon P. Anderson, University of Minnesota, Minneapolis, MN 55455; anderson@physics.umn.edu

This poster will discuss how QuarkNet has impacted teachers nationwide and at the University of Minnesota. The experiences and observations of a QuarkNet Lead Teacher for eight years will form the basis of the topics presented on this poster. These topics range from QuarkNet history at a national level to the implementation of particle physics into existing physics and physical science courses to building a collaborative network of physics/physical science teachers. QuarkNet has provided the training and direction for these efforts to succeed.

PST2B-02: 9:15–10 p.m. A Remotely Accessible Synchrotron Radiation Beamline

Richard K. Cole, Evansville High School, Evansville, WI 53536; coler@evansville.k12.wi.us

Dan Wallace, UW – Synchrotron Radiation Center

The University of Wisconsin–Madison's Synchrotron Radiation Center has created a remotely accessible beamline and experimental chamber combination suitable for use by advanced high school-level students or mid-level undergraduate students. The beamline incorporates a Mark-V type of monochromator providing a photon energy range from 50 eV to 800 eV. A variety of selectable photo-transmission and electron photo-emission samples are available in the experimental chamber. The system is readily accessible via the Internet and is free to educational institutions. The author's high school students have used the system for several years to study the effect of nuclear charge on core electron binding energies. One need not be a Particle Accelerator Physicist to understand and use the experimental system as a valuable teaching tool.

(C) Physics and Society Education

PST2C-01: 8:30–9:15 p.m. Helping General Education Students Become Scientifically Literate

Sadri Hassani, Illinois State University, Normal, IL 61790; hassani@phy.ilstu.edu

One of the main symptoms of scientific illiteracy is the belief in unfounded claims and pseudoscientific disciplines taught on many campuses. Physics, when applied to the analysis of such beliefs, can be of tremendous help in curbing scientific illiteracy among students. I have been teaching a conceptual physics course to general education students for many years, and have incorporated the analysis of the unfounded beliefs in it. I'll describe the content and method of teaching this course in the poster.

PST2C-02: 9:15–10 p.m. Simple Pumps for Accessing Clean Drinking Water*

James J. Carroll, Eastern Michigan University, Ypsilanti, Mi 48197; jcarroll@emich.edu

Andrew M. Ross, Amanda Cogburn, Erin Lederman, Eastern Michigan University

The elephant pump, the piston pump, and the play pump are three innovative devices being used in underdeveloped nations to access clean drinking water. All of these pumps use the basic principles of physics to raise clean drinking water to the surface. The simplicity of these devices makes them well-suited for use in rural areas with no access to electrical power. We describe here the societal need for such devices and the difference they are making in the world. We built working models of these three pumps for an interdisciplinary, one-hour seminar called "5 Miles to Clean Drinking Water" as part of the Creative Scientific Inquiry Experience (CSIE) at EMU. We present details about the construction of the models and compare the strengths and weakness of the different pumps.

*CSIE funded by NSF DUE grant #0525514.

PST2C-03: 8:30–9:15 p.m. Research Projects in an Environmentally Themed Introductory Physics Course*

Mathew A. Martinuk, UBC Department of Physics and Astronomy, Vancouver, BC V6T 1Z1; martinuk@physics.ubc.ca

Rachel Moll, UBC Department of Curriculum Studies

Andrzej Kotlicki, UBC Department of Physics and Astronomy

Over the last two years, UBC has completely revamped its introductory course for non-physics majors to present physics in terms of everyday situations and real-world issues of energy and climate change. These changes attempt to reinforce connections between classroom physics and real-world phenomena through the lecture examples, weekly context-rich tutorials, and incorporation of real-world model problems in lab experiments. An important change was the incorporation of a final project where groups of students research and present on a topic of their choice related to the course. Students were asked to quantitatively model a real-world situation to make a choice or settle a dispute. Near the end of the second year of implementation students were surveyed to examine the project's impact on their attitudes toward physics and were tested for transfer using novel real-world problems. This poster will present the results of these assessments and discuss their implications for the course.

*This work is funded by the Carl Wieman Science Education Initiative.

PST2C-04: 9:15–10 p.m. Climate Leadership and Energy Awareness Program at UNC-CH

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

Dana Haine, UNC Institute for the Environment

The Climate Leadership and Energy Awareness Program (Climate LEAP) at the University of North Carolina at Chapel Hill engages selected high school students in interdisciplinary, hands-on science and mathematics activities, and provides opportunities to develop science communication and leadership skills. Students participate in a one-week, nonresidential summer institute at UNC and at least three, half-day Saturday academies during the academic year. Climate LEAP is made possible by a three-year grant from the Burroughs Wellcome Fund which includes providing stipends for the two cohorts of 24 students each who will participate in the program each year. The Department of Physics and Astronomy is collaborating with UNC's Institute for the Environment and the Morehead Planetarium and Science Center to develop scientifically rigorous activities that include inquiry-based experiments, lectures by scientists, lab tours, and field trips. We will share lessons learned from the planning and initial offering of this program.

PST2C-05: 8:30–9:15 p.m. Examining the Global Greenprint

Gordon J. Aubrecht, Ohio State University at Marion, Marion, OH 43302; aubrecht@mps.ohio-state.edu

The Aspen Science Center in Aspen, CO, ran a Global Greenprint conference to try to chart the future of energy production and policy in June, 2009. This poster reports on the meeting.

(D) Physics and Life Science

PST2D-01: 8:30–9:15 p.m. Locomotion Speeds of Various Dinosaurs

Scott Lee, University of Toledo, Toledo, OH 43606; Scott.Lee@utoledo.edu

Mary Dougherty, Mifflin High School

Engaging students with diverse backgrounds can be enhanced by finding an intriguing activity. In this poster, a methodology for estimating the locomotion speed of an animal based upon their footprint tracks is developed. Using this technique, an analysis of the locomotion speeds of various dinosaurs is performed. The tracks studied include 28 theropods (meat-eating dinosaurs), 23 sauropods (the "long-necked" herbivores), 28 non-armored, non-sauropod herbivores and 10 armored, non-sauropod herbivores. The theropods show the fastest locomotion speed as well as the greatest variety of speeds while the armored dinosaurs are the slowest.

PST2D-02: 9:15–10 p.m. Investigating Blood Flow in Arteries: A Case Study for Pre-Med Students

Michael A. Waxman, University of Wisconsin – Superior, Superior, WI 54880; mwaxman@uwsuper.edu*

This small case study is designed to increase appreciation of the principles and relevance of physics by pre-med students. We start by introducing a problem on determination of the speed of blood flow by the magnitude of emf this flow generates in an imposed magnetic field (electromagnetic flowmeter). We continue with a more sophisticated problem on using such flowmeters to probe the change of the inner diameter of the artery (due to plaque deposits etc). We then complete the study by discussing more complex hydrodynamics of blood than that required for solving the above problems, such as the laminar and turbulent regimes of the flow, and the Poiseuille's law.

*Sponsored by Myron O. Schneiderwent.

PST2D-03: 8:30–9:15 p.m. Physics and Physiology: The Lens and the Ossicles

Richard P. McCall, St. Louis College of Pharmacy, St. Louis, MO 63110; rmccall@stlcop.edu

Applications of physics to the human body help to spark interest in students who are majoring in the medical sciences. Two areas of study in the introductory physics course are optics and torque. A close look at optics of the eye shows that the shape of the lens is important for producing a focused image on the retina. The shape of the lens changes when the tension in ligaments attached to the lens changes. An interesting example of torque is a system of bones in the middle ear called the ossicles, which act as levers that transfer vibrational energy from the eardrum to the cochlea.

PST2D-04: 9:15–10 p.m. Strategies for Teaching Physics to Undergraduate Biologists

Dawn C. Meredith, University of New Hampshire, 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

See Full Abstract Under BA07

PST2D-05: 8:30–9:15 p.m. Introductory Physics for Life Science Students

Phil Lockett, Centre College, Danville, KY 40422; lockett@centre.edu

See Full Abstract Under BA05

PST2D-06: 9:15–10 p.m. Applications Oriented Problems & Laboratories for Introductory Physics for Life Science Students

Suzanne Amador Kane, Haverford College, Haverford, PA 19072; samador@haverford.edu

See Full Abstract Under BA06

PST2D-07: 8:30–9:15 p.m. A Stand-Alone Course in Optics, Electricity, and Magnetism for the Life Sciences

Catherine H. Crouch, Swarthmore College, Swarthmore, PA 19081; ccrouch1@swarthmore.edu

See Full Abstract Under BA08

PST2D-08: 9:15–10 p.m. Evolving Reform of an IPLS Course Serving a Significant Underprepared Student Population

Nancy Beverly, Mercy College, Dobbs Ferry, NY 10522; nbeverly@mercy.edu

See Full Abstract Under BA09

(E) Introductory Physics

PST2E-01: 8:30–9:15 p.m. A Conceptual Course on LASERS for General Education

Mark F. Masters, Indiana University Purdue University Fort Wayne, Fort Wayne, IN 46805; masters@ipfw.edu

It is important to improve the technological skills and scientific understanding of students who are not pursuing scientific and technological degrees in today's complex society. Every day, people are inundated with scientific or technological jargon. To assist students in interpreting this jargon, we created a conceptual course with a laboratory: Introduction to LASERs. LASERs hold a fascination for students, making this course a gateway into developing better critical thinking skills and an appreciation of basic physics. In this poster we present several of our successful classroom and laboratory activities.

PST2E-02: 9:15–10 p.m. The Usefulness of Mathematics Pre-tests in Introductory Calculus-Based Physics Courses

Michael F. Weber, BYU Hawaii, 55-220 Kulanui St., Laie, HI 96762; weberm@byuh.edu

At BYU Hawaii, a prerequisite for Physics 121 (calculus-based mechanics) is one semester of calculus. However, prior to 2007, each semester a large number of Physics 121 students earned D and F grades due, in part, to poor recall and application of previously learned principles of algebra, trigonometry, and calculus. Since 2007, each Physics 121 student has been required take a mathematics pre-test during the first week of classes. If a student does poorly on the pre-test, the student must either: 1) take a two-week mathematics review course and then take and pass another pre-test, or 2) drop Physics 121 and learn the relevant mathematics before registering again for Physics 121. I will describe our mathematics pre-test, our two-week mathematics review course, and our success with this program.

PST2E-03: 8:30–9:15 p.m. Multiple Models and Methods for Physics Education in BIT

Haiyun Hu, Beijing Institute of Technology, Haidian District, Beijing, 100081; huhy@bit.edu.cn*

Zhaolong Liu, Xiaoli Wu, Beijing Institute of Technology

This paper mainly introduces a series of reforms in physics education aimed at students of arts, science, and engineering at a joint program at the Beijing Institute of Technology. Based upon a full-time course and distance learning, the foreign and Sino-British joint program sums up the achievements in the students' innovation ability and includes specific methods designed to stimulate students' interest in physics study and enhance the students' understanding. We put forward new thoughts on the existing problems and share with all physics teachers a better practice of teaching reform.

*Sponsored by Lei Bao

PST2E-04: 9:15–10 p.m. A Mechanics Review Course Employing Modeling Applied to Problem Solving

Analia Barrantes, Physics Dept., MIT, Cambridge, MA 02139; analiab@mit.edu

Daniel C. Guetta, Andrew Pawl, Evangelos I. Sfakianakis, David E. Pritchard, MIT

We describe a three-week ReView course that employed a "Modeling Applied to Problem Solving" pedagogy,[1] concentrating on its Problem Modeling Rubric as a universally applicable procedure for justifying which concepts apply to a given problem. The class was offered for students who received a D in the fall mechanics course. Class activities included applying the rubric to multi-concept, multi-stage problems, sequences of apparently similar "touchstone problems" with important differences in deep structure, classifying problems by physical principle, and grading other students' work using instructor-supplied grading criteria. The course was assessed by a final exam re-test as well as pre- and post-CLASS surveys.[2] We obtained a 1.2 standard deviation improvement in the students' ability to solve final exam problems, and a statistically significant positive shift in seven of the nine categories in the CLASS. Students felt that the Problem Modeling Rubric improved their problem solving ability.

1. A. Pawl, A. Barrantes and D.E. Pritchard, "Modeling Applied to Problem Solving," contributed talk (these proceedings).
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," *Phys. Rev.* ST-PER 2, 010101 (2006).

PST2E-05: 8:30–9:15 p.m. Introductory Course Reform at Oregon State: Promoting Sustainable Reform

Dedra Demaree, Oregon State University, Corvallis, OR 97331; demareed@physics.oregonstate.edu

Sissi Li, Oregon State University

At Oregon State University, we are undergoing curriculum reform in our large-enrollment introductory calculus-based physics sequence. As a major research university our introductory courses are large and taught by multiple instructors, with the assistance of an army of teaching assistants (TAs). As a department with nationally recognized upper-division reformed courses, we have a strong culture for excellence in teaching and innovative practices. We are therefore pushing the envelope with our lower division courses and implementing cutting-edge curricular ideas—requiring need for instructors with a high level of pedagogical content knowledge, well thought out TA training, and robust activities that support our goals. This poster will talk about some of the things we are doing to achieve this, including goal-setting on the departmental level, what we are borrowing from others, how we are developing and documenting activities in teams, and how we are studying the implementation of our new activities.

PST2E-06: 9:15–10 p.m. The S.E.N.S.E. Problem-Solving Strategy*

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

The S.E.N.S.E. problem solving strategy was developed at Tenn. Tech. University for the algebra-based physics course sequence. The first two steps in the S.E.N.S.E. problem solving strategy were adapted from the Physics and Everyday Thinking curriculum. The first step requires students to see the physics through a diagram, picture or graph. The second step requires students to explain the physics in words. The third step notates the physics in equation form. The fourth step is where students solve the math, and step five is where students evaluate their solution. The problem solving strategy and examples of ideal and student solutions will be provided.

*This material is based upon work supported by the NSF under Grant No. (NSF CCLI DUE 0737324). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

PST2E-07: 8:30–9:15 p.m. Introducing Contemporary Teaching and Learning Methods to Bilingual College Physics in China

Xiaoli Wu, Beijing Institute of Technology, Beijing, PR China 100081; xlwu@b3it.edu.cn*

Haiyun Hu, Zhaolong Liu, Beijing Institute of Technology

In this article, the current situation of college physics in Beijing Institute of Technology and the problems that we are facing in teaching and learning are analyzed. Contemporary teaching and learning methods are introduced into a bilingual college physics course. These approaches make students active participants in the learning process and responsible for their own learning. Students can develop practical skills that they need in the future as well as conceptual understanding of physics through carefully designed learning events in this course.

*Sponsored by Lei Bao

PST2E-08: 9:15–10 p.m. Bilingual Education of College Physics for Engineers in China

Zhaolong Liu, Beijing Institute of Technology, Physics Department, Beijing, PR China 100081; zlliu@bit.edu.cn*

Haiyun HU, Xiaoli Wu, Bejing Institute of Technology

The curriculum college physics for engineers has been presented in many universities in China under the support of the Chinese ministry of education. It is a controversial curriculum questioned by some experts in physics education and students in China, although it meets the increasing needs of native Chinese students as well as international students in China. With the development of the curriculum, traditional Chinese education idea and methods of college physics for engineers are reformed. The appearance of bilingual curriculum reflects the tendency of global education integration and it will supply a platform of showing Chinese physics education for engineers and international physical education in China.

*Sponsored by Lei Bao

PST2E-09: 8:30–9:15 p.m. Earth Rotating Around Its Axis – How Do We Know?

Ann-Marie Pendrill, University of Gothenburg, Goteborg, SE 412 96 Sweden; Ann-Marie.Pendrill@physics.gu.se

CANCELED

How do we know? 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. For example, 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.

PST2E-10: 9:15–10 p.m. A New Hydrostatic Paradox

Enrique Miranda, CCT-CONICET-Mendoza, Casilla de Correo 131, Mendoza, 5500 Argentina; emiranda@mendoza-conicet.gov.ar

It is shown that for a liquid in any connected vessels system, it is not possible to fulfill simultaneously Pascal's principle, mass conservation, and energy conservation. The viscosity has to necessarily be taken into account to understand the system change.

PST2E-11: 8:30–9:15 p.m. An Active Introduction to Entropy and Irreversibility for Liberal Arts Students

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

This poster describes an approach to teaching liberal arts students about the concepts of entropy and irreversibility. The approach uses a hands-on activity involving coins and dice to illustrate the distinction between microstates and macrostates and introduce students to the concept of multiplicity. Entropy is then defined in terms of multiplicity. While completing the activity, students will not only see that the model system approaches an equilibrium state, but they will also understand why it does so. This activity is followed by another in which students use open-source computer simulations (developed by the author) to connect what they have learned about entropy and irreversibility to the behavior of ideal gases. These computer simulations also allow students to explore some of the objections that were initially raised. Simulations and other materials available at http://facultyweb.berry.edu/ttimberlake/entropy/.

PST2E-12: 9:15–10 p.m. Special Relativity Using Spacetime Trigonometry: A Short Course

Roberto B. Salgado, Mount Holyoke College, South Hadley, MA 01075; rsalgado@mtholyoke.edu

Spacetime Trigonometry* (a unified formalism for two-dimensional Euclidean space, Galilean spacetime, and Minkowski spacetime) provides a new geometric framework for teaching relativity. Elements of this formalism were used to teach a short January-term course for undergraduates, with high school mathematics as the only prerequisite. We display some animations used to motivate the formalism and present spacetime-trigonometric solutions to homework problems drawn from a standard algebra-based introductory textbook. We conclude with a sketch of a possible syllabus for an introductory physics course implementing aspects of spacetime trigonometry.

*For Spacetime Trigonometry, refer to http://www.aapt-doorway.org/Posters/SalgadoPoster/SalgadoPoster.htm .

(F) Upper Division

PST2F-01: 8:30–9:15 p.m. Photon Quantum Mechanics in the Undergraduate Curriculum: Phase I

David P. Jackson, Dickinson College, Carlisle, PA 17013; jacksond@dickinson.edu

Brett J. Pearson, Dickinson College

Armed with an NSF CCLI grant, the physics department at Dickinson College is infusing a number of optics experiments throughout the physics curriculum. The ultimate goal is to bring students face to face with some of the fascinating and subtle aspects of quantum mechanics in a hands-on setting. This includes demonstrating that a single photon "must" go one way or the other at a beam splitter, and then demonstrating that a single photon "must" simultaneously go both ways at a beam splitter. These "which-way" experiments are relatively straightforward to perform in an undergraduate setting and this poster describes the details of our implementation thus far.

PST2F-02: 9:15–10 p.m. New Correlated-Photon Labs for Teaching Quantum Mechanics*

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

We present new layouts and experiments used for teaching quantum mechanics principles via Dirac notation. The use of photon polarization helps illustrate state-vector manipulations that are used to explain spins going through Stern-Gerlach devices. The experiments help students correlate the operator matrix algebra of quantum mechanics with real physical systems. The experiments that we report were used as a laboratory section of an introductory quantum mechanics course for undergraduates.

*Funded by NSF.

PST2F-03: 8:30–9:15 p.m. Investigating Light Pressure Due to Rotations: 2D to 3D Transition Is Interesting!

Michael A. Waxman, University of Wisconsin – Superior, Superior, WI 54880; mwaxman@uwsuper.edu*

We introduce a series of problems on rotation of suspended 2D objects due to radiation pressure. All these objects are half-reflective, half-black. After solving such a problem in the class, we assign a problem on rotation of a similar (cylinder vs. rectangle, sphere vs. circle, cone vs. triangle, etc.) 3D object. The solution is quite different from the 2D case!

*Sponsored by Myron O. Schneiderwent.

PST2F-04: 9:15–10 p.m. Motions of a Small Black Hole Traveling Through the Earth

David Tamres, University of Wisconsin – Stevens Point, Stevens Point, WI 54481; dtamres@uwsp.edu

Michelle Stephens, University of Wisconsin – Stevens Point

In a tongue-in-cheek op-ed that appeared in *The New York Times* (p. A-19) on August 23, 2008, writer Gail Collins mused on the possibility that the Large Hadron Collider, once it begins operation, might produce a small black hole that would devour our planet and end all life as we know it. Collins' essay inspired our investigation into the trajectories of a hypothetical black hole created at the LHC. We consider both an evaporating and a non-evaporating black hole and take into account the increase in the black hole's cross section as it plows through Earth's interior. We use classical Newtonian dynamics and a fourth-order Runge-Kutta algorithm for calculating trajectories. Results will be presented, along with reasons to feel reassured that the LHC will not produce a black hole that will swallow the Earth.

PST2F-05: 8:30–9:15 p.m. Liquid Drop Collisions

Stefanie L. Cumberledge, University of Michigan (Westminster College), Evans City, PA 16033; cumbersl@westminster.edu*

The purpose of this research was to study the liquid drop model of the nucleus and liquid collisions in general. The collision of liquid drops can be used to model the collision of nuclei, as well as many other collisions, including neutron stars and asteroids. A better understanding of liquid drop collisions can enhance overall understanding of collisions. Specifically, this research focused on colliding drops composed of water, water with a surface-tension reducing agent, and oil. I varied the drop sizes and the collision impact parameters. The goal was to find a correlation between the Weber number and the collision outcome—coalescence or fission. An effort was made to study the mass transfer of these collisions by using drops of different colors. The collisions were filmed and processed to create image sequences. My data shows a significant correlation between the Weber number and the collision outcome.

*Sponsored by Prof. Fred Becchetti

PST2F-06: 9:15–10 p.m. Visualizing Proper Time in Special Relativity: The Accelerated Light-Clock

Roberto B. Salgado, Mount Holyoke College South Hadley, MA 01075; rsalgado@mtholyoke.edu

By supplementing worldlines with light-clocks and tracing the spacetime paths of the associated light rays, we obtain a visualization of the ticks of these clocks. After a brief review of our earlier work on visualizing proper time for piecewise-inertial observers, we present an animated visualization of the proper time for uniformly accelerated observers. http://physics.syr.edu/courses/modules/LIGHTCONE/LightClock/ has animations for the piecewise-inertial observers.

PST2F-07: 8:30–9:15 p.m. Entropy and Temperature of Radiation

Carl E. Mungan, U.S. Naval Academy, Annapolis, MD 21402-5002; mungan@usna.edu

Calculation of the entropy of a system is a standard starting point in statistical mechanics for accessing other thermodynamic quantities of interest such as temperature and energy-conversion efficiencies. However, when intermediate-level thermal textbooks consider the topic of electromagnetic radiation, they typically restrict themselves to blackbodies, as described by a Planck spectrum. Unfortunately, many photon systems in the real world are not thermalized. This poster will review a number of different but equivalent formulae for computing the entropy of nonequilibrium radiation and then show how they can be used to deduce various effective temperatures of an optical beam for application to practical light absorbing and emitting devices.

PST2F-08: 9:15–10 p.m. Between a Free Adiabatic Expansion and a Quasi-static One

Enrique Miranda, CCT-CONICET-Mendoza, Mendoza, Argentina 5500; emiranda@mendoza-conicet.gov.ar

In thermodynamics textbooks two adiabatic processes are studied: the free expansion of a gas (Joule experiment) that is a highly irreversible process, and the reversible expansion due to a quasi-static process. We analyze an intermediate situation: the expansion takes place at a high speed, therefore the quasi-static approximation does not hold, but not as high as in a free expansion. In a free expansion the volume changes instantaneously, i.e., with an infinite velocity, while in a quasi-static process the volume change velocity is almost zero. We will find a parameter r that describes the process when the velocity is neither zero nor infinite.

PST2F-09: 8:30–9:15 p.m. Active Learning Using Tutorials in Intermediate Optics*

Mark F. Masters, Indiana University Purdue University Fort Wayne, Fort Wayne, IN 4680\masters@ipfw.edu

Timothy T. Grove, Indiana University Purdue University Fort Wayne

Active learning is the process through which students in a class are actively engaged in the material under investigation. The success of this method of instruction has been well documented for introductory classes. In intermediate/advanced undergraduate physics classes there are fewer published results of experience or materials for use in active learning. This may be due to the mathematical rigor required in these classes and the traditional use of derivations to gain insight into physical problem solving. In this presentation we present our work in developing tutorials to help the students learn and use the mathematics and techniques of derivations as well as develop a stronger conceptual foundation for intermediate optics. These tutorials form a basis for the development of an active learning process in an advanced physics class setting. In this poster we will give various examples of the tutorials we use to guide the students and discussions.

*Supported by NSF Grant #0410760.

PST2F-10: 9:15–10 p.m. Thinking Like a Physicist: Transforming Upper-Division Electricity & Magnetism*

Stephanie V. Chasteen, Physics Department and Science Education Initiative, University of Colorado at Boulder, Boulder, CO 80309; stephanie.chasteen@colorado.edu

Steven J. Pollock, Michael Dubson, Ed Kinney, Paul Beale, Katherine Perkins, University of Colorado at Boulder

We expect certain skills in graduate students, such as the ability to justify problem-solving strategies, choose and apply problem-solving techniques, and recognize the interconnectedness of ideas in physics. But these skills are typically not explicitly taught. So as to directly define and address these learning goals and help students become more sophisticated thinkers, we have reformed an upper-division Electricity & Magnetism course using research-based methods. The reformed materials include 1) Consensus learning goals; 2) Concept ("clicker") questions; 3) Interactive lecture techniques such as kinesthetic activities and whiteboarding; 4) Homeworks including conceptual problems, real-world physics, and items from the physicists "toolbox," such as estimations and approximations; 5) Out-of-class tutorials and small-group help sessions; and 6) A research-based post-course assessment test for measuring student learning. We will highlight some key results regarding the effectiveness of these reforms relative to a traditional course, sustainability across semesters, and student feedback.

*All reform materials are available through http://www.colorado.edu/sei/departments/physics.htm. This work was funded by the University of Colorado's Science Education Initiative and the National Science Foundation Grant No. 0737118.

PST2F-11: 8:30–9:15 p.m. The Capstone Project Course at Eastern Michigan University

Ernest R. Behringer, Eastern Michigan University, Ypsilanti, MI 48197; ebehringe@emich.edu

PHY 420 Capstone Project is a one-semester course intended to develop and augment a variety of student skills, including searching the literature, designing and conducting experiments, developing theoretical and computational models, and communicating technical information using written, oral, and graphical means. PHY 420 also provides an opportunity to qualitatively assess the influence of prior coursework on student knowledge and on collaboration skills. During winter 2009, students taking PHY 420 worked in teams to measure the fluorescence spectra of quantum dots using variable excitation. Each team gave oral presentations to general and disciplinary audiences, gave a poster presentation, and produced a final written report that satisfied the criteria for submission to a journal. PHY 420 has been designated as Writing Intensive, which fulfills an Eastern Michigan University general education requirement for writing in the discipline. A detailed description of the course and its impact on the students will be given.

PST2F-12: 9:15–10 p.m. Physics Research Experiences for Undergraduates

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

Sherry Yennello, Texas A&M

The National Science Foundation sponsors close to 60 Physics Research Experiences for Undergraduate sites across the country each summer. Additional sites of interest to physics students are sponsored in related areas of materials science, astronomy, chemistry, and mathematics. In this poster we highlight the advantages to students and institutions for participating in and sponsoring these sites. Research has shown that students who participate in these kinds of programs are more likely to attend and persist in graduate education. The sites are particularly anxious to involve participants from groups such as women, minorities, and first-generation college students who would otherwise be less likely to consider graduate studies in physics.

PST2F-13: 8:30–9:15 p.m. A Curriculum for a Third Semester Waves Course

David H. Kaplan, Southern Illinois University Edwardsville, Edwardsville, IL 62026; dkaplan@siue.edu

Thomas M. Foster, Southern Illinois University Edwardsville

An important factor contributing to the loss of physics majors relates to the transition from the introductory-level courses, for which the necessary mathematical and physical background is clearly specified, to the intermediate and advanced courses. In the latter, usually tacitly assumed or only cursorily provided are the necessary background and facilities related to properties of waves, wave equations, Fourier methods, approximation techniques, and completeness properties of superpositions of modes, standing waves and traveling waves. For this reason, we have designed and implemented a course aimed at the critical third semester and dedicated to the physics of waves and Fourier methods. We present aspects of a curriculum that we have developed for this course and preliminary results on its effectiveness. The curricular modules developed are being incorporated into a comprehensive textbook on waves that is being prepared for publication by one of the authors.

PST2F-14: 9:15–10 p.m. Two-Laser Spectroscopy in Atomic Cesium

Andrzej Sieradzan, Central Michigan University, Mt. Pleasant, MI 48858; andy@phy.cmich.edu

CANCELED

A. Hankin, M. Harvey, C. VanDam, Central Michigan University

Relatively inexpensive, narrowly tuned diode laser is often employed in optics laboratories to introduce students to modern atomic spectroscopy. Projects, like saturation spectroscopy of alkali resonance lines became a standard undergraduate research experience in many institutions. For laboratories, which could afford two lasers, tunable around specific wavelengths, we propose a two quantum two-photon spectroscopy experiment in which relative strengths of atomic transitions can be determined. These relative transition probabilities can be also modeled using simple quantum mechanics, so theoretical prediction and experimental results can be compared and discussed. Using the same set-up, a step-wise excitation with narrow-line lasers can be conducted, in which a clear evidence for velocity-selective atomic excitation, and Doppler shift proportionality to the frequency can be demonstrated.

(G) Technology in the Intro Course

PST2G-01: 8:30–9:15 p.m. LivePhoto Workshops on Active Learning with Video Analysis*

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

Priscilla Laws, Maxine Willis, Dickinson College

Patrick Cooney, Millersville University

The LivePhoto Physics Project is 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 a gain in learning when selected video-analysis materials were added to an introductory physics course at Dickinson College. The project is offering three-day and five-day LivePhoto workshops for college and university physics instructors at all levels. Participants will learn how digital video analysis can be used in conjunction with physics education research findings to help students overcome learning difficulties. In addition, workshop participants will take part in a large controlled study of the effectiveness of these video-analysis curricular materials at diverse institutions.

*Supported by NSF grants 0424063, 0717699 and 0717720 (http://livephoto.rit.edu/)

PST2G-02: 9:15–10 p.m. Multimodal Representation to Support Students to Conceptualize Submacroscopic Sizes

Minyoung Song, University of Michigan, Ann Arbor, MI 48109; mysong@umich.edu

Chris Quintana, University of Michigan

Students need to understand size and scale in order to choose the appropriate physical model to explain the behavior of matter. However, prior research indicates that many students have difficulty in conceptualizing the size of objects that are too small to see with the naked eye. The absence of direct visual experience with an object is considered to be the main reason that such misconceptions arise. This study introduces a computer simulation called "Wow, It Is Small!," which is designed to help students conceptualize the sizes of submacroscopic objects. By interacting with a simulation that incorporates temporal, aural, and visual representations (TAVR), students order submacroscopic objects from the smallest to the biggest and group them by similar sizes. The goals of this current study are to explore whether middle school students can understand TAVR simulations and observe how they use these simulations to refine their mental models of submacroscopic sizes.

PST2G-03: 8:30–9:15 p.m. Social and Technological Challenges in Creating a Web-Based Tutoring System

Chris M. Nakamura, Kansas State University, Manhattan, KS 66506; cnakamur@ksu.edu

Sytil K. Murphy, Nasser M. Juma, N. Sanjay Rebello, Dean A. Zollman, Kansas State University

Mike Christel, Scott Stevens, Carnegie Mellon University

There is currently increasing interest in developing and deploying learning materials on the Internet. The Internet brings many opportunities to bring physics content, presented via research-based pedagogical methods, to students at a time and place that suits their schedules. However, using the Internet as an instructional tool presents technological challenges as well as challenges related to student access, and technological familiarity, that must be resolved to meet the goal of producing an accessible learning tool. Successful resolution requires research designs that draw upon student samples that accurately reflect various levels of students' Internet access and familiarity, as well as use the technology in ways that do not exclude students. We discuss these issues and methods of addressing them in the context of the ALT-Pathway web-based tutoring project. This work is supported by the U.S. National Science Foundation.

PST2G-04: 9:15–10 p.m. Physics for Computer Graphics and Animation as General Education Courses

Mark F. Masters, Indiana University Purdue University Fort Wayne, Fort Wayne, IN 46805; masters@ipfw.edu

Over the past six years we have been offering a two-course sequence on physics for computer graphics and animation. Both courses are laboratory based with hands-on investigations. The first course of the sequence concentrates on the nature of light and color. Students perform physical investigations and "simulations" of the same scenario using the free software: Blender 3D. The second course concentrates on mechanics, biomechanics, and "scaling." In this course, students learn to go from a "theoretical" description of motion to an animation. The students learn to articulate problems in animations. In each of these courses there is an emphasis on scientific thinking and process. This poster will present activities, techniques used in the course to measure student comprehension of the material, and difficulties encountered.

PST2G-05: 8:30–9:15 p.m. Conceptual Electricity and Magnetism Problem Database (http://physinfo.uark.edu/inventory)*

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

This poster introduces a new digital resource for teaching and evaluating introductory electricity and magnetism classes: a digital library of highly characterized, multiple-choice, conceptual electricity and magnetism problems. The library contains more than 700 problems that were algorithmically constructed from a collection of introductory sources. Each problem is characterized by the complexity of its solution and by the fundamental intellectual steps found in the solution. Evaluation construction, administration, and analysis tools are provided through the library's website. Problems may be downloaded for use in exams or as clicker questions. Instructors may also design and administer conceptual evaluations online. There is no cost associated with using any of the facilities of the site.

*Supported by NSF # DUE 0535928. Site

(H) comPADRE

PST2H-01: 8:30–9:15 p.m. The Open Source Physics comPADRE Collection*

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

Mario Belloni, Davidson College

Anne Cox, Eckerd College

Over the past dozen years the Open Source Physics (OSP) project has produced some of the most widely used interactive computer-based curricular materials for the teaching of introductory and advanced physics courses. These materials are based on Java applets called Physlets and on new OSP programs and authoring tools. This poster outlines the pedagogical and technical features of our curricular material and our current effort to distribute it via a partnership with the comPADRE National Science Digital Library. We show how the combination of the OSP Easy Java Simulations modeling and authoring tool with comPADRE allows teachers to easily incorporate computer-based modeling into their curriculum by providing an open and extensible solution for the creation and distribution of educational software.

*The OSP collection is available on the comPADRE website at <http://www.compadre.org/osp/>. Partial funding for this work was obtained through NSF grant DUE-0442581.

PST2H-02: 9:15–10 p.m. PTEC.org – The National Science Digital Library Collection on Teacher Preparation

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

comPADRE is the National Science Digital Library portal for physics and astronomy education. PTEC.org (http://PTEC.org) is the comPADRE collection for physical science teacher preparation and the Internet home of the PTEC (Physics Teacher Education Coalition) organization. The PTEC collection contains a growing set of resources including articles on teacher preparation, best-practice materials, PTEC conference proceedings, national reports, and teacher recruiting materials. You can register for PTEC's annual conference and regional conferences through the site. The site seeks to serve a community of institutions dedication to improving physics and physical science teacher preparation by promoting the sharing of information and by capturing best-practice techniques. We seek your input as to how to better fill the needs of the PTEC community and to distribute the expertise of this community to the world.

PST2H-03: 8:30–9:15 p.m. The Quantum Exchange: Teacher and Student Resources in Quantum Physics

Bruce Mason, University of Oklahoma, Norman, OK 73019; bmason@ou.edu

Lyle Barbato, University of Oklahoma/AAPT

Matt Riggsbee, AAPT

The Quantum Exchange is a cataloged, vetted, and free online collection of teaching resources to enhance quantum physics courses. The materials contained in the collection include simulations, tutorials, homework problems, and research on teaching quantum mechanics. Resources that can expand on the traditional materials used in quantum courses, such as interactive visualizations and links to modern quantum research, are a focus of this collection. This poster presents both featured content and the tools available to users of The Quantum Exchange. The Quantum Exchange is part of the comPADRE network of physics and astronomy resource communities. comPADRE is part of and supported by grants from the National Science Foundation's National Science Digital Library.

PST2H-04: 9:15–10 p.m. The Physical Sciences Resource Center: 12 Years of Growth*

Bruce Mason, University of Oklahoma, Norman, OK 73019; bmason@ou.edu

Lyle Barbato, University of Oklahoma/AAPT

Matt Riggsbee, AAPT

The Physical Sciences Resource Center (PSRC) was developed 12 years ago as a way to leverage the web to deliver resources and information to physics teachers at all levels. It has become the central hub for the comPADRE network of resource collections, housing materials in all topics in physics, astronomy, and related fields, and at levels from middle school through graduate school. This poster will feature the highlights of the PSRC and the tools available to find and personalize the resources.

*Sponsored by NSF-DUE grants 0226129 and 0532798

PST2H-05: 8:30–9:15 p.m. Physics to Go: Online Informal Physics Learning/Classroom Resource

Edward V. Lee, American Physical Society, College Park, MD 20470; lee@aps.org

Raina Khatri, American Physical Society

Physics to Go is an online collection of carefully selected websites for informal learning at the level of introductory physics. In addition, the homepage offers images from both everyday physics and physics research, along with supporting text and links. Physics to Go is part of the comPADRE network of physics and astronomy resource communities. comPADRE is part of and supported by grants from the National Science Foundation's National Science Digital Library.

PST2H-06: 9:15–10 p.m. PER – Community Enhancing Network for Teaching, Research, and Learning

Vince H. Kuo, Colorado School of Mines, Golden, CO 80401; hkuo@mines.edu

PER-CENTRAL is a cataloged, vetted, and free online collection designed specifically to serve as an informational touch-point and online community for producers and consumers of physics education research. Along with a database of PER articles and dissertations, there are links to research groups, PER-based curricular materials, news and events, grant opportunities, and many other things of interest to our community. This poster presents both featured content and the tools available to users of PER-CENTRAL. PER-CENTRAL is part of the comPADRE network of physics and astronomy resource communities. comPADRE is part of and supported by grants from the National Science Foundation's National Science Digital Library.

PST2H-07: 8:30–9:15 p.m. The Statistical and Thermal Physics Collection on comPADRE

Harvey Gould, Clark University, Worcester, MA 01610; hgould@clarku.edu

Jan Tobochnik, Kalamazoo College

Anne J. Cox, Eckerd College

Wolfgang Christian, Davidson College

The Statistical and Thermal Physics (STP) Collection is a cataloged, vetted, and free online collection of teaching resources for courses in statistical and thermal physics. The collection includes over 50 simulations, a textbook with over 400 problems, and links to related materials. In addition to the problems involving simulations, suggestions for how to use the simulations in teaching will be available. The simulations are freely distributable under the GNU GPL license. The poster will illustrate some of the simulations and ways that they can be used. The STP project is part of the Open Source Physics project and the comPADRE network of physics and astronomy resource communities. Additional STP-related contributions such as articles, lecture notes, simulations, and text books are sought. comPADRE is part of and supported by grants from the National Science Foundation's National Science Digital Library. The Statistical and Thermal Physics collection is available at www.compadre.org/stp/. Partial funding for this work is by NSF grant DUE-0442581.

PST2H-08: 9:15–10 p.m. What Can the Physics Front Digital Library Do for Me?

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

The Physics Front is free and vetted collection of physics and astronomy materials targeted for pre-college physics teachers and their students. These materials include teacher content support, labs, student tutorials, simulations, reference material, homework problems, research-based teaching and assessment methods. The Physics Front features images and current resources for teachers and highlights new teacher materials and help. Our goals include providing example units and unit elements, model lessons and a myriad of vetted online materials as well as excellent PTRA and other teacher submitted resources. This poster presentation features the tools and resources available to registered users on The Physics Front. The Physics Front is one of the 16 digital library collections under the umbrella of comPADRE—one of the 10 Pathways Projects supported by grants from the National Science Foundation's National Science Digital Library.

PST2H-09: 8:30–9:15 p.m. "uCOMP," a comPADRE Collection, Devoted to Computational

David M. Winch, P.O. Box 1648, El Prado, NM 87529; winch@taosnet.com

David Winch, Kalamazoo College

Norman Chonacky, Yale University

The uCOMP mission is to improve and update physics education through computational physics. Computational physics plays an essential and vital role in physics research. It can—and should—play the same role in physics education. uCOMP (www.ucomp.org) is a comPADRE collection devoted to computational physics.The collection will provide lessons, code, executable files, animations, and other materials that span a broad range of physics topics. The collection will also have value to faculty and students at high schools and graduate schools. Objectives: collect computational physics materials into a single digital library, provide faculty with an extensive and organized collection of computational physics materials (lessons, code, simulations, examples, etc.). By doing so, uCOMP will: promote the use of computational methods in physics education, encourage the development of new computational physics materials, raise the awareness of the benefits of incorporating computational methods in the physics curriculum—increase usage of supercomputing as a tool in the undergraduate physics curriculum, better prepare physics undergraduates for the scientific workforce, and create a community of faculty and students competent in computational methods.

(I) Teaching with Technology

PST2I-01: 8:30–9:15 p.m. Using Easy Java Simulations to Model a Rolling and Slipping*

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

Wolfgang Christian, Davidson College

In introductory physics, the combination of translational and rotational motion is usually discussed in the special case of rolling without slipping. This is not too surprising given that there is a very simple condition for this motion that relates the rotational and translational motion. Less often discussed is the case of rolling with slipping, which must be treated more carefully. In this poster we describe the process of computer modeling with Easy Java Simulations (EJS) the rolling and slipping wheel. We will explain the theoretical model and how this model gets incorporated within EJS, as well as the condition for the transition between rolling with slipping and rolling without slipping.

*This poster is supported in part by NSF Grant #DUE-0442581.

PST2I-02: 9:15–10 p.m. Exchange of Clicker Questions for Your Introductory Physics

Albert H. Lee, The Ohio State University, Columbus, OH 43210; alee@mps.ohio-state.edu

Lin Ding, Neville W. Reay, Lei Bao, The Ohio State University

Tom Carter, College of DuPage

We have been using research-based clicker question sequences to enhance active learning in introductory physics courses. We will discuss some examples of our clicker question sequences and would like to invite others to come and swap question sets, discuss what makes a good question and show off their own favorite questions. Our clickers question sequences will be available as PowerPoint files on CDs that will be distributed during this session.

PST2I-03: 8:30–9:15 p.m. Ranking Tasks with the WebWork Quiz System

Michael R. Gallis, Penn State Schuylkill, Schuylkill Haven, PA 17972; mrg3@psu.edu

Ranking Tasks are a type of question that encourages a different mode of thinking than students employ for standard quiz problems. This presentation describes some preliminary work on implementing Ranking Tasks on WebWork, a web-based quiz system. The questions are used in low-stakes quizzes in which the students receive randomized data but identically formatted questions. The unique requirements of Ranking Tasks Web Questions with regards to the randomization of quiz data will be discussed. Example Ranking task questions will be shown, as well as anecdotal assessment of their impact. The computer algorithm for answer assessment will also be presented.

PST2I-04: 9:15–10 p.m. Developing Middle School Physics Concepts in the 21st Century Classroom

James Finley, New Providence Middle School, Berkeley Heights, NJ 07922; finleyjames@mac.com

The importance of technology in the classroom, specifically web-based social networking applications, has become a growing interest over that last five years. Concurrently, research has continued to illustrate the importance of metacognition and self-generated explanations to help improve breadth and depth of comprehension. Fortunately, new Internet technologies and applications like Blogger and Wordpress help unite these seemly independent ideas. Blogging provides students with a physical space to organize and manipulate their reflections. Students can describe observations and experiments, explain what they extrapolate from their experiences, create representations in the form of pictures and concept maps, and make physical connections between their ideas and other content on the Internet via links. Additionally, since student work is published online, other students have an opportunity to analyze, evaluate, and comment on their peers' thinking and understanding. This further aids in conceptualization.

PST2I-05: 8:30–9:15 p.m. A Video Analysis of Projectile Motion...Without Fancy Equipment

Roland C. Woodward, University of Wisconsin – Fond du Lac, Fond du Lac, WI 54935-2950; carey.woodward@uwc.edu

Fast-moving physical phenomena are notoriously difficult to measure in the traditional physics lab, resulting in compromises in the analysis. In the usual projectile motion lab, only the initial and final conditions are generally measured: typically horizontal and vertical displacement, launch angle, and launch speed. Recently, this problem has been addressed by capturing a video of the projectile in motion, which allows the entire trajectory to be viewed and analyzed. Such video analysis has been reported to significantly enhance student learning; however, the cost of the video capture hardware and the video analysis software has deterred many instructors from implementing it. I show here how I have used a long flight-time projectile (a "potato gun"), an inexpensive digital still camera, and a stock computer with freely distributable software, to accomplish the same goal, and with greater student engagement.

PST2I-06: 9:15–10 p.m. Video Analysis of Motion – So Easy, Even a Kid Can Do It*

Djamel Brahmia, Spotswood High School, Spotswood, NJ 08884; jamalbrahmia@yahoo.com

David Brookes, University of Illinois

Eugenia Etkina, Rutgers University

Recent video technology advancements make it possible now to take reasonably high-resolution video of common motions studied in a physics course. With the simultaneous advent of FlipDigital® video cameras, YouTube and user-friendly editing software, analyzing motion using video has become so simple that even a kid can do it. In fact, students tend to be better than the teachers at mastering this technology! We'll present video data-acquisition of several common motions and analyze the data, all in real-time. We'll also present curricular materials that integrate this method into a typical physics lab, making use of the video library at http://paer.rutgers.edu/pt3 and based on the new PUM (Physics Union Mathematics) middle school/high school curriculum.

*Sponsored by NSF grant # DRL-0733140

(J) Evaluation of Technology

PST2J-01: 8:30–9:15 p.m. Use of Student Response Systems in a Small Classroom

Matt Evans, University of Wisconsin – Eau Claire, Eau Claire, WI 54701; evansmm@uwec.edu

Amy Raplinger, University of Wisconsin – Eau Claire

In the past, research has shown the effectiveness of Student Response Systems (SRS) in large introductory physics classes. In the summer of 2007, however, SRS was used in a second semester calculus-based physics course. Seven of the nine students completed a post-course survey that looked at their experience using the clickers. The results of the survey lead to the conclusion that students feel clickers are effective in small classes. We were also able to reaffirm our previous conclusions that SRS helps students learn, understand, and remember material and those students also enjoy using SRS.

PST2J-02: 9:15–10 p.m. Evaluating Web-Based Tutorials to Develop Expertise in Introductory Students*

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

Daniel Haileselassie, University of Pittsburgh

We are developing and evaluating interactive web-based problem-solving tutorials to help introductory physics students learn effective problem-solving heuristics and enhance their problem solving, reasoning, and meta-cognitive abilities. The self-paced tutorials provide scaffolding support for a variety of problem-solving techniques,and opportunities for knowledge and skill acquisition. We will discuss the development and assessment of the tutorials.

*Supported by the NSF (NSF-DUE-0442087).

PST2J-03: 8:30–9:15 p.m. The Use of PDAs in Physics and Physical Science Classes in a Predominantly Hispanic Institution*

Edgar G. Corpuz, University of Texas-Pan American, Edinburg, TX 78539; ecorpuz@utpa.edu

Ma Aileen A. Corpuz, Mark Cunningham, Liang Zeng, Rolando Rozalez, University of Texas-Pan American

We have been implementing an interactive teaching approach using personal digital assistants (PDAs) as a classroom interaction system in various physics and physical science courses in our predominantly Hispanic institution. In this paper, we will document the issues faced by the instructors in the course of implementing the said interactive approach as well as their experiences on how the use of the PDAs is affecting their student's participation in class. We will likewise present data on the attitude of students toward the aforementioned teaching approach and determine their perceptions on whether the system is enabling them to learn better. These results have significant implications on how we can maximize the benefits of using handheld computers like PDAs in the science classrooms.

*Supported by NSF Grant DUE-CCLI-0737375"?

PST2J-04: 9:15–10 p.m. Developing, Validating and Evaluating Clicker Question

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

Lin Ding, Albert Lee, Lei Bao

We have completed a four-year project to develop clicker question sequences for a year of introductory physics. Based on the hypothesis that learning is context dependent, we have created more than 150 question sequences containing more than 450 individual questions. Each question in a sequence contains the same concept but has different surface features. Our sequences have been validated through hundreds of interviews with experts and students, and have been used in classrooms at multiple institutions. Students enjoy answering the sequences and believe that their understanding is improved. Actual learning has been evaluated by comparing students in lecture sections that use clickers with our question sequences to students in otherwise identical lecture sections that don't use our material. Students in clicker sections consistently perform better on common conceptual examination questions and exhibit larger gains based on pre-/post-testing with concept inventories. Free disks containing the question sequences will be distributed.

PST2J-05: 8:30–9:15 p.m. Efficiency Analysis on Use of Computer Simulations in the Abstraction of Parabolic Motion Problem

Monica Quezada, Universidad Autonoma de Ciudad Juarez, Juarez, CHIH 32300 Mexico; eordonez@uacj.mx

Elsa G. Ordoñez, Hector A. Trejo, Sergio Flores, Universidad Autonoma de Ciudad Juarez

An efficiency analysis on the use of computer simulations in the form of lab practices as a learning tool over traditional teaching is presented. We show the improvement on the abstraction in knowledge over a parabolic motion problem mainly on the concepts of velocity and acceleration vectors along the trajectory. Using conceptual before and after tests as a measuring instrument, we demonstrate that this type of technologies have an efficiency and student motivation degree sufficient to make the recommendation for official use. The data source of this work was obtained applying exams at three schools at the college level in Juarez, Mexico, with approximately 500 students.

PST2J-06: 9:15–10 p.m. Andes Homework System in a High School Classroom

Sophia Gershman, Watchung Hills Regional High School, Warren, NJ 07059; sgershman@whrhs.org

Brett van de Sande, Arizona State University

Physics teachers and education researchers agree on the importance of homework and the importance of students working through multifaceted applications of principles taught in the course. Attempts to increase the effectiveness of homework for student learning and to ease the instructors' grading load have led to the use of Webassign, Mastering Physics, ANDES Physics Tutor, and other computer-based homework/tutor systems (Bonham, 2001, 2003; Lee, 2008). We conducted an initial study in an Advanced Placement class that compared quiz results for students who had used Andes or WebAssign for the previous homework assignment. We discuss the results of this study as well as additional information gained from analysis of logs of student activity as they solved problems. Results of student surveys are also reported. The fast growth in the use of computers in high school education amplifies the importance of reliable assessments of these new tools.

PST2J-07: 8:30–9:15 p.m. Internal and External Assessments for Andes Homework System

Brett van de Sande, Arizona State University,Tempe, AZ 85287-8809; bvds@asu.edu

Kurt Vanlehn, Arizona State University

Andes is an intelligent tutor homework system designed for use in a two-semester introductory physics course. We describe a tightly controlled multi-year study run at the U.S. Naval Academy demonstrating the effectiveness of Andes relative to pencil-and-paper graded homework. We also show how Andes itself can be used to measure students' learning, as they solve homework problems. We use a variety of chronometric and accuracy measurements to assess how long it takes students to master concepts, skills, and problem-solving strategies.

(K) Innovations in Teaching Astronomy

PST2K-01: 8:30–9:15 p.m. Good Astronomy on a Modest Budget

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

Robert Moore, Jr., University of West Georgia

The University of West Georgia has had an on-campus observatory since 1979. This facility has been used by students in astronomy classes and laboratories and students who studied eclipsing binaries. Monthly observations for the public have been held as well as special observations for school groups. Recently the primary telescope has been upgraded to a 16-inch Meade computer-driven telescope. New equipment (a Coronado solar telescope with a calcium-K filter and an Orion StarShoot Pro Deep Space Color CCD Camera) have been purchased. With this improved telescope and accessories, quality images have been made of the Sun, the Moon, planets, one comet, and Messier objects. Student projects, such as the study of the Sun, eclipsing binaries, and near Earth objects have been started.

PST2K-02: 9:15–10 p.m. Developing a Student-Run Observatory Program

Carrie M. Swift, The University of Michigan – Dearborn, Dearborn, MI 48128; cmswift@umd.umich.edu

Dmytro Obraz, Rebecca M. Wilczak, Eric J. Rasmussen, The University of Michigan – Dearborn

Since its installation two years ago, the University of Michigan – Dearborn's Observatory's 0.4 m reflecting telescope has been used in a variety of activities, including public events and for classroom laboratory demonstrations. However, the primary purpose of the telescope is to provide research opportunities in Astronomy to undergraduate students. Our goal is an observatory research program that is developed and maintained by undergraduates, with supervision from faculty as appropriate. We have made significant progress in this direction. Students have made major contributions to the Telescope User's Guide, including sections on image calibration, three color imaging, and photometry. Future users of the telescope, both students and faculty, will benefit from these efforts. Student research activities in differential photometry are ongoing, and show the potential of such a student-run approach.

PST2K-03: 8:30–9:15 p.m. Turning a Lecture into a Tutorial

Michael C. LoPresto, Henry Ford Community College, Dearborn, MI 48128; lopresto@hfcc.edu

The process used to develop tutorials on the formation of the solar system and the geological and atmospheric evolution of terrestrial planets will be outlined and the methods and results of assessment of instruction by both the tutorials and the lectures on which they were based will be reported.

PST2K-04: 9:15–10 p.m. How It Works to Use Hexagon Bulbs for a Light Source to Perform Solar Eclipse Demonstrations

In Sik Kim, Korea National University of Education, Chung-Buk, 363-791; insig21@hanmail.net

Hye Yoon Kim, Jung Bog Kim, Korea National University of Education

It is difficult for students to have scientific concept about total shadow and half shadow of the Moon when science teachers teach about solar eclipse. Students think that rays from the Sun only run parallely about axis of the Sun, Moon and Earth. They do not understand that the Sun is not a point source of light. Therefore we need an instrument using a multi-point source of light like the Sun for a solar eclipse demonstration. We use seven bulbs to form a hexagon source of light. A bulb is located at the center of a hexagon, and the others are located at the corners of a hexagon. We compare a case using a bulb for a light source to perform a solar eclipse demonstration with the other case using hexagon bulbs as the source to perform the demonstration.

PST2K-05: 8:30–9:15 p.m. Extraordinary Matter: Visualizing Space Plasmas and Particles

Shirley B. Barbier, NASA GSFC / SP Systems, Inc., Greenbelt, MD 20771; Beth.Barbier@nasa.gov

We present a searchable online NASA multimedia library now in development, "Extraordinary Matter: Visualizing Space Plasmas and Particles," designed to assist educators with explaining these concepts that cannot be easily demonstrated in the everyday world. Such resources are currently few in number and/or difficult to locate, and most do not provide suitable context. On our site, each ready-to-use product will be accompanied by a supporting explanation at a reading level matching the educational level of the concept. The site will target primarily grades 9-14 and the equivalent in informal education and public outreach. Products are intended to stand alone, making them adaptable to the widest range of uses, including scientist presentations, museum displays, teacher professional development, and classroom use. Our space science and education specialists are in the process of determining specific needs, gaps, and priorities by surveying the potential user community, and participation will be offered to visitors.

PST2K-06: 9:15–10 p.m. Exploring the Copernican Revolution Through Computer

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

The author and a colleague have developed a course for liberal arts students that focuses on the development of astronomical theories from the Ancient Greeks to Isaac Newton. In the first part of the course, students use planetarium software (Starry Night) to observe a wide variety of celestial motions. The remainder of the course is devoted to studying the various theories that have been presented to explain and predict these motions. Students work with open-source computer simulations developed by the author to visualize the predictions of astronomical models and compare these predictions to their earlier "observations." This approach helps students to see the great power and sophistication of Ancient Greek astronomical theories, as well as the aesthetic features of the Copernican theory that paved the way to its ultimate acceptance. The simulations developed by the author (and worksheets to guide their use) are available free at http://facultyweb.berry.edy/ttimberlake/copernican/.

PST2K-07: 8:30–9:15 p.m. Visual Assessments of Solar System Topics

Michael C. LoPresto, Henry Ford Community College, Dearborn, MI 48128; lopresto@hfcc.edu

Gains after instruction by tutorial and lecture on the solar system topics of extra-solar planets and comet orbits were compared using assessments of a purely visual nature. Prior to and after instruction, students were shown plots of Doppler-shift data from stars and asked to compare relative masses and orbital radii of extra-solar planets as well as determine whether the planets were in circular or eccentric orbits or in multiple-planet systems. Gains from instruction on comet-orbits were assessed with a diagram of the portion of a comet orbit near the Sun on which students were instructed to draw the relative size of the comet and length and direction of the tail at different points in the orbit both prior to and after instruction. Results of assessments and observations will be reported.

PST2K-08: 9:15–10 p.m. The Story of Astronomy: An Activities-Based, Historical Approach to Classroom Instruction

Alan Hirshfeld, University of Massachusetts Dartmouth, Newton, MA 02461; ahirshfeld@umassd.edu

Missing from the standard introductory astronomy course is the essential "story line" that tells how astronomers came to know so much about the universe. Without such context, students find it hard to engage with the presentation of scientific principles and knowledge, no matter how logically organized. Through a series of in-class, modestly mathematical, paper-and-pencil activities, coupled with brief lectures, and available online simulations, nonscience students can recapitulate the epic advancement of astronomical thought, from the rudimentary observations of prehistoric skywatchers through the cosmic models of ancient and Renaissance thinkers, and culminating in the development and application of modern astrophysics. Whenever possible, historical observations are adapted for use in the activities. The new approach has been in use since fall 2006 in the 90-student introductory astronomy course at UMass Dartmouth. The complete set of activities is available in the "Astronomy and Laboratory Manual" published by Jones & Bartlett (http://www.jbpub.com/catalog/9780763760199/).

(L) Problem Solving

PST2L-01: 8:30–9:15 p.m. Assessment of Student Problem-Solving Processes*

Jennifer L. Docktor, University of Minnesota, Minneapolis, MN 55455; docktor@physics.umn.edu

Ken Heller, University of Minnesota

At Minnesota we have been developing a rubric to evaluate students' written solutions to physics problems that is easy to use and reasonably valid and reliable. The rubric identifies five general problem-solving processes and defines the criteria to attain a score in each (useful description, physics approach, application of physics, math procedures, and logical progression). An important test of the instrument is to check whether these categories represent the actual processes students engage in during problem solving. We will report an analysis of problem-solving interviews conducted with students enrolled in an introductory physics course and examine the implications of these results for the rubric.

*Supported in part by NSF DUE-0715615

PST2L-02: 9:15–10 p.m. Toward an Inventory Assessing Expert Problem Solving Skills

Andrew Pawl, MIT, Physics Dept., Cambridge, MA 02139; aepawl@mit.edu

Analia Barrantes, David E. Pritchard, MIT

We are constructing an inventory to assess expert problem-solving skills, and we solicit your suggestions. We have so far focused particularly on three expert skills that novices don't possess: understanding problems with extra or insufficient givens; sense-making by using limiting cases, dimensional analysis, etc. to select a correct answer from a set of possible answers; and coping with problems that are more easily approached with diagrammatic representations than with numerical or algebraic representations. Preliminary analysis involves a comparison of the skills tested by our questions with the skills tested on the MBT.[1] We are looking for collaborators willing to critique and test preliminary versions of the inventory.

1. D. Hestenes and M. Wells, "A mechanics baseline test," *Phys. Teach.* **30**, 159-165 (1992).

PST2L-03: 8:30–9:15 p.m. Attitudes Toward Problem Solving and Reflection Depending on Expertise

Andrew J. Mason, University of Pittsburgh, Pittsburgh, PA 15260; ajm_per@yahoo.com

Chandralekha Singh, University of Pittsburgh

Cummings et al.[1] propose an initial survey of attitudes toward problem solving partially based upon the Maryland Physics Expectations Survey (MPEX).[2] We expand upon this survey to include additional considerations and examine how students in introductory algebra-based and introductory calculus-based physics compare to physics faculty and graduate students. In addition, we examine whether introductory student performance correlates with student responses to the survey.

1. K. Cummings, S. Lockwood, & J.D. Marx, *Attitudes Toward Problem Solving as Predictors of Student Success.* In 2003 Physics Education Research Conference Proceedings, edited by J. Marx, S. Franklin , and K. Cummings, 133-136, (2004).
2. E.F. Redish, J.M. Saul, & R.N, Steinberg, "Student expectations in introductory physics," *Am. J. Phys.* **66,** 212–224 (March 1998).

PST2L-04: 9:15–10 p.m. Students' Performance on Text Editing, Jeopardy, and Problem Posing Tasks*

Fran Mateycik, Kansas State University, Manhattan, KS 66506-2601; mateyf@phys.ksu.edu

N. Sanjay Rebello, Kansas State University

David H. Jonassen, University of Missouri, Columbia

While research on problem solving has focused primarily on traditional end-of-chapter problems, nontraditional problems can provide insights into the students' conceptual schema. Physics Jeopardy, text-editing, and problem-posing tasks are not amenable to the use of novice problem-solving strategies that students tend to use in typical, structured end-of-chapter problems; therefore, these tasks provide a nontraditional assessment tool for how students use their conceptual knowledge in problem solving. We adapted these tasks into multiple-choice questions that were presented to students as extra credit problems on each exam of the course over two semesters. In this poster, we report on students' performance on these tasks and how it compares with their performance on traditional problems covering the same material.

PST2L-05: 8:30–9:15 p.m. From Conceptual Understanding to Problem Solving

Lin Ding, The Ohio State University, Columbus, OH 43210; ding.65@osu.edu

Neville Reay, Albert Lee, Lei Bao, The Ohio State University

Studies have shown that increased student conceptual understanding itself does not translate into increased problem-solving skills.[1,2] We conducted pilot studies to explore possible ways to close this gap by combining open-ended problems with related conceptual questions. The problems were specifically designed to synthesize materials widely separated in traditional courses, and the concept questions were created to address related fundamental concepts. Students first answered and discussed two concept questions prior to solving an associated problem. Recognition of the underlying connection between the concept questions and the problem was the key to successful completion of the problem. We conducted both small-scale interviews and a large-scale written test to compare student performance between an experiment group and a control group. We report our pilot-study results and discuss possible future work.

1. C. Singh, "Assessing student expertise in introductory physics with isomorphic problems. II. Effect of some potential factors on problem solving and transfer," *Phys. Rev. ST-PER,* **4**, 010105 (2008).
2. E. Etkina, A. Karelina & M. Ruibal-Villasenor, "How long does it take? A study of student acquisition of scientific abilities," *Phys. Rev. ST-PER*, **4,** 020108 (2008).

PST2L-06: 9:15–10 p.m. Providing Individualized Guidance and Feedback with Web-Based Problem-Solving Coaches*

Leon Hsu, University of Minnesota, Minneapolis, MN 55455; lhsu@umn.edu

Ken Heller, University of Minnesota

The Physics Education Research group at the University of Minnesota is designing web-based coaches to help students develop competent problem-solving skills in an introductory physics course. Based on the cognitive apprenticeship model, the coaches provide students with individualized guidance and feedback as they practice using an expert-like problem-solving framework to solve problems. We will demonstrate prototypes of these coaches, as well as describe a pilot study performed to assess the usability of the coaches and their perceived usefulness by students.

*Supported by the NSF through DUE-0715615.

PST2L-07: 8:30–9:15 p.m. Students' Performance on Problem-Solving Tasks in Teaching/Learning Interviews*

Dong-Hai Nguyen, Kansas State University, Manhattan, KS 66506-2601; donghai@phys.ksu.edu

N. Sanjay Rebello, Kansas State University

Learning how to solve problems in different contexts, domains, and representational forms is at the heart of training future scientists and engineers. We conducted individual teaching/learning interviews with 20 students in a calculus-based physics course. A total of four interviews per student were conducted during the semester, with each coming after an exam in their physics class. During each interview, students were asked to solve a problem that had been selected from their exam along with one or two more problems that shared deep physical similarities but had surface differences from the first problem. The differences might have been in representation, in context, or both. We present some of the interview protocols, the common difficulties that students encountered and the hints we provided to help them overcome those difficulties.

* Supported in part by U.S. NSF grant 0816207.

PST2L-08: 9:15–10 p.m. Examining Student Problem Solving in the Context of Model-Based Instruction

Daniel R. Able, Purdue University, Lafayette, IN 47907; dable@purdue,.edu

Lynn Bryan, Wendi Wampler, Mark Haugan, Greg Robison, Purdue University

This study explores how students approach problem solving while taking a course using Matter & Interactions (Chabay & Sherwood, 2007). This first-year calculus-level physics course emphasizes a systematic approach to problem solving that involves constructing models of relevant physical situations and starting from fundamental principles. Student participants in this study were observed working in small groups on whiteboards to solve problems during recitation sessions. Video data was transcribed and analyzed using a rubric developed for this study. The rubric examined student use of fundamental physics principles, system and surroundings, interactions, idealizations and approximations, and mathematical representation and reasoning. The degree to which students' problem solving approaches align with the learning goals of the course will be discussed.

PST2L-09: 8:30–9:15 p.m. Getting Ready to Learn: The Power of Innovation*

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

Michael Gentile, Anna Karelina, Gregory Suran, Maria Ruibal-Villasenor, Rutgers University

Transfer studies have shown that when students struggle to invent a concept and then listen to a lecture or read a text, they are better prepared to learn related new ideas than when the innovation task is omitted. However, these studies were conducted in domains other than physics. Do these findings apply to physics? Could labs prepare students to learn? To answer these questions we invited three groups of students to participate in a "double transfer" experiment. The first group struggled to re-invent the physical quantity of thermal conductivity; the second conducted a cook-book lab to measure the conductivity of a plastic bottle, and the third conducted an unrelated mechanics lab. After that, all groups read the same text describing thermal and electrical conductivity and answered individually the same set of difficult conceptual and quantitative questions. We compared the performance of the three groups by analyzing and contrasting their responses.

*Sponsored by the NSF grant DRL 0241078.

PST2L-10: 9:15–10 p.m. Designing Experiment in Unfamiliar Content: Patterns in Student Metacognition

Anna Karelina, GSE, Rutgers University, New Brunswick, NJ 08901; anna.karelina@gmail.com

Maria Ruibal-Villasenor, Eugenia Etkina, Rutgers University

When students design their own experiments in instructional labs they plan their actions, monitor the progress, and evaluate results. If the content is unfamiliar to the students, they have to activate even more metacognitive resources to detect their lack of knowledge, acquire it, evaluate whether they know enough and whether they are able to apply that knowledge to solve the problem. We analyzed the videos of groups of students designing their own investigations when solving a problem in a new area of physics without any hints or help of instructors. We developed a reliable coding scheme to analyze students' metacognitive behavior and investigated the activities and the discussions of eight groups of students with different levels of expertise and different background. We found intriguing similarities between graduate students in biology and physics and high-achieving undergraduate science majors. We also found "triggers" of metacognition for low-achieving students.

*Suppported by NSF grant REC grant REC 0529065.

(M) General Topics of Interest in PER

PST2M-01: 8:30–9:15 p.m. The Surprising Effectiveness of College Scientific Literacy

Art Hobson, University of Arkansas, Fayetteville, AR 72701; ahobson@uark.edu

Science education research by Jon Miller, Director of the Michigan State University International Center for Scientific Literacy, shows that U.S. scientific literacy courses for nonscience college students pull the U.S. into second place in international rankings of adult scientific literacy, even despite the poor science scores of U.S. primary and secondary school students as compared with other nations. The far lower adult scientific literacy rankings of most European nations and other industrialized nations appear to be due to the lack of any such college scientific literacy requirement in those nations. Instituting such a requirement in all nations, and improving the quality and quantity of such courses on U.S. campuses, would increase global scientific literacy significantly, arguably doubling Europe's scientific literacy rate. In view of this result and the world's crying need for scientific literacy, physics educators should make physics for nonscientists their top priority.

PST2M-02: 9:15–10 p.m. Physics Education in an Interdisciplinary Science & Engineering Department

Zahra Hazari, Dept. of Engineering & Science Education and Dept. of Mathematical Sciences, Clemson University, Clemson, SC 29634; zahra@clemson.edu

Geoff Potvin, Clemson University

This poster will outline a unique new interdisciplinary department in STEM education, the Department of Engineering & Science Education at Clemson University. This Department, housed in the College of Engineering & Science, has gathered together education researchers from many STEM fields including physics, chemistry, computer science, and several engineering disciplines. This interdisciplinary environment presents unique opportunities for cross-fertilization of research. An overview of the research in physics education that is being conducted in this innovative department will also be presented.

PST2M-03: 8:30–9:15 p.m. Predictors of Student Exam Performance in Introductory Physics Courses

Joss Ives, University of the Fraser Valley, Abbotsford, BC V2S 7M8; joss.ives@ufv.ca

Can student behaviors, such as self-reported study habits and achievement/effort in various elements of the course, be used as predictors of exam performance in introductory physics courses? Are there different predictors for different types of questions, such as conceptual questions, quantitative "end-of-the-chapter" problems and "explain-your-reasoning" questions? The primary goals of this study are to identify at-risk students early in the term, and to quantitatively characterize the study behavior of high-achievement students so that these successful study behaviors can be shared with future students.

PST2M-04: 9:15–10 p.m. How Readable Is Your Textbook?

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

Casey A. Colombo

Have you ever wondered how readable the textbook you are using is for students? This poster will present a short study on the readability of a select set of college-level introductory algebra-based physics textbooks. The poster will also discuss the various methods for determining the readability of a passage of text and what typical readability levels are for various types of passages.

PST2M-05: 8:30–9:15 p.m. College Teaching and the Development of Reasoning, the Book Really![1,2]

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

Robert G. Fuller, University of Nebraska-Lincoln

Thomas C. Campbell, Illinois Central University

Scott M. Stevens, Carnegie Mellon University

Part of the foundation for the physics education research (PER) community of physics is the work of Robert Karplus and Arnold Arons in the 1970s. They expressed a strong concern about conceptual understanding and mature reasoning of students. Karplus led a team of AAPT members to produce a workshop, Physics Teaching and the Development of Reasoning, that was published by the AAPT in booklet form in 1975. That work was broadened to include other college disciplines and was offered on many campuses for faculty development activities for more than a decade. This book, with the AAPT workshop manual in Appendix B, brings together those broader materials along with new chapters to show how today's interest in interactive learning is based on this earlier work of Karplus and his interest in the work of Jean Piaget. The poster will provide additional information about the book and a publication flyer.

1. This book will be the first title in the new series, Science & Engineering Education Sources, Calvin S. Kalman, Editor-in-Chief, by Information Age Publishing, Inc. of Charlotte, NC. It is to be published in the summer of 2009. Go to http://www.infoagepub.com/.

2. In addition to the book editors named above, the book will be informed by advice from Arnold A. Strassenburg and Lesler G. Paldy, of SUNY, Stony Brook, who helped with the original AAPT version and from Dean Zollman, Kansas State University and Anton E. Lawson, Arizona State University.

(N) Scientific Reasoning, Expectations, and Gender Issues

PST2N-01: 8:30–9:15 p.m. Development of Standardized Instruments for Assessment of Scientific Reasoning

Tianfang Cai, Physics Dept., Beijing Jiaotong University, Beijing, 100044, PR China; tfcai1998@gmail.com

Jing Wang, Jing Han, Lei Bao, The Ohio State 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. Built on the Lawson's test, we started to develop new questions that involve a wide range of contexts and additional skill dimensions. We will 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.

PST2N-02: 9:15–10 p.m. Developing Scientific Reasoning as a Means of Addressing Student Retention*

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

Michael Edwards, Michele Wheatly, Wright State University

Jing Wang, The Ohio State University

Douglas Bradley-Hutchison, Sinclair Community College

Science-intent majors who lack competency-based scientific and mathematical skills typically have low retention rates. This poster describes how an innovative course was developed to target these students. The course involves explicit scientific reasoning training and math skill development activities integrated within multidisciplinary science contexts. Sample activities and other course elements such as the use of learning communities and supplemental instruction will be presented. Evaluation of the course indicates that student scientific reasoning ability, as measured by the Lawson Classroom Test of Scientific Reasoning, and mathematical skills improve while maintaining students' positive attitude and motivation towards science. Fall-to-Fall retention data shows the course has a positive impact. In addition, the need for department buy-in, using the course for general elective credit, and automatic enrollment of "not-yet-ready" students will be presented. The course, including pilots, has been offered six quarters to roughly 230 students.

*Supported in part by NSF Grant DUE 0622466

PST2N-03: 8:30–9:15 p.m. An Analysis of Scientific Reasoning Skills in Introductory Science Success

Kimberly A. Shaw, Columbus State University, Columbus, GA 31907; shaw_kimberly@colstate.edu

Zodiac Webster, Pinar Gurkas, Columbus State University

Identifying factors contributing to the poor performance of students in STEM courses is a necessary (but not sufficient) step in improving the learning of students in those courses. One hypothesis is that poor scientific reasoning skills will be a predictor of student performance. After conducting a pilot study focusing on Lawson's Classroom Test of Scientific Reasoning in math and physics classrooms, our findings reveal that student reasoning skills in science courses improved. In the present study, we have examined relationships between scientific reasoning and academic, demographic, and social variables. Students in introductory biology, chemistry, and geology courses participated as subjects over the 2008-2009 academic year. Preliminary results indicate that scientific reasoning level appears to correlate with SAT score, ethnicity, vocabulary, and reading comprehension, as well as post-test scores of attitude.

PST2N-04: 9:15–10 p.m. Developmental Convergence of Scientific Reasoning Skills

Jing Wang, The Ohio State University, Columbus, OH 43210; wang.870@osu.edu

Tianfang Cai, Beijing Jiaotong University, Beijing, China

Kathy Koenig, Wright State University, Dayton, OH

Jing Han, Lei Bao, The Ohio State University

In our current research, we have done statistical analysis of the developmental data on scientific reasoning ability. A convergence trend of several reasoning skill dimensions was found in both U.S. and Chinese data. To deepen our understanding of assessment of scientific reasoning, we designed new questions to expand the scope of current measurements. We have collected data from both U.S. and Chinese students. The poster will report the up-to-date results, and we will make an attempt to explain the meaning of analysis outcome and its implications to research in scientific reasoning.

PST2N-05: 8:30–9:15 p.m. Comparing Gender Differences in Introductory Physics Between U.S. and China

Xiumei Feng, Huazhong Normal University/The Ohio State University, Columbus, OH 43210; feng.91@osu.edu*

Ying Luo, Beijing Normal University

Tianfang Cai, Beijing Jiaotong Unvierstity

Kathy Koenig, Wright State University

Lei Bao, The Ohio State Unviersity

Existing research has shown gender differences in U.S. students' performances on physics concept tests such as FCI and BEMA. In this study we use these two tests to collect data from first-year college students in China. We employed FCI for pre-test and BEMA for pre-and post-test. The analysis results show that there is no significant gender differences in FCI and BEMA test scores from Chinese students. We will also present detailed analysis on selected items of the tests and discuss the implications.

*Sponsored by Lei Bao.

PST2N-06: 9:15–10 p.m. Gender Achievement Gaps in Introductory Physics at the Colorado School of Mines

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

Vince H. Kuo, Colorado School of Mines

In recent years, researchers have found differing results regarding gender-based achievement gaps in PER-based introductory physics courses. It has been hypothesized that courses emphasizing group work and interactive engagement will substantially reduce gender gaps. Some research groups have in fact seen those gaps eliminated, while others have not been able to reproduce this result. In this poster, we consider the gender gaps in the introductory courses at the Colorado School of Mines. These courses have been transformed to make use of a Studio Physics model. The CSM introductory sequence is comparable in some ways to other courses studied for gender gaps, but does exhibit differences in structure, curriculum, and population. Notably, as an engineering school, the entire student body takes the same calculus-based introductory physics courses. We report on the magnitude of the physics gender gaps at CSM, and speculate on the causes of the observed results.

PST2N-07: 8:30–9:15 p.m. Unpacking the Gender Gap in Introductory Physics

Lauren E. Kost, University of Colorado at Boulder, Boulder, CO 80309; Lauren.Kost@colorado.edu

Steven J. Pollock, Noah D. Finkelstein, University of Colorado at Boulder

Prior research has shown that: 1) male students outperform females on conceptual assessments (a gender gap) at our institution, 2) the gender gap persists despite the use of several research-based reforms, and 3) the gender gap is correlated with students' prior physics and mathematics background and prior attitudes and beliefs [Kost, et. al. PRST-PER, 5, 010101]. We next begin to explore how background differences give rise to the gender gap, and how males and females experience the introductory courses differently. To this end, we have administered a survey to students in the first- and second-semester introductory physics courses at the University of Colorado. This survey probed students' physics identity and sense of belonging, epistemology, and self-efficacy. We find that there are significant gender differences in each of these areas. We report correlations between student responses to these questions and their performance in the class and on conceptual surveys.

PST2N-08: 9:15–10 p.m. Exploring the Effects of Cultural Backgrounds on Student Attitudes on Learning

Jing Han, The Ohio State University, Columbus, Oh 43210; han.286@osu.edu

Tianfang Cai, Beijing Jiaotong University, Beijing

Kathy Koenig, Wright State University

Jing Wang, Lei Bao, The Ohio State University

Based on research, traditional physics courses in the United States often lead students to develop unfavorable views about physics and learning physics. In our research, we explore how Chinese students' views are affected by their college courses. We use multiple survey instruments such as MPEX to collect data with Chinese college students. We analyze data to study how Chinese students' views are changed. We will further discuss the effects of other factors on students' views such as gender differences.

PST2N-09: 8:30–9:15 p.m. Physics Education Research in Logic Thinking Capability of College Students

Yue Xiao, Department of Physics, Tongji University, Shanghai, PR China 200092; nunki.xiao@gmail.com

jingqing Gao, Zuyuan Wang, Kai Fang, Tongji University

The target group of this research mainly includes college students (around 1,000) with educational backgrounds in different majors. The test of logic thinking capability was used to quantitatively assess the scientific abilities of understanding and interpreting representations in physics study. Admittedly, the central concept is programmed to inspect the students' logic thinking capability. We have attained the preliminary results as follows: in China, the most influential factor is their elementary education; the gender and grades are not of the first magnitude. Recently we emphasized other aspects referring to the reasoning process and the branches of physics study, which aim to establish a more integrated view of logic thinking capability of Chinese college students. Our study is supported by PER in Logic thinking capability of Chinese college students under the project "Students Innovation Training Program."

PST2N-10: 9:15–10 p.m. Individual Differences in Temperament and Success in Science: Should We Care?

Pinar Gurkas, Columbus State University, Columbus, GA 31907; gurkas_pinar@colstate.edu

Kimberly A. Shaw, Zodiac Webster, Columbus State University

Understanding factors related to student performance in introductory science courses is necessary for helping a growing number of students who have difficulties with STEM courses to learn and succeed. Individual differences in self-regulatory skills[2] are consistent markers of overall academic success. There are also consistent links between poor academic achievement in college and excessive paid work responsibilities.[1] However, the exact nature of the relationship between these factors and performance in science has not been explored. In the present study, our aim was to examine the role of individual differences in temperament, job-school relationships, and students' perceptions of their classroom environments, as predictors of introductory science success. Participants were students in introductory biology, chemistry, and geology courses over the 2008-2009 academic year. Preliminary results indicated that in understanding the nature of student performance in science, individual differences in temperament correlate with traditional measures of success.

1. A.B. Butler, "Job characteristics and college performance and attitudes: A model of work-school conflict and facilitation," *Journal of Applied Psychology,* **92**, 500-510, (2007).

2. M.K. Rothbart, S.A. Ahadi, & D.E. Evans, "Temperament and personality: Origins and outcomes," *Journal of Personality and Social Psychology*, **78,** 122-135, (2000).

PST2N-11: 8:30–9:15 p.m. Students' Expectations and Interests About Using Contexts in Physics Classroom

Bijaya Aryal, Lake Superior State University, Sault Ste. Marie, MI 49783; baryal@lssu.edu

Integrating real-world contexts in physics topics can improve student learning of physics through student motivation. Introductory physics students can have their prior expectations about the use of contexts such as everyday life phenomena and devices in physics topics. Moreover, their interests about the use of everyday life contexts can be different from the contexts they expect. To investigate this, a survey was given to three different introductory physics classes. The students were asked to mention with reasons the everyday life devices or phenomena they would like to learn most and they would expect to learn most in a physics class. The results of the study show the difference between students' interests and expectations. The results also indicate the variations of both interests and expectations among the students of different physics classes. The study shows the variation of expectation and interest among students majoring in different areas and physics backgrounds.

PST2N-12: 9:15–10 p.m. Varying Quantum Interpretations and Implications in Modern Physics Instruction

Charles Baily, University of Colorado at Boulder, Boulder, CO 80309-0390; baily@colorado.edu

Noah D. Finkelstein, University of Colorado at Boulder

While expert physicists may agree on how to apply the mathematical formalism of quantum mechanics, instructors may hold different views regarding the physical interpretation of quantum processes when teaching an introductory course in modern physics. There has been relatively little research in the physics education community on how these instructional choices impact student thinking. We investigate two courses in modern physics recently taught at the University of Colorado where the instructors held markedly different views on how to teach students about quantum processes, and find significant differences in how students from each course responded to end-of-term surveys designed to probe their attitudes and beliefs about quantum mechanics. We also compare the instructional outlooks and methods of the two instructors in order to better understand what messages are sent to students during instruction, and their ultimate impact on student thinking.

Session EEE: Crackerbarrel – Professional Concerns of PER Solo Faculty

Location: CC Little 1512
Sponsors: Committee on Research in Physics Education, Committee on Professional Concerns
Date: Tuesday, July 28
Time: 11:30 a.m.–1 p.m.

Presider: Paula Engelhardt

This crackerbarrel deals with the professional concerns of physics education researchers who are either the only one or one of a small number of researchers at their home institution conducting education research. Physics faculty who are actively conducting research in physics education are encouraged to come discuss issues related to the advantages and disadvantages associated with conducting research at small to mid-size institutions. This session will also discuss the available options for developing communication avenues and collaborations through the use of PER Central.

Session EEF: Crackerbarrel – International Issues in the AAPT

Location: CC Little 1505
Sponsor: Committee on International Physics Education
Date: Tuesday, July 28
Time: 11:30 a.m.–1 p.m.

Presider: Genaro Zavala

International issues in the AAPT is a crackerbarrel session to discuss topics of interest that may include discussions on how the AAPT can help to open sections in other countries and how the AAPT can help sections outside the U.S. to get support from local governments; and comments of experiences on forming sections outside the US and of experiences of collaborations among education organizations around the world.

Session EEG: Crackerbarrel – Professional Concerns of Graduate Students

Location: CC Little 1518
Sponsors: Committee on Research in Physics Education, Committee on Professional Concerns
Date: Tuesday, July 28
Time: 11:30 a.m.–1 p.m.

Presider: Shawn Weatherford

Meet graduate students from other universities engaged in physics education research. This crackerbarrel provides an informal opportunity for students to discuss concerns and share advice. We will go out to lunch as a group following the meeting.

Session EA: New Faculty Workshop for Two-Year College Faculty

Location: CC Little 1528
Sponsor: Committee on Physics in Two-Year Colleges
Date: Tuesday, July 28
Time: 1–2:30 p.m.

Presider: Dwain Desbien

This is a session describing the TYC New faculty conference from the organizers and the participants.

EA01: 1–1:30 p.m. A Professional Development Experience for New TYC Instructors

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

Tom O'Kuma, Lee College

Dwain Desbien, Estrella Mountain Community College

Todd Leif, Cloud County Community College

Sherry Savrda, Seminole Community College

From January 2008 through July 2009, 30 new physics instructors at two-year college institutions participated in a training experience to equip them to transform the way they teach to a dynamic student-centered pedagogical approach. The experience consisted of an online component where groups discussed seminal papers in Physics Education Research, an intensive three-day conference where participants learned proven techniques, an implementation stage for participants to utilize what they learned at their home institutions, and finally a follow-up conference as a tandem meeting to the 2009 summer AAPT meeting. This talk will highlight the various aspects of the experience and will be followed by participants sharing how the experience has impacted their careers. The conference was supported by the National Science Foundation through the ATE Project for Physics Faculty, The American Association of Physics Teachers, Lee College, Estrella Mountain Community College and Delta College.

EA02: 1:30–1:40 p.m. Improving Physics Teaching with New Faculty Training Conference (NFTC) Techniques

Dominic Sarsah, Illinois Valley Community College, Oglesby, IL 61348; dominic_sarsah@ivcc.edu

Many of our calculus- and noncalculus-based physics students are not going to major in physics. These students come into our classroom with the general notion the public shares that physics is tedious, incomprehensible, and sometimes irrelevant. Teaching physics from the traditional approach seems to magnify this perception. I would present how some of these techniques learned from NTFC has helped me to teach physics so that students leave my classroom convinced of the fact that physics is interesting, fun, enjoyable and very relevant in our modern world.

EA03: 1:40–1:50 p.m. New Faculty Workshops (ATE Program): Teaching the Technical Student

Sheri L. Christensen, Southeast Community College, Milford, NE 68405; schriste@southeast.edu*

Scott Schultz, Delta Community College

Todd Leif, Cloud Community College

I teach conceptual physics at a community college that among many other tasks prepares automotive service personnel for technical careers. Students will be responsible for learning advanced diagnostics and troubleshooting procedures in addition to hands-on repair procedures. I provide a case study of my experience as a new instructor developing her class. Walk with me as I share my evaluation of the tools that New Faculty Workshops for Two Year Community colleges has provided, refine my approach, and incorporate new methodology and technology into my classroom. I share my thought process as I evaluate student discourse, ICP21, using MBLs and simulations. I share anecdotal evidence of my students' perceptions and my reflections as I further strive to develop a conceptual physics course that is relevant,

*Sponsored by Todd Leif

EA04: 1:50–2 p.m. Teaching Strategies from the NFW for TYC Faculty

Danny Mattern, Butler Community College, El Dorado, KS 67042; dmattern@butlercc.edu

The new faculty workshop for two-year college faculty provided a wide range of useful teaching strategies to implement into lecture- and lab-based courses. One of my favorites has been the use of MBLs in the laboratory. These provide hands-on approaches to learning the principles of physics in a technology-friendly and fun way. I have changed a lot of the traditional physics laboratory activities and used the idea of MBLs in the laboratoy setting for students to discover the same principles but using computers and modern technology to help stimulate their understanding of the concepts. The students seem to enjoy working in this type of environment compared to the traditional approaches. There are many other activities that I use in my courses that I picked up at the NFW—ranking tasks, E and M tipers, group discussions, video-digital analysis and alternate assessments just to name a few.

EA05: 2–2:10 p.m. Using Micro-Based Computer Labs and Project-Based Physics in the Instruction of Physics Courses at Neosho County Community

Luka Kapkiai, Neosho County Community College, Chanute, KS 66720; lkapkiai@neosho.edu

In previous years, the use of traditional labs in physics courses has been the mode of instruction for all our lab courses. Although these labs serve the purpose, they do not intrigue students' interests as much as the use of computers or technology, which students see as relevant or connected to their real world experiences. So after attending the New Faculty Training Conference for two year colleges (NFTC) and an additional physics workshop project conference and having learned of the new teaching techniques and tools, we have been able to integrate the use of micro-based computer (MBL) labs and project based activities in our physics courses here at Neosho County Community College. This has helped develop some interest and appreciation to the use of technology among students taking sciences and especially in physics.

Session EB: Presenting Cutting-Edge Research for Outreach and Teaching

Location: Chemistry 1200
Sponsors: Committee on Physics in Undergraduate Education, Committee on Science Education for the Public
Date: Tuesday, July 28
Time: 1–2:30 p.m.

Presider: Ernest Behringer

EB01: 1–1:30 p.m. Teaching Biophysics as a Discipline in its Own Right

Invited – Jens-Christian Meiners, LSA Biophysics, University of Michigan, Ann Arbor, MI 48109-1040; meiners@umich.edu*

Over the last decade, research in biophysics has changed dramatically. In the past, biophysics was often interdisciplinary in the sense that physical techniques were used to solve problems in biochemistry or structural biology. Graduate and, in particular, undergraduate courses in biophysics were, therefore, taught using separate instruction in physics, chemistry, and biology, plus examples of how each discipline can be applied to the others. Modern biophysics research, however, takes an increasingly holistic approach in an attempt to understand biological function through tightly interwoven physical,chemical, and biological principles. I will discuss how these changes in biophysics research have driven the development of a new, integrated undergraduate biophysics curriculum at the University of Michigan, which features lower-level gateway courses, a suite of dedicated upper-level biophysics courses, an advanced laboratory, and opportunities for research experience.

*Sponsored by Ernest Behringer.

EB02: 1:30–2 p.m. School-Based Supernova Search

Invited – David Cinabro, Wayne State University, Detroit, MI 48201; cinabro@physics.wayne.edu

We live in the Golden Age of Cosmology. One of modern cosmology's three pillars is the observation of distant Type Ia supernova. This can actually be pursued with modest collaborative effort at schools. Modern GoTo telescopes are fast and easy to set up and can view thousands of galaxies that are potential supernova hosts. The cost for such telescopes and associated CCD cameras is surprisingly modest. With central coordination and sharing of data on the web, a few collaborating schools can implement a supernova search and participate in modern cosmology. I describe such a program being developed at Wayne State University with schools in the Detroit area. The program also includes school-year enrichment presentations aligned with the Michigan High School Physics Content Expectations and a summer training workshop for participating teachers.

EB03: 2–2:30 p.m. Teaching and Outreach Derived from University-Based Research on Novel Energy Conversion Technology and Organic Semiconductor Devices

Invited – Max Shtein, University of Michigan, Ann Arbor, MI 48109; mshtein@umich.edu*

The challenge of developing commercially viable technologies for renewable energy utilization is of global importance and therefore constitutes a very compelling topic and context for engaging the general public and K-12 students in scientific education and research. In this talk I will describe my recent outreach efforts in this area. These efforts include teaching highly interdisciplinary courses with nonscientist instructors, outreach via community venues (e.g. local museum), public speaking at humanities events, and research collaborations with nonscientists. I will also describe research projects in which we develop technology that should lower the barriers for doing research in the area of semiconductor devices for energy conversion and other applications.

*Sponsored by Ernest Behringer.

Session EC: The Art and Science of Physics Teaching

Location: Chemistry 1210
Sponsors: Committee on Physics in Undergraduate Education, Committee on Research in Physics Education
Date: Tuesday, July 28
Time: 1–2:30 p.m.

Presider: Ray A. Burnstein

At the end of the three talks in this invited session, a half hour audience question-and-answer period is planned.

EC01: 1–1:30 p.m. Improving the Art & Science of Instruction Through Physics Education Research

Invited – Peter S. Shaffer, University of Washington, Seattle, WA 98195-1560; shaffer@phys.washington.edu

Results from research on the learning and teaching of physics have prompted significant changes in how the subject is currently taught. The impact extends from elementary grades through graduate courses in physics. The way in which the findings are used to guide the development of instruction combines elements of both art and science. Continued improvement, however, requires systematic long-term investigations that examine the impact of research-based curricula on student thinking. The process by which research guides the design of instructional materials by the Physics Education Group at the University of Washington will be illustrated with examples that span introductory and more advanced physics topics.

EC02: 1:30–2 p.m. Interactions Between the Art & Science of Physics Learning, Teaching

Invited – Dean Zollman, Kansas State University, Manhattan, KS 66506-2601; dzollman@phys.ksu.edu

"Instruction begins when you, the teacher, learn from the learner, put yourself in his place so that you may understand what he understands and in the way he understands it," [1] Long before physics education research began studying how students learn physics, Soren Kierkegaard (1813-1855) expressed many of the goals of physics education research. Teaching is the art of realizing our students are not us and understanding how they learn topics that came easy to us. Some "natural" teachers seem to do this automatically and we can learn from how they do it. At the same time, research on the teaching-learning process can go a long way toward helping all of us understand how the student understands physics. This interplay between the art (what some teachers do naturally) and the science (physics education research) is the foundation for the continual improvement of physics education.

1. Soeren Kierkegaard, *The Point of View for My Work as an Author*, 1848 English translation, Princeton University Press, 1998, available on Google Books.

EC03: 2–2:30 p.m. Why Students Fail to Transfer and What to About It

Invited – Daniel L. Schwartz, Stanford University, Stanford, CA 94305; daniel.schwartz@stanford.edu

Doris B. Chin, Cathy C. Chase, Marily Oppezzo, Stanford University

Educators count on students to transfer learning from class to class, year to year, from home to school, and school to work. An empirical study with students learning physics indicates that, compared to a control condition, direct instruction inadvertently undermines transfer, because it focuses students on taught procedures rather than deep problem structures, leaving the students with memory for formulas and obvious surface features. Direct instruction, and not problem surface features, causes the failed transfer. The poor transfer of direct instruction matters because transfer helps students to learn in the future and to adapt to novel situations. Yet, a literature survey indicates that 75% of all transfer studies in the past five years used direct instruction for both treatment and control conditions. Concrete suggestions for how to improve instruction and assessment, as well as improve the value of direct instruction, are included.

Session ED: Teachers in Residence (TIR): Adding Reality to Physics Teacher Preparation Programs

Location: Chemistry 1300
Sponsors: Committee on Teacher Preparation, Committee on Physics in High Schools
Date: Tuesday, July 28
Time: 1–2:30 p.m.

Presider: Paul Hickman

Invited and contributed session will focus on the roles, responsibilities and contributions of Teachers in Residence (TIR).

ED01: 1–1:30 p.m. Once an Arkansas TIR, Always an Arkansas TIR

Invited – Marc Reif, Fayetteville High School, Fayetteville, AR 72701; marc.pricereif@gmail.com

My high school is less than a mile from the University of Arkansas Physics building. Serving as Teacher-in-Residence in 2002-2003 was a natural extension of a relationship begun years before. As a TIR I have mentored new physics teachers, given prospective teachers a chance to "try out" teaching informally in my classroom, and served as a resource for prospective elementary, middle, and high school teachers, as well as TAs and professors. The relationship has proven surprisingly durable; we continue to collaborate. The benefits flow both ways. My school district has been able to hire teachers trained by the physics department. I was able to influence the professional development offered to teachers by the university, and to identify promising students, a number of whom have gone on to major in physics at the university.

ED02: 1:30–1:40 p.m. From TIR to the Classroom: A Journey There and Back Again

Drew Isola, Allegan High School, Allegan, MI 49010; disola@alleganps.org

I had the privilege to serve as a Teacher-in-Residence for Western Michigan University for two years, from 2005-2007, as part of the PhysTEC Project. I've been back in the classroom now for two years since that experience. I will share some of my experiences and observations drawn from stepping out of the world of a high school physics classroom into the realm of teacher preparation on a national level and then stepping back again into the classroom. The PhysTEC project is led by the American Physical Society, in partnership with the American Association of Physics Teachers and the American Institute of Physics (www.phystec.org).

ED03: 1:40–1:50 p.m. The Challenge of Teaching How to Approach Teaching Physics

Elizabeth D. Woolard, TIR, University of North Carolina, Chapel Hill, Raleich, NC 27610; lwoolard@unc.edu

In my forty-two years of teaching physics, I have been most fortunate to find such pleasure in teaching physics to high school students. In my new experience as TIR at UNC-CH, I have been just as fortunate to discover the rewards of teaching college students interested in a career as a high school physics teacher. To my amazement, I have discovered many similarities between the two groups. I also have found many differences. Using those similarities and differences to build a ladder for learning about teaching physics (in my role as Teacher in Residence) has been the challenge. Examining teacher practices in a reflective manner establishes a productive pattern for all teachers. I attempted to do that in my role as TIR for my students and for myself. I shall describe how my year as TIR evolved around the previous concepts and what I used as tools in those processes.

ED04: 1:50–2 p.m. TiR and SPIN-UP

Steven Iona, Univ of CO/ Univ of Denver, Denver, CO 80208; siona@du.edu

The Teacher in Residence (TiR) can influence future teachers; the TiR can influence students who might consider becoming future teachers; but can the TiR influence a physics department to be more interested in preparing future teachers? The SPIN-UP report describes characteristics of physics departments that increased the number of physics majors. Are the characteristics different for increasing physics students interested in becoming teachers? Can a TiR make a difference in a department? I will identify some parallels between the SPIN-UP recommendations and my experiences with characteristics that are helpful to supporting future physics teachers.

ED05: 2–2:10 p.m. PhysTEC at the University of Minnesota Turns Two

Jon P. Anderson, University of Minnesota, Minneapolis, MN 55455; anderson@physics.umn.edu

PhysTEC at the University of Minnesota has recently completed its second year. The strategies for success and the problems of implementation are unique to each site and ours is no exception. We have learned valuable lessons in the first two years that will make our program more effective in the third year. However, the program's future beyond the third year remains uncertain and is dependent upon receiving the funding necessary to sustain it. This talk will detail some of what we have learned, outline the role of the Teacher in Residence, discuss plans for the future of the program, and address the rationale for keeping it funded.

ED06: 2:10–2:20 p.m. TIR Project: A Continuum at FIU

Jorge C, Gibert, Florida International University, Miami, FL 33174; jorge.gibert@fiu.edu

From the recruitment of future teachers to the improvement of traditional courses, the role of the Teacher-in-Residence at Florida International University would not be possible if not for the help and support of many and others inside and outside of FIU. During this year our group has increased the number of Learning Assistants, doubled the number of reform physics courses, and significantly increased the amount of assessments. The TIR project is a part of an inseparable group of dedicated individuals and institutions that contribute to its continuous progress and success. That is the reason why building bridges is an essential part of any Teacher-in-Residence. An overview of project activities as effective practices will be presented.

Session EE: Wii Remote for Physics Learning

Location: Chemistry 1400
Sponsor: Committee on Educational Technologies
Date: Tuesday, July 28
Time: 1–2:30 p.m.

Presider: Taha Mzoughi

The Wii gaming platform has been used by many of us to help increase interest in physics and to help teach some topics. We encourage those who have used Wiis or similar technologies to share with us their experiences and findings.

EE01: 1–1:30 p.m. Wiimote Whiteboard

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

William F. Junkin, Eckerd College

Would you like to have an interactive whiteboard in your classroom (but don't want to pay the high price)? If you have a computer and data-projector in your classroom, then all you need is a Wii Remote (Wiimote) and some Infrared LED pens. This talk will demonstrate the Wiimote Whiteboard and the ways it can be used to enliven your classroom and make it more interactive.

EE02: 1:30–2 p.m. Yes, Wii Can Do Physics with Vpython

Invited – Roberto B. Salgado, Mount Holyoke College, South Hadley, MA 01075; rsalgado@mtholyoke.edu

Taviare L. Hawkins, Mount Holyoke College

We describe our efforts to do real-time data acquisition from a set of Wii Remotes using VPython (the Python programming language together with the Visual 3-D visualization library). Each Wii Remote has an infrared (IR)-sensitive camera and a three-axis accelerometer. Using data from the cameras and IR-LEDs mounted onto a pair of safety glasses, we demonstrate our version of Johnny Chung Lee's head-tracking idea for virtual-reality displays. Using data from the accelerometers, we show examples of free fall, oscillatory motions, and collisions. Finally, we describe ongoing student projects for 3-D tracking of projectiles and of simple objects to act as input-devices for a virtual reality scene (e.g., a wave source for a virtual ripple tank).

http://physics.syr.edu/~salgado/software/vpython/#realtimedata has details of our first attempts using the Wii Remote with VPython.

EE03: 2–2:10 p.m. Wii Remote-Based, Inexpensive "Digital" Whiteboards for Capturing Student Work

Edward Price, California State University San Marcos, San Marcos, CA 92096; eprice@csusm.edu

Dustion Dorrah, California State University San Marcos

Many instructors use whiteboards as a space for collaborative group work. The responses generated on the whiteboards can later be used for whole class discussions or other activities. Whiteboards have two drawbacks, however—students' work is lost when the whiteboard is erased, and the whiteboard can be difficult to see in a whole class discussion. These problems can be overcome with a "digital" whiteboard, which we implement by using a Wii Remote to control a computer's cursor based on the position of a modified dry-erase marker. This provides an inexpensive way to digitally capture students' work, which can then be archived or projected in class. This talk will describe our Wii Remote-based whiteboard system and its use in the classroom.

Session EF: Forgotten Women in Science

Location: Chemistry 1640
Sponsors: Committee on Women in Physics, Committee on History & Philosophy of Physics
Date: Tuesday, July 28
Time: 1–2:30 p.m.

Presider: Mary Kay Patton

EF01: 1–1:30 p.m. Henrietta Swan Leavitt: Measuring the Universe

Invited – Tetyana Antimirova, Ryerson University, 350 Victoria St., Toronto, ON M5B 2K3; antimiro@ryerson.ca*

Henrietta Leavitt (July 4, 1868-Dec. 12, 1921) was an American astronomer whose groundbreaking discovery known as the Period-Luminosity Relationship provided a unique tool for measuring distances between stellar objects in the Universe that became the foundation for the pioneering work of Edwin Hubble. Miss Leavitt graduated from Radcliffe College and became one of the women "human computers" hired to measure the brightness of stars in images of Harvard Observatory photographic plate collection. Based on her study of thousands of variable stars, she discovered the relationship between the brightness of the variable stars and their periods. Despite the magnitude of her contribution, she was under-recognized during her time, and even today relatively little is known about her. As we celebrate the International Year of Astronomy, it is a perfect time to acknowledge her extraordinary contribution during the era when career opportunities for women were very limited.

*Supported by FEAS, Ryerson University

EF02: 1:30–2 p.m. Helen Sawyer Hogg: A Woman, an Astronomer, and a Great Communicator of Science

Invited – Marina Milner-Bolotin, Ryerson University, Toronto, ON M5B 2K3; mmilner@ryerson.ca

Helen Sawyer Hogg was born 104 years ago in Lowell, MA. She earned her doctorate in Astronomy from Radcliffe College in 1931 working under the supervision of H. Shapley. In 1931 Helen and her husband Frank (a Canadian) moved to Victoria, BC, where he got a job at the Dominion Observatory and Helen became a volunteering assistant. Her pay allowed them to hire a nanny while she worked at the observatory. In 1935 the couple was offered two paid jobs at the David Dunlap Observatory at the University of Toronto, becoming one of the first Canadian official academic dual career families. H. Sawyer Hogg published a large number of influential papers and became a true leader in the field of astronomy. Additionally she was a very successful science communicator. Helen Sawyer Hogg was awarded a number of prestigious awards, becoming an Officer of the Order of Canada in 1986.

EF03: 2–2:10 p.m. From X-Rays to Nuclear Proliferation: The Life of Katherine Chamberlain

Matthew A. Geramita, National Institute of Mental Health, National Institutes of Health, Bethesda, MD 20852; mgeram@gmail.com

Timothy McKay, University of Michigan

In 1924, Katherine Chamberlain became the first woman to receive a doctorate in physics from the University of Michigan. As one of the first women in the world to earn a doctorate in physics, Katherine reached a level of prominence in the scientific community that few women had achieved. As a scientist, Katherine studied the outer energy levels of various elements using x-ray spectroscopy at the University of Michigan. In her thesis, she showed the potential for x-rays to reduce highly oxidized compounds and in 1925 won the Ellen Richards Prize for the world's best scientific paper by a woman. As an educator, she taught an introduction to photography course for 35 years in the hopes of creating new ways to inspire a love for physics in her students. As a community leader, she worked with The United World Federalists and The Michigan Memorial Phoenix Project to find peaceful uses for nuclear energy. Looking at these aspects of Chamberlain's life offers a unique perspective on the physics community of the 1920s, physics education, and the nuclear panic that followed WWII.

Session EG: Biography in Physics

Location: Dana 1040
Sponsor: Committee on History & Philosophy of Physics
Date: Tuesday, July 28
Time: 1–2:30 p.m.

Presider: Cheryl Schaefer

EG01: 1–1:30 p.m. Eureka Man: The Life and Legacy of Archimedes

Invited – Alan Hirshfeld, UMass Dartmouth/Physics Dept., N. Dartmouth, MA 02747-2300; ahirshfeld@umassd.edu

Archimedes, antiquity's foremost mathematician/physicist/engineer, investigated an amazing variety of technical subjects, from square roots to the stability of ships, number systems to machines of war, the value of pi to the size of the universe. Archimedes' critical studies of buoyancy and levers form the foundations of these areas of physics. His treatises, rediscovered after a thousand years, helped guide nascent thinkers out of the Dark Ages and into the Renaissance. This talk, based on the forthcoming book *Eureka Man: The Life and Legacy of Archimedes*, presents an overview of Archimedes' achievements in mathematics, astronomy, and invention—a body of work that stations Archimedes alongside Newton and Einstein in his impact on scientific thought.

EG02: 1:30–2 p.m. The Physicists and their Apparatus

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

Many pieces of apparatus that we use in lecture and lab have names of physicists and physics teachers associated with them, many of them familiar: Archimedes, Wheatstone, Coulomb, Millikan, Rumford. But there are many that will be unfamiliar: Pickering, Gage, Hare, Packard, Lloyd. In this talk I will describe a number of pieces of apparatus, some well known, and some that ought to be revived, and their inventors.

Session EH: Enabling Us All: The Broad Physics Legacy of H. Richard Crane

Location: Dennison 170
Sponsor: Committee on the Interests of Senior Physicists
Date: Tuesday, July 28
Time: 1–2:30 p.m.

Presider: John Rigden

Invited talks will celebrate the impact of Dick Crane on physics and physics teaching.

EH01: 1–1:30 p.m. Dick Crane's California Years

Invited – Charles H. Holbrow, Colgate University/ MIT (visiting), Cambridge, MA 02319-4510; cholbrow@mail.colgate.edu

Crane (1907-2007) had a fortunate, uncomplicated childhood. Born and raised in Turlock, a farming community in California's Central Valley, his early interest in science appeared in familiar ways that I will describe. He did his undergraduate work at Caltech, made a short visit to Europe, and from 1930 to 1934 earned his Ph.D. in physics from Caltech. Crane helped his thesis supervisor, Charles C. Lauritsen, begin accelerator based nuclear physics in America. They achieved the first accelerator produced neutrons, the first accelerator produced artificial radioactivity, and the first evidence for resonant absorption. I will discuss some of their techniques and results. In 1935 Crane made the reverse of the great American migration—he left California for the Middle West and, in the midst of the Great Depression, took up a tenure-track position with start-up funds at the University of Michigan where he spent the rest of his career.

EH02: 1:30–2 p.m. H.R. Crane – An Icon of Michigan Physics

Invited – Jens C. Zorn, University of Michigan, Randall Laboratory of Physics, Ann Arbor, MI 48109-1040; jenszorn@umich.edu

Dick Crane came to Michigan in 1935 and began a program of experiments that produced many results in nuclear physics including the first (1938) quantitative evidence for the existence of the neutrino. After WWII, Crane worked simultaneously in several areas: He established a premier lab for radiocarbon dating. He did biophysics that included theoretical studies of the unwinding of DNA. He developed a novel form of synchrotron, a research effort that also led to his invention of the g-2 method for measuring the anomalous magnetic moment of electrons and positrons, results recognized with the Davisson-Germer Prize and election to the National Academy of Sciences. He subsequently served as chair of Michigan Physics, as president of the AAPT, and as chair of the Board of Governors of the AIP. Crane retired in 1977 but remained active in science and science education for the remaining 30 years of his life.

EH03: 2–2:30 p.m. H. Richard Crane – Enabling Teacher Par Excellent of "How Things Work"

Invited – Richard W. Peterson, Bethel University, St. Paul, MN 55112; petric@bethel.edu

Dick Crane's life always showed a passion for sharing physics with students at all levels, yet his deep identity with the physics teaching community began in the late-50s post-Sputnik era. In the decade that followed, he helped lead the Commission on College Physics, served as AAPT President ('65), and intensified efforts to revitalize the teaching of introductory physics—especially for "captive" pre-professionals fatefully called to endure the noncalculus physics sequence. His Oersted Medal response ('77) intimated his wish that students experience and learn physics in a manner providing lasting value and by building on experimental experiences in the "real world"—provoking their own questions and preparing for abstractions to follow. This emphasis on real-world systems also motivated his long-term "How Things Work" column in *The Physics Teacher* that clearly sought to help each of us convey our own curiosity about the beautiful physics that daily surrounds us.

Session EI: Highlights of the International Year of Astronomy

Location: Dennison 182
Sponsor: Committee on Space Science and Astronomy
Date: Tuesday, July 28
Time: 1–2:30 p.m.

Presider: Janelle M. Bailey

This session will continue our discussion of activities associated with the 2009 International Year of Astronomy, on both the national and local scenes.

EI01: 1–1:30 p.m. IYA Celebrations in Michigan

Invited – Michael C. LoPresto, Henry Ford Community College, Dearborn, MI 48128; lopresto@hfcc.edu

A non-exhaustive review of events celebrating the International Year or Astronomy being sponsored by Michigan colleges, universities, planetariums, observatories, astronomy clubs, and other facilities and groups, both public and private. Among other events, highlights include events at the speaker's college, Henry Ford Community College, and their "Partner in Astronomy," University of Michigan-Dearborn and in Saline, MI, the speaker's town of residence, as well as at our host town and institution Ann Arbor and the University of Michigan.

EI02: 1:30–2 p.m. IYA at the Adler Planetarium

Invited – Lindsay M. Bartolone, Adler Planetarium, Chicago, IL 60605; lbartolone@adlerplanetarium.org*

Michelle Nichols, Adler Planetarium

The Adler is celebrating IYA by opening two new space shows: IBEX: Search for the Edge of the Solar System and 3-D Universe: A Symphony. We'll also open a special exhibition, which will honor the 400th anniversary of Galileo's first observations called Telescopes: Through the Looking Glass. In addition to the shows and exhibition, we also offer special events and programming that focuses on space and the impact that space exploration has had on our society and how it has influenced our culture. Through these shows, exhibitions, events and programs, we're hoping to get people to look up at the sky and help them to discover more about the Universe around them. In this session, learn how to view these programs in your area or take advantage of the related resources.

*Sponsored by Janelle Bailey

EI03: 2–2:10 p.m. The Michigan Galileo Manuscript

Peggy Daub, University of Michigan, Ann Arbor, MI 48109-1205; pdaub@umich.edu

The talk will focus on the Michigan Galileo Manuscript, which is 400 years old in 2009. This manuscript is of immeasurable importance to our current understanding of the solar system. On this piece of paper Galileo, who had just begun to experiment with building telescopes in summer 1609, penned his first ideas for how to explain to the Doge of Venice the usefulness of a telescope. A few months later, in January 1610, Galileo used empty space at the bottom of the page as scratch paper to reason through his recent observations and conclude that he had found four objects that were orbiting Jupiter (now known as the four Galilean moons). The manuscript has been in the Library at the University of Michigan since the 1930s. The talk will also describe Galileo's pamphlet Sidereus Nuncius [The Starry Messenger], which appeared just two months after he wrote this manuscript, and Kepler's answer to it.

EI04: 2:10–2:20 p.m. Celebrating Galileo at The Franklin

Mary Ann Hickman Klassen, Swarthmore College, Swarthmore, PA 19081; mklasse1@swarthmore.edu

The Franklin science museum in Philadelphia currently hosts the exhibit "Galileo, the Medici and the Age of Astronomy," which is on loan from the Institute and Museum of the History of Science in Florence, Italy. This is the first time one of Galileo's two surviving telescopes has left Italy. Local organizers of the exhibit anticipated the need to help museum visitors understand the scientific and historical context of what they see. Part of the solution was to train museum staff and volunteers to interact with visitors within the exhibit. Another was to design interactive demonstrations on telescopes and astrolabes which take place outside the special exhibit. I will relate some of my experiences as a museum volunteer celebrating the IYA with the public in the midst of Galileo's own tools of discovery.

Ceremonial Session: AAPT and AIP Awards

Location: Mendelssohn Theater
Date: Tuesday, July 28
Time: 2:30–4:15 p.m.

Presider: Lila Adair

AAPT's Excellence in Pre-College Physics Teaching Award


Deborah Roudebush

What Your Mother Never Told You About...Physics Teaching

Deborah Roudebush, Oakton High School, Herndon, VA

Take a walk through the growth and development of physics education as told through the eyes of a naive practitioner. Share the adventures of one person's struggle to make physics accessible to everyone. The trepidation, the toils, the turmoil, and the triumphs of implementing meaningful pre-college physics education will be discussed.

AAPT's Excellence in Undergraduate Physics Teaching Award


Mario Belloni

Using Technology to Increase Student Engagement Inside and Outside of the Classroom

Mario Belloni, Davidson College, Davidson, NC

In recent years, physics education research has documented that students who are in active learning environments learn more than students in more passive learning environments. With the creation of numerous PER-based and inspired interactive pedagogies and with digital libraries such as comPADRE providing high-quality material to teachers, the inclusion of these new pedagogies and resources is easier than it has ever been. Even with all these materials, it is still the personal touch and expertise of a teacher that is required to meld these materials and methods together. We will describe how we at Davidson College have used a variety of pedagogies, such as Just-in-Time Teaching (JiTT) in combination with simulations, such as Easy Java Simulations, Physlets, and Open Source Physics, to generate in-classroom and out-of-classroom environments that emphasize personal teacher-student interactions.

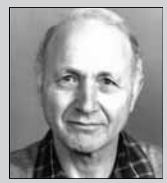
AAPT's Distinguished Service CItations


Alan M. Gibson
Rochester Hills, MI


David Maiullo
Rutgers Univ.
Piscataway, NJ


Bruce Mason
Univ. of Oklahoma
Norman, OK

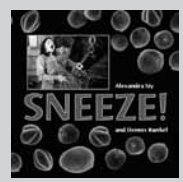

Mary Winn
Tampa, FL


Mel Steinberg
(award given posthumously)

AIP's Science Writing Award in the Children's Category


Alexandra Siy


Dennis Kunkel



The winners of AIP's Science Writing award in the Children's Category are Dennis Kunkel and Alexandra Siy. Their book is called *SNEEZE*! (Charlesbridge, 2007). Siy is a photographer and children's book author in upstate New York and Kunkel is a scientist in Hawaii who specializes in imaging the invisible microscopic world. Combining Siy's photographs and prose with Kunkel's electron micrographs of pollen, mold, dander, mites, and other invisible irritants, *SNEEZE*! is about nine kids discovering nine different reasons for sneezing.

Session FA: Panel – Research Based Studies on Writing to Learn: From the Fine Grained to the Large Scales

Location: CC Little 1528
Sponsors: Committee on Research in Physics Education, Committee on Educational Technologies
Date: Tuesday, July 28
Time: 4:15–6 p.m.

Presider: Dedra Demaree

This session focuses on research-based studies that aim to understand the deeper connection between writing and learning within physics. Presentations will range from fine scale discussions on linguistic issues to the large scale such as successful lab report writing.

FA01: 4:15–6 p.m. Language and Communication in Physics

Panel – David T. Brookes, University of Illinois at Urbana-Champaign, Urbana, IL 61801; dbrookes@illinois.edu

Physicists communicate with each other and with their students using many different representations. One of these is spoken and written language. In this talk I will give a brief overview of the functions of language in physics. In particular, language performs two major roles. 1) Language serves as a means of modeling the world and communicating physical models. 2) Language functions to encode and communicate discourse-level messages. Both of these functions of language are critical to the success of the physics field. However, many of the subtle details of how physicists communicate remain tacit, and only implicitly understood. Examining the role of language at both the semantic and discourse levels can help us understand some of the hidden obstacles our students face as they learn physics. I will highlight some linguistic difficulties our students may be experiencing in the physics classroom.

FA02: 4:15–6 p.m. Writing Qualitative Strategies to Highlight the Role of Concepts in Problem Solving

Panel – Jose Mestre, University of Illinois, Loomis Lab, Urbana, IL 61801-3080; mestre@illinois.edu

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. I will describe an approach that encourages students to begin by writing a strategic analysis of a problem solution 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. Additional reflective writing exercises in which students compare/contrast strategic analyses and documented solutions to identify similarities and differences will be described. Preliminary data on the effect of these interventions will be presented.

FA03: 4:15–6 p.m. Key-logging as a Window into Student Writing

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

Lisa Hermsen, Rochester Institute of Technology

Reflective, rather than responsive, writing is an inherently scaffolding activity. While grappling with an essay (or any piece of writing), one implicitly defines what is meant by coherent in that context, and the writer's understanding of the topic can become framed by the choices he or she makes. This process can therefore lead to true learning of a topic, its limits of applicability, context, and consequences. I will present one such writing session, where a student wrote and subsequently revised an essay on density. Key-capturing software was used to log the entire writing process, including revisions. Analysis of the process reveals where the student paused to think, the order in which he revised his words, and much about his evolving conception of density. We believe this episode contains striking evidence that the student is reorganizing his understanding of density, and has learned a significant amount through the 30 minute episode. This points to the tremendous potential that reflective writing assignments have for improving student understanding.

FA04: 4:15–6 p.m. Rethinking Writing Assignments for the Introductory Physics Lab

Panel – Melissa A. Vigil, Marquette University, Milwaukee, WI 53201-1881; melissa.vigil@marquette.edu

CANCELED

Traditional introductory physics laboratory assignments ask students to complete worksheets or to write formal laboratory reports for each of a series of short individual exercises. All too often, students regurgitate the information they have acquired that week and forget it before the next experiment is performed. Therefore, students frequently develop only a surface acquaintance with physics facts rather than a deeper understanding of physics concepts. Our project grouped shorter laboratory assignments into clusters of experiments that deal with the same physical concept, such as Newton's second law. Weekly formal laboratory reports were replaced with summative papers that ask students to discuss the ways in which the individual laboratory experiences work together to form a bigger picture of the physical concept(s) in question. Results of the pilot program were very positive but implementation of the project to a broader audience has had mixed results. Both our successes and challenges will be discussed.

FA05: 4:15–6 p.m. Using Guiding Questions and Rubrics to Improve Students' Scientific Writing*

Panel – Corinne A. Manogue, Oregon State University, Corvallis, OR 97331-6507; corinne@physics.oregonstate.edu

Drew Watson, Oregon State University

We used a modified version of Calibrated Peer Review to measure the impacts on junior-level students' scientific writing. The project developed and implemented a set of guiding questions, instructor written examples, and a rubric which were implemented in a multi-staged process. Students were asked, not only to complete writing assignments themselves, but also to evaluate prewritten examples and examples of peer work using the rubric. Quantitative data obtained using the rubric itself, as well as free-form student reflection on the process, suggests that students' writing improved in three distinct ways: judgment as to the appropriate level of detail to include, explanations and structuring of mathematics, and organization of thought.

*The Paradigms in Physics Project: supported in part by NSF grant DUE 0618877.

Session FB: Frontiers in Variable Star Astronomy

Location: Chemistry 1200
Sponsor: Committee on Space Science and Astronomy
Date: Tuesday, July 28
Time: 4:15–6 p.m.

Presider: Kevin Lee

This session will survey new areas of variable star work in both education and research. One area of emphasis will be the impact that large scale sky surveys have had on variable star astronomy.

FB01: 4:15–4:45 p.m. RR Lyrae Variable Stars – Research and Education

Invited – Glenn P. Tiede, Bowling Green State University, Bowling Green, OH 43403; gptiede@bgsu.edu

Andy C. Layden, Bowling Green State University

I present an overview of an observational astronomical program at Bowling Green State University (BGSU) designed to both further basic knowledge of RR Lyrae variable stars and to involve undergraduate students and science educators in the science of astronomy. We have obtained observations of the full light curves of 40 nearby field RR Lyra variable stars—measuring their brightnesses in the visual (V) and near infrared (I) parts of the spectrum. In combination these brightness measurements allow us to quantitatively measure the color (V-I) of the stars as they vary. This information provides a calibration of the color variation of RR Lyrae variables through their periods of variation, and thus can be used for determining interstellar reddening toward RR Lyrae located anywhere. The process of making the observations, measuring the brightnesses, calibrating the data, and drawing the conclusions provides a good framework around which to teach fundamental concepts in astrophysics and hands-on scientific analysis to our students and teacher collaborators.

FB02: 4:45–5:15 p.m. Mining Sky Surveys for Variable Stars

Invited – Edward G. Schmidt, University of Nebraska – Lincoln, Lincoln, NE 68588-0111; eschmidt1@unl.edu

In recent years, advances in technology have made it possible to obtain digital images of the entire available sky over the course of a single night. Several sky surveys have exploited this to obtain a continuous record of the brightnesses of stars over intervals of several years. These data sets have been exploited to discover tens of thousands of previously unknown variable stars. This has revolutionized the study of these interesting objects. To fully exploit the plethora of newly found variable stars, follow-up studies are needed. We are using Behlen Observatory at the University of Nebraska to identify astrophysically interesting stars from these surveys and to investigate their properties. I will discuss how this is done and some interesting stars that have emerged so far.

FB03: 5:15–5:45 p.m. RR Lyrae Variables and the Formation of the Milky Way Galaxy

Invited – Horace A. Smith, Michigan State University, East Lansing, MI 48824-2320; smith@pa.msu.edu

Many recent models of galaxy formation propose that the Milky Way was built through the accretion of smaller fragments, a so-called bottom-up process. Today, the Milky Way is surrounded by a number of small dwarf galaxies. This begs the question: Could the Milky Way have been formed through the accretion of systems similar to those remaining dwarf galaxies? RR Lyrae stars are pulsating old stars in the core helium burning stage of their evolution. With ages of 10-12 billion years, the RR Lyrae stars were, in an earlier phase of their existence, present during the youth of the Milky Way. By comparing the properties of RR Lyrae stars in the halo of the Milky Way to the properties of RR Lyrae stars in the Milky Way's satellite dwarf galaxies, we can address the question of whether the Milky Way halo could have been built through the mergers of many dwarf galaxies similar in properties to the present-day satellite systems. RR Lyrae stars in many of the dwarf galaxies are found to have average properties different from those of RR Lyrae stars in the halo of the Milky Way.

Session FC: Students' Reasoning, Understanding, and Mental Models

Location: Chemistry 1210
Sponsor: Committee on Research in Physics Education
Date: Tuesday, July 28
Time: 4:15–6 p.m.

Presider: Andrew Heckler

FC01: 4:15–4:25 p.m. Exploring Students' Patterns of Reasoning

Mojgan Matloob Haghanikar, Kansas State University, Manhattan, KS 66506-2601; 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] The rubric is being used to assess the levels of reasoning represented in students' responses to written examination questions. In this way we believe that we can compare students' pattern of reasoning across disciplines.

1. L.W. Anderson & D.R. Krathwohl, *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*, Longman, NYC (2001).

FC02: 4:25–4:35 p.m. Developing Scientific Reasoning Through a Unique Introductory College Science Course*

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

Michael Edwards, Michele Wheatly, Wright State University

Jing Wang, The Ohio State University

Douglas Bradley-Hutchison, Sinclair Community College

This presentation describes the curriculum of an innovative entry-level college science course originally designed and implemented to address the low retention of average and "not-yet-ready" science majors. The course framework is guided by a set of scientific reasoning and mathematical skills determined lacking in these students. The curriculum employs explicit scientific reasoning training, and skills developed early on are repeatedly practiced in other multidisciplinary science contexts throughout the course. Sample activities will be presented in the context of the targeted reasoning skills. Evaluation of the curriculum indicates that student scientific reasoning ability, as measured by the Lawson Classroom Test of Scientific Reasoning, significantly improves. Student retention data and next steps including incorporating the curriculum in courses at other high schools and colleges will be discussed. The course, including pilots, has now been offered during six quarters to roughly 230 students.

FC03: 4:35–4:45 p.m. Correlation Analysis of High School Students' Coursework and Reasoning

Mark Schober, John Burroughs School, St. Louis, MO 63124; mschober@jburroughs.org

Hugh Ross, Guerin Catholic HS

Kathleen Koenig, Wright State University

Lei Bao, The Ohio State University

Scientific reasoning is an important ability in learning and has attracted much attention in PER. In this study we investigated the relationships involving high school physics students' scores on the Lawson Classroom Test of Scientific Reasoning (LCTSR) and multiple factors including completion of course assignments, performance on exams, and student scores on the Force Concept Inventory. Data was collected from physics students enrolled in two high schools with very different student populations. Moderate to high correlations were found between the LCTSR and performance on exams, the LCTSR and FCI, and between performance on exams and completion of course assignments. Further correlation analysis using the six reasoning domains within the LCTSR will also be presented. The results of this research contribute to our broader understanding of reasoning and provide possible implications for the need to integrate more reasoning training in our high school curriculum.

FC04: 4:45–4:55 p.m. The Developmental Trend of Scientific Reasoning Skills

Jing Wang, The Ohio State University, Columbus, OH 43210; wang.870@osu.edu

Tianfang Cai, Beijing Jiaotong University, Beijing

Kathy Koenig, Wright State University

Jing Han, Lei Bao, The Ohio State University

We have collected assessment data of scientific reasoning skills from both pre-college and college students in the United States and China. Using existing and newly developed assessment instruments, we examined the developmental models of these skills. Mathematical models of developmental trends are given using item response modeling methods. We especially pay attention to the developmental change of responses to each question at different ages. The similarity and differences between the two countries are carefully examined, and the effect of different curricula of the two countries will be discussed.

FC05: 4:55–5:05 p.m. Item Analysis of Gender Difference on Scientific Reasoning Test

Xiumei Feng, Huazhong Normal University/The Ohio State University, Columbus, OH 43201; feng.91@osu.edu*

Tianfang Cai, Beijing Jiaotong University

Ying Luo, Beijing Normal University

Kathy Koenig, Wright State University

Lei Bao, The Ohio State University

In our previous research we investigated the developmental trend of students' scientific reasoning ability both in the United and States and China. To gain deeper understanding of the gender differences and similarities, we conducted detailed analysis of data from individual items of the Lawson's test. In this presentation, we will discuss how students' answers on test items change over time and compare the change patterns of female and male U.S. and Chinese students.

*Sponsored by Dr. Lei Bao

FC06: 5:05–5:15 p.m. Cross Cultural Comparison of Students' Attitudes on Learning

Jing Han, The Ohio State University, Columbus, OH 43210; han.286@osu.edu

Tianfang Cai, Beijing Jiaotong University, Beijing

Kathy Koenig, Wright State University

Jing Wang, Lei Bao, The Ohio State University

Research has shown that traditional courses in the United States often lead students to unfavorable changes toward physics and learning physics. In this study, we use multiple survey instruments including MPEX to collect data with Chinese college students and explore how their views are affected by their college courses. We will further study the relations among the students' attitudes, their academic achievements, and their reasoning abilities.

FC07: 5:15–5:25 p.m. Mapping Changes in Student Understanding During Instruction*

Eleanor C. Sayre, Ohio State University, Columbus, OH 43202; le@zaposa.com

Andrew F. Heckler, Ohio State University

As part of a large study of how student ideas change in response to instruction, we collect student test data many times throughout a course, allowing for the measurement of the changes of student knowledge with a time resolution on the order of a few days. In this talk, we report on conceptual data taken in three similar calculus-based introductory E&M classes populated primarily by first- and second-year engineering majors. Some student ideas peak and decay rapidly during a quarter, and others improve more slowly. Furthermore, there appears to be a difference between low- and high-performing students on when they learn the material and how much they forget.

*Partially supported by a grant from the Institute of Education Sciences, U.S. Department of Education (#R305H050125).

FC08: 5:25–5:35 p.m. Observing Different Levels of Resource Coordination in Differential Equations Problems

Katrina Black, University of Maine, Orono, ME 04469; katrina.black@umit.maine.edu

Michael C. Wittmann, University of Maine

We are interested in modeling the process by which new, high-level resources are created. In this talk, we present video from two groups of intermediate mechanics students separating variables while solving a first-order linear differential equation arising from an air resistance problem. We summarize our analysis of these groups in terms of fluency, use of overt (e.g. divide or equals) and covert (e.g. bring over) mathematical language, and accompanying gestures. Briefly, we will introduce resource graphs for each group and discuss how these graphs could describe the reification of the process of separation of variables into the procedural resource separate variables.

FC09: 5:35–5:45 p.m. Using Shifts in Student Language and Behavior to Identify "A-ha" Moments

Kate Hayes, Center for Science and Mathematics Education Research – University of Maine, Eddington, ME 04428; katie.mccann@umit.maine.edu

Michael C. Wittmann, Center for Science and Mathematics Education Research, Brandon Bucy, Randolph Macon Academy

Students often have an "a-ha" moment during instruction, a moment when ideas fall into place and things just make sense. We use video to observe students working on the Intermediate Mechanics Tutorials (http://perlnet.umaine.edu/imt/). We characterize their behavior and activities as they interact, as well as the language they use when talking to each other. Inspired by Tannen,[1] we identify key elements of discourse that indicate speakers' expectations about an activity during dialogue. In this talk, we show how elements of discourse are observed and analyzed in video of instruction. In a related poster, we present a more detailed analysis that makes use of these methods.

1. D. Tannen, D. "What's in a Frame? Surface Evidence for Underlying Expectations," *New Directions in Discourse Processing*, ed. by Roy Freedle, 137-181 (Ablex, Norwood, NJ, 1979).

FC10: 5:45–5:55 p.m. The Semantics of Students' Mental Models

José P. Mestre, University of Illinois at Urbana Champaign, Urbana, IL 61801; mestre@illinois.edu

David T. Brookes, Elizabeth A. L. Stine-Morrow, University of Illinois at Urbana Champaign

In previous research we showed how a timed reading paradigm could be used to examine the mental models that students construct while reading physics passages. We now present follow-up data from think-aloud protocols and exit interviews. To probe non-Newtonian students' mental models, we asked students to think aloud while reading passages about Newton's third law, energy, and momentum. After the think-aloud phase, we asked students to describe further their understanding of what they read. These data reveal that students draw on a meaning of force from everyday language. Within this meaning, force is defined as a property of an object that can be related to both its mass and velocity. Students argue that larger and/or faster moving objects exert more force because they have more force.

Session FD: Modeling Instruction in Physics

Location: Chemistry 1300
Sponsors: Committee on Research in Physics Education
Committee on Physics in High Schools
Date: Tuesday, July 28
Time: 4:15–6 p.m.

Presider: Kathy Harper

This session will look at the Modeling Instruction program, developed at Arizona State University nearly 20 years ago, that has spread to a large number of physics and other science teachers nationwide. A particular emphasis will be on how the flexibility of the approach allows each practicing teacher to put his or her own personal spin on how it works in the classroom

FD01: 4:15–4:45 p.m. Stuck in Grade Nine? Modeling Instruction in Freshman Physical Science

Invited – Jason M. Cervenec, Thomas Worthington H.S., Worthington, OH 43085; cervenec.1@osu.edu

Modeling Instruction offers a framework to teach a typical high school freshmen physical science course using guided inquiry. Multiple representations, formative assessment, and learning cycles are intrinsic to modeling. Representational tools that are particularly effective with freshmen will be discussed, including but not limited to particle diagrams, motion maps, and energy pie graphs. Challenges, including student mathematical backgrounds and curriculum breadth, will also be addressed as will the success of the national modeling community in developing and refining instructional materials.

FD02: 4:45–5:15 p.m. Equations Don't Fall from the Ceiling, or Anywhere Higher

Invited – Frank D. Lock, Lemon Bay H.S., Englewood, FL 34224; fasterlock@ewol.com

The high school Modeling Physics, and Modeling Chemistry curriculums use chemistry and physics to facilitate student learning of what science is. This presentation will introduce participants to the strategies used in the modeling pedagogy to develop mathematical models (equations) that enable students to make predictions about how nature works. Specific examples from high school chemistry and physics will be presented and discussed. The success of the pedagogy, as well as the satisfaction derived from employing it, will also be discussed.

FD03: 5:15–5:25 p.m. Engaging Students in Productive and Meaningful Classroom Dialogue

Laura Ritter, Troy H.S., Troy, MI 48098; lritter2@troy.k12.mi.us

One of the most effective means for students to attain a profound understanding of physics is to engage in productive and meaningful classroom dialogue. There are many successful strategies that can be used to achieve these goals including classroom management techniques and motivational strategies specific to classroom dialogue. In addition, there are several effective instructional tactics a teacher can use to become a master facilitator. Strategies effective for students of varying abilities and motivation are addressed. This talk is geared for the teacher who is interested in modeling practice as well as one who is just interested in increasing the level of dialogue in the classroom.

FD04: 5:25–5:35 p.m. Modeling Instruction: Creating Supportive Learning Environment at a High School*

Eric Brewe, Florida International University, Miami, FL 33137; ebrewe@fiu.edu

Laird Kramer, George O'Brien, Florida International University

Modeling-based introductory physics courses are the foundation for undergraduate student community reform at Florida International University (FIU). During these courses, students learn cooperatively in groups and build their scientific reasoning skills as they actively engage content and build their physics understanding. Upon completing these courses, physics majors continue learning cooperatively in a rich learning, teaching, and research community supported by CHEPREO. CHEPREO, the Center for High-Energy Physics Research and Education Outreach, is located at FIU, a MSI serving more than 38,000 students in Miami, FL. The presentation will include learning and epistemological gains as well as performance in upper-division physics courses for majors, with comparisons between students in modeling courses and traditional lecture classes. We find that Modeling students outperform traditional students as indicated by these measures, and report the first significant gain in favorable attitudes toward science and science learning. In this presentation, we present results of our implementation of Modeling Instruction and discuss the impacts of Modeling educational reforms on the diverse population of students at FIU.

*Supported by NSF grant #0312038 and the FIU PhysTEC project.

Session FE: Improving the Student Teaching Experience for Future Teachers of Physics

Location: Chemistry 1400
Sponsor: Committee on Teacher Preparation
Date: Tuesday, July 28
Time: 4:15–6 p.m.

Presider: Paul Hickman

As in previous teacher preparation sessions, this session follows the format of one invited talk to set the stage, followed by contributed papers.

FE01: 4:15–4:45 p.m. A Look at Student Teaching from Different Sides of the Campus

Invited – Marcia K. Fetters, Western Michigan University, Kalamazoo, MI 49008; marcia.fetters@wmich.edu

Gay Stewart, University of Arkansas

Student teaching or supervised clinical experience is required for initial teacher licensure by all states. It is a full-time, uncompensated, long-term classroom experience that provides teacher candidates the opportunity to practice what they have learned through classes and previous clinical experiences. We will examine the history and elements of this experience and outline some strategies to maximize the professional growth of the interns during this time from our two different perspectives.

FE02: 4:45–4:55 p.m. A Physics Teaching Community as a Solution to Student Teaching Problems

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

We have rigorous training for our pre-service physics teachers about how people learn and how to best engage their future students. And then the pre-service teachers do student teaching. They return and say: "Nobody does what you taught us... It is all a theory. It does not work in real life." How do we turn the student-teaching experience into a time to practice what they learned in our pre-service courses? One way to solve this problem is to create a pool of physics teachers who are graduates of the same program and who can serve as mentors for the pre-service teachers' student teaching. They can form a community of learners (the present teachers and the pre-service student teachers) who meet regularly to sustain their work through constant communication. In this talk I will describe how to start such a community, how to keep it going, and how to use it to improve all of our teaching.

FE03: 4:55–5:05 p.m. The Effect of Inquiry-Based Early Field Experience on Pre-Service Teachers' Content Knowledge, Attitude Toward Teaching*

Sarai Costley, California Polytechnic University, Pomona, Pomona, CA 91768; sarai.costley@pusd.org

Homeyra Sadaghiani, California Polytechnic University, Pomona

As part of a pre-service science course for teachers at California Polytechnic University, Pomona we provided an early field inquiry-based teaching experience. A K-12 science specialist and Cal Poly faculty member worked together to help students develop a formal standards-based lesson plan and present it to a class of 5th grade students in a local elementary school. Data will be presented to demonstrate the effect of the field experience in student content knowledge, science reasoning skills, ability to teach inquiry-based science lessons, as well as their attitudes toward teaching.

*Supported in part by Teacher Quality Enhancement (TQE).

Session FF: Diversity Issues

Location: Chemistry 1640
Sponsor: Committee on Minorities in Physics
Date: Tuesday, July 28
Time: 4:15–6 p.m.

Presider: Kathleen Falconer

FF01: 4:15–4:25 p.m. Race and Student Achievement in an Interactive Classroom

Jessica Watkins, Harvard University, Cambridge, MA 02138; watkinsj@seas.harvard.edu

Eric Mazur, Harvard University

In this talk, we examine student learning and achievement in introductory physics courses taught using Peer Instruction. While controlling for incoming background knowledge, we compare racial groups on several different measures: conceptual survey scores, exam scores, and final grades. Finally, we discuss possible reasons for observed racial differences and implications for instruction.

FF02: 4:25–4:35 p.m. Gender Differences in Students' Perceived Experiences in Introductory Physics

Lauren E. Kost, University of Colorado at Boulder, Boulder, CO 80309; Lauren.Kost@colorado.edu

Steven J. Pollock, Noah D. Finkelstein, University of Colorado at Boulder

Prior research has shown that: 1) male students outperform females on conceptual assessments (a gender gap) at our institution, 2) the gender gap persists despite the use of several research-based reforms, and 3) the gender gap is correlated with students' prior physics and mathematics background and prior attitudes and beliefs [Kost, et. al. PRST-PER, 5, 010101]. We next begin to explore how background differences give rise to the gender gap. To this end, we have administered a survey to students in the first and second semester introductory physics courses at the University of Colorado. This survey probed students' physics identity and sense of belonging, epistemology, and self-efficacy. We find that there are significant gender differences in each of these areas, and the largest gender differences are on questions of self-efficacy. We report correlations between student responses to these questions and their performance on conceptual surveys, as well as course grades.

FF03: 4:35–4:45 p.m. When and Why do Students Decide to Major in Physics?

Donya R. Dobbin, Western Michigan University, Kalamazoo, MI 49001; donya.dobbin@wmich.edu

Charles Henderson, Western Michigan University

In the last 20 years the number of students who major in physics has declined while the number of jobs requiring a college physics degree has increased. Instead of finding ways to plug holes in a leaky pipeline, this study has taken the perspective of identifying ways to increase the number of students who enter the pipeline by focusing on when and why students decide to major in physics and identifying what types of support or information they might need at different times. To accomplish this, the researcher conducted e-mail interviews with physics majors from several Michigan universities and colleges. The sample includes representation from both genders. Interview questions focused on five possible areas of influence identified from the relevant literature: family, physics teacher, peers, themselves, and perceptions of themselves. Suggestions will be made for how to encourage more students to major in physics.

FF04: 4:45–4:55 p.m. Evaluating Gender Differences in the Sources of Self-efficacy*

Vashti Sawtelle, Florida International University, Miami, FL 33199; davisvas@gmail.com

Eric Brewe, Florida International University

The quantitative results of a diagnostic for the sources of self-efficacy in physics will be presented as a comparison between genders. Self-efficacy as a theory to explain human behavior change has recently become a focus of education researchers. In 2005 Fencl and Scheel[1] showed that teaching methods have an impact on self-efficacy in physics. Additionally, Zeldin et al.[2,3] found evidence that indicates men and women draw on different sources for evaluation of their self-efficacy in science fields. At Florida International University we have examined the self-efficacy of students in the introductory physics classes from the perspective of teaching reform as well as gender theory. The data from this research support both sets of literature. Students in the Modeling Physics classroom have a higher self-efficacy than those in the traditional classroom, as well differences in the sources of self-efficacy for men and women.

*Supported in part by NSF award #0802184.

1. H. Fencl & K. Scheel, "Engaging students," *J. of Coll. Sci. Teach.* **35**(1), 20-24. (2005).
2. A.L. Zeldin & F. Pajares, "Against the odds: Self-efficacy beliefs of women in mathematical, scientific, and technological careers," *Am. Educ.Research J.* **37**(1), 215, (2000).
4. A.L. Zeldin, S.L. Britner, & F. Pajares, "A comparative study of the self-efficacy beliefs of successful men and women in mathematics, science, and technology careers," *J. of Research in Sci. Teach.* **45**(9), 1036-1058, (2008).

FF05: 4:55–5:05 p.m. Effects of Single Sex Lab Groups on Physics Self-efficacy, Behavior, and Academic Performance

Gary Hunt, Boise State University, Boise, ID 83725-1570; garyhunt@boisestate.edu

The purpose of this study was to investigate the relationships between the gender composition of a laboratory group and student behaviors, self-efficacy, and quiz performance, within the college physics laboratory. A student population was chosen and subdivided into two groups, which were assigned either same-sex or coed laboratory teams while executing identical laboratory activities and instruction. Assessments were carried out prior to instruction, during the course, and at the end of one semester worth of instruction and laboratory activities. Students were assessed in three areas: behaviors exhibited during laboratory activities, self-efficacy, and scores on laboratory quizzes. Analyses considered the differences in outcomes after a single semester of physics laboratories that differed only in team gender organization. In an analysis of the individual behaviors data, it was noted that there is present a practical difference in the individual behaviors exhibited by males and females. This difference implies a difference in how males and females successfully engage in the lab activities.

Session FG: Upper-Level Undergraduate Physics

Location: Dana 1040
Sponsor: Committee on Physics in Undergraduate Education
Date: Tuesday, July 28
Time: 4:15–6 p.m.

Presider: Mary Lowe

FG01: 4:15–4:25 p.m. Relativistic Causality and Quantum Entanglement

William E. Baylis, University of Windsor, Windsor, ON N9B 3P4; baylis@uwindsor.ca

Crystal McKenzie, University of Windsor

The principle of relativistic causality—that influences or actions cannot propagate faster than light—is required by the consistent interpretation of events in spacetime. If violated, a causal event could follow its resulting event, even if both events occurred at the same spatial position. However, the instantaneous collapse of a wave function due to a measurement can conflict with relativistic causality when events are interpreted classically. The conflict is especially striking for wave functions of entangled particle pairs with large spatial separations. The measurement of the state of one particle of the pair immediately determines the state of the other, and this process has led many authors to conclude that "quantum mechanics embraces ("spooky") action at a distance" that would violate causality. The conflict is resolved by avoiding classical constructs and accepting that nature uses amplitudes (wave functions) and their superpositions to determine probabilities of events. It is the use of amplitudes that violates Bell's inequality, even with a single (unentangled, local) beam. Nonlocality exists not only in quantum systems but also in classically correlated ones: measurement of one part can immediately determine the spin or position of the other part. However, more correlation exists in entangled systems because of the use of amplitudes to calculate probabilities.

FG02: 4:25–4:35 p.m. Scientific Computing with Python in Introductory Quantum Mechanics

Steve Spicklemire, University of Indianapolis, Indianapolis, IN 46227; spicklemire@uindy.edu

In addition to traditional homework and exams, we have introduced several computing projects with Python in our introductory quantum mechanics course. These are small group projects in which students engage in computing "experiments" in which they create programs to predict the evolution of quantum systems and display some representation of the results. Python is a very clear and simple language that is particularly well-suited to handling arrays of complex numbers required in many quantum mechanics problems. Specific examples of Python code used in the course will be presented in this talk. A variety of computational methods are involved, including Visscher's half-step method for integrating the Schrodinger equation, variational methods, and some flavors of quantum "Monte Carlo." As a final project, students run a fairly large Monte Carlo simulation on a multi-node parallel computing network of computer systems.

FG03: 4:35–4:45 p.m. Active Learning Using Tutorials in Intermediate Optics*

Mark F. Masters, Indiana University Purdue University Fort Wayne, Fort Wayne, IN 46805; masters@ipfw.edu

Timothy T. Grove, Indiana University Purdue University Fort Wayne

Active learning is the process through which students in a class are actively engaged in the material under investigation. The success of this method of instruction has been well documented for introductory classes. In intermediate/advanced undergraduate physics classes there are fewer published results of experience or materials for use in active learning. This may be due to the mathematical rigor required in these classes and the traditional use of derivations to gain insight into physical problem solving. In this presentation we present our work in developing tutorials to help the students learn and use the mathematics and techniques of derivations as well as develop a stronger conceptual foundation for intermediate optics. These tutorials form a basis for the development of an active learning process in an advanced physics class setting.

*Supported by NSF Grant #0410760

FG04: 4:45–4:55 p.m. Simulations for Teaching Vision and Wavefront Aberrometry*

Dyan L. McBride, Kansas State University, Manhattan, KS 66502; dyanm@ksu.edu

Dean A. Zollman, Kansas State University

Helmut Wiesner, Alexander Rachel, Ludwig Maximilians University

Based on research in the transfer of student learning, we have developed two interactive visualizations that help students understand the optics of the human eye and recent advances in the use of wavefront aberrometry for vision defect diagnosis. The first visualization enables students to explore the optics related to accommodation of the eye lens, vision defects, and corrective lenses. The second visualization focuses on helping students learn about wavefront aberrometry, a relatively new method of diagnosing vision defects. Along with the visualizations, we will present our initial assessment of the effectiveness of the visualizations.

*Supported in part by NSF Grant DUE 04-27645

FG05: 4:55–5:05 p.m. Investigation of Factors that Influence the Dynamics of a Precessing Gyroscope

Joseph Tasic, Loyola University Chicago,Chicago, IL 60626; agangop@luc.edu*

Joseph Schneider, Basit Hussain, Loyola University Chicago

We present the outcome of an investigation of factors that affect the dynamics of a precessing gyroscope. Many major universities have antique gyroscopes in their museums, since gyroscopes played an important role in physics education. However, it seems that gyroscopic motion is generally poorly understood by today's students. As a paradigm for demonstrating the vector nature of angular momentum, especially the relationship between torque and the rate of change of angular momentum with moving axis, it is almost unique. With a detailed study of this motion, we plan to bring out various aspects of this complex instrument that carry substantial pedagogical value and beg to be introduced into the curriculum.

*Sponsored by Asim Gangopadhyaya

FG06: 5:05–5:15 p.m. A Less Counterintuitive Approach to Special Relativity

M. Sultan Parvez, Louisiana State University at Alexandria, Alexandria, LA 71302; sparvez@lsua.edu

If four-dimensional spacetime is real, then it is necessary to incorporate this fact into the postulate of special relativity which assumes a world of three dimensions. Postulating a four-dimensional Minkowski spacetime, instead of counterintuitive constancy of speed of light, Special Relativity may be derived with an alternative approach from Minkowski metric. Even if Minkowski spacetime is considered a mathematical convenience, this alternative approach provides a better comprehension for the introduction of special relativity and is pedagogically important at the least.

FG07: 5:15–5:25 p.m. Categorization of Quantum Mechanics Problems by Professors and Students

Shih-Yin Lin, University of Pittsburgh, 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 an 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 the National Science Foundation.

FG08: 5:25–5:35 p.m. Improving Students' Understanding of Quantum Mechanics*

Guangtian Zhu, University of Pittsburgh, Pittsburgh, PA 15232; guz11@pitt.edu

Chandralekha Singh, University of Pittsburgh

Learning quantum mechanics is challenging. Our group is 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 tutorials and peer-instruction tools employ computer simulations to help students visualize and develop better intuition about quantum phenomena. We will discuss the common students' difficulties, share the material we have developed and evaluated to make the quantum mechanics class engaging and useful, and show ways to bridge the gap between quantitative and conceptual aspects of quantum mechanics.

*Supported by the NSF (NSF-PHY-0653129 and 055434).

Session FH: Physics and Society Education

Location: Dennison 170
Sponsor: Committee on Science Education for the Public
Date: Tuesday, July 28
Time: 4:15–615 p.m.

Presider: John Roeder

This session consists of invited and contributed papers on topics pertaining to physics and society education, which include, but are not limited to, energy, the environment, nuclear issues, and pseudoscience.

FH01: 4:15–4:45 p.m. Nuclear Energy – Is There a Renaissance?

Invited – Aris S. Candris, Westinghouse Electric Company, Monroeville, PA 15146-2808; candrias@westinghouse.com

The speaker will provide an overview of the nuclear industry, including the drivers behind, and the status of an emerging "nuclear renaissance"; nuclear safety and next-generation plant design features; nuclear waste; and how nuclear power fits within a "renewable" electrical generation scheme. Candris is the President and Chief Executive Officer of Westinghouse Electric Company. He was invited to speak by David M. Cook, Vice President and Program Chair.

FH02: 4:45–5:15 p.m. The Magic of Physics

Invited – Fred Becchetti, University of Michigan, Dept. Physics-Randall Lab, Ann Arbor, MI 48109; fdb@umich.edu

The public (as well as students) are generally fascinated by magic. Like others, I have exploited this by incorporating stage magic, illusions, and other effects into my physics lectures, a summer high school science camp, as well as public lectures. However, unlike others who often use magic unrelated to any physics per se, I have incorporated (or developed) magic that has a direct relevance to a specific physics topic and the "magic" of Nature revealed in physics research: penetration effects: quantum-mechanical tunneling and radioactive decay, the age of the Earth, and evolution. Mentalism and predictions: the relevancy of time (relativity) and the possibility of time travel (or not). Vanishing effects: matter-anti-matter and the Big Bang. Math-based magic: the quark model, etc. Several of the above will be demonstrated.

FH03: 5:15–5:25 p.m. Research Projects in Introductory Physics: Impacts on Student Attitudes*

Mathew A. Martinuk, UBC Dept. of Physics and Astronomy, Vancouver, BC V6T 1Z1; martinuk@physics.ubc.ca

Rachel Moll, UBC Dept. of Curriculum Studies

Andrzej Kotlicki, UBC Dept. of Physics and Astronomy

Over the last two years UBC has completely revamped its introductory course for non-physics majors to present physics in the context of everyday issues of energy and climate change. One major goal of these changes is to encourage students to make connections between classroom physics and real-world phenomena. One of the key changes was the incorporation of a final project where groups of students research and present on a topic of their choice related to the course. Students were asked to quantitatively model a real-world situation to make a choice or settle a dispute. Following the theme of the course, many of these projects were related to energy conservation, efficiency, or greenhouse gas emissions. This talk will examine the effect of participating in this self-directed collaborative activity on the students' interest in physics and their confidence in its application to the real world. Survey data and example projects from the first two years of implementation will be presented.

*This research is funded by the Carl Wieman Science Education Initiative.

FH04: 5:25–5:35 p.m. A Project-Based Seminar on Accessing Clean Drinking Water

James J. Carroll, Eastern Michigan University, Ypsilanti, MI 48197; jcarroll@emich.edu

Andrew M. Ross, Eastern Michigan University

Undergraduate students at Eastern Michigan University (EMU) explored how physics and mathematics are used to address one of the major issues of the 21st century: access to clean drinking water. This exploration took place in an interdisciplinary, one-hour seminar called "5 Miles to Clean Drinking Water" as part of the Creative Scientific Inquiry Experience (CSIE)* at EMU. This seminar complemented the introductory calculus-based physics course in which they were co-enrolled. The seminar provided an opportunity for students to research the issue, create presentation material to raise awareness about the issue, organize and hold a fundraiser, and build models of devices currently being used in underdeveloped nations to address the issue. Specifically, the students built working models of the Hippo roller, an elephant pump, a piston pump, and the Playpump.

*CSIE funded by NSF DUE grant #0525514

FH05: 5:35–5:45 p.m. Some Dogma and Karma for Teaching About Science and Religion

Matthew B. Koss, College of the Holy Cross, Worcester, MA 01610-2395; mkoss@holycross.edu

Paul Nienaber, Saint Mary's University

The back-and-forth between science and religion has been an issue of serious interest and no little heat. As science educators we have an investment in this discussion, and not just because it has an impact on curricular policy in the public schools. Curious students and colleagues often seek us out with questions, the answers to which can require exploring some subtle distinctions. In teaching such issues in our classrooms and in preparing a workshop to lay out a particular approach to the discourse, we have formulated a set of heuristic suggestions to help guide us. In this brief presentation, we would like to present some of our ideas about how to productively hold discussions to promote a collegial examination of some of the fundamental (and sometimes deeply implicit) characteristics of science and in the classroom.

FH06: 5:45–5:55 p.m. Ethics Education in Physics: It's More than Meets the Eye

Marshall Thomsen, Eastern Michigan University, Ypsilanti, MI 48197; jthomsen@emich.edu*

While upcoming requirements of the America COMPETES Act have turned a spotlight on ethics education in science, Eastern Michigan University has used an ethics course to introduce physics students to issues that are rarely addressed directly in other physics courses. When taking PHY 406 Ethical Issues in Physics, these students not only investigate the responsible conduct of research, but they also study how knowledge develops in the field and how the physics community interacts with society at large. Studying the latter provides an opportunity to explore the ethical issues facing scientists who provide technical input to the public, as well as to explore the impact of physics research on society. This discussion takes place in the context of current topics, such as alternative energy. PHY 406 has become an essential element of our nature of science program for pre-service secondary education majors.

*Sponsored by Ernest Behringer.

FH07: 5:55–6:05 p.m. Quantum Connections: Nonscientists Speaking the Unspeakable About Quantum Mechanics

David P. Jackson, Dickinson College, Carlisle, PA 17013; jacksond@dickinson.edu

In the fall of 2007, I taught a freshman seminar titled "Where is the electron?—The strange and fascinating theory of quantum mechanics." As part of this course, students wrote a term paper on some aspect of quantum mechanics. Additionally, they were to produce a three-minute podcast on this topic that would air on the college's radio station. The podcast assignment turned out to be tremendously popular and a wonderful learning opportunity for the students. In this talk, I will discuss this experience and give pointers on how to design successful podcast assignments.

FH08: 6:05–6:15 p.m. Antarctic Pictures Illustrate Climate Concepts

Thomas C. Gibbons, 707 Eighth Ave., South, Clinton, IA 52732; tomgib@mchsi.com

On a recent trip to the Antarctic coast, I obtained a number of pictures that can illustrate various climate-related concepts. Although climate change is not as easily seen in the Antarctic as in the Arctic, there have nevertheless been changes. Large icebergs from ice shelf breakup can be seen as well as some pullback of ice from the coast. Glacier ice is evident nearly everywhere along the coast, on islands, and in icebergs with the blue color frequently visible. Small islands are often covered by small icecaps that resemble miniature versions of the entire continent as well as of Greenland. During the talk, I intend to show and describe as many of these as possible. More are available for free download on the website* in the footnote for anyone having use for them.

*www.gibbworld.com

Session FI: Interactive Lecture Demonstrations: Physics Suite Materials that Enhance Learning in Lecture

Location: Dennison 182
Sponsors: Committee on Research in Physics Education, Committee on Educational Technologies
Date: Tuesday, July 28
Time: 4:15–6 p.m.

Presider: Ronald Thornton

The results of physics education research and the availability of microcomputer-based tools have led to the development of the activity-based Physics Suite. One component of the Suite, Interactive Lecture Demonstrations (ILDs), has been shown to be an effective strategy for promoting active learning in large (or small) lecture classes, and improving student learning. This session will begin with an update on ILDs, followed by contributed papers on their use at a variety of institutions. This session should be of special interest to teachers of large lecture classes as well as those who have only one computer available to them.

FI01: 4:15–4:45 p.m. Interactive Lecture Demonstrations: Active Learning in Lecture

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

Ronald K. Thornton, Tufts University

The results of physics education research and the availability of microcomputer-based tools have led to the development of the activity-based Physics Suite.[1] Most of the Suite materials are designed for hands-on learning, for example student-oriented laboratory curricula like RealTime Physics. One reason for the success of these materials is that they encourage students to take an active part in their learning. This interactive presentation will demonstrate—through active audience participation—Suite materials designed to promote active learning in lecture [Interactive Lecture Demonstrations (ILDs)].[2] Examples will be on second semester topics.

1. E.F. Redish, *Teaching Physics with the Physics Suite* (Wiley, Hoboken, NJ, 2004).
2. David R. Sokoloff and Ronald K. Thornton, *Interactive Lecture Demonstrations* (Wiley, Hoboken, NJ, 2004).

FI02: 4:45–5:15 p.m. Interactive Lecture Demonstrations: Effectiveness in Teaching Concepts

Invited – Jason Kahn, Tufts University, Medford, MA 02155; jason.kahn@tufts.edu

Ronald K. Thornton, Tufts University

The effectiveness of Interactive Lecture Demonstrations in teaching physics concepts has been studied using physics education research-based, multiple-choice conceptual evaluations. Results of such studies will be presented. These results should be encouraging to those who wish to improve conceptual learning in lecture.

FI03: 5:15–5:25 p.m. Interactive Lecture Demonstrations: A First Attempt at UCF

Costas J. Efthimiou, University of Central Florida, Orlando, FL 32816; costas@physics.ucf.edu

Enrique del Barco, University of Central Florida

At UCF quite recently we adopted the RealTime Physics curriculum for the Introductory Physics labs. At the same time, we introduced Interactive Lecture Demonstrations in some Introductory Physics classes and kept a traditional format in others. In this talk, we will review the lessons learned from the implementation of the Interactive Lecture Demonstrations and present the data collected so far.

FI04: 5:25–5:35 p.m. Using Interactive Lecture Demonstrations in Electricity and Magnetism

Linghong Li, The University of Tennessee at Martin, Martin, TN 38238; lilyli@utm.edu

We used the Interactive Lecture Demonstrations (ILDs) in Electricity and Magnetism in three different classes. This presented considerable evidence that lectures using ILDs improved the student comprehension and the instructor's teaching, which further supports earlier findings of ILDs improving student understanding of electricity and magnetism. The research in this paper also reports new findings not previously observed. Not only does using ILDs show gains in mechanics but also in electricity and magnetism. Second, gains from ILDs are not affected by class size. Third, students in a regular semester have a greater improvement than those of a summer (one month) semester. Last, students from algebra-based introductory physics classes have greater improvement than those in calculus-based introductory physics classes. These findings will help future physics instructors implement ILDs in their classes and help physics education researchers better refine ILDs.

FI05: 5:35–5:45 p.m. Interactive Lecture Demonstration in Introductory Physics

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

I will talk about how I implemented Interactive Lecture Demonstrations (ILDs) in the Physical Science class for elementary childhood education students and in the algebra-based introductory physics class for nonmajors. I will share pro and cons in using the ILDs in these two classes.

FI06: 5:45–5:55 p.m. LivePhoto Interactive Lecture Demonstrations*

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

Priscilla Laws, Maxine Willis, Dickinson College

Patrick Cooney, Millersville University

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. In this talk we will demonstrate how we have integrated digital video analysis into interactive lecture demonstrations.

*Supported in part by NSF grants 0424063, 0717699 and 0717720.

Session FJ: Make and Take for Demonstrations

Location: Randall 1412
Sponsors: Detroit Metro Area Physics Teachers, Committee on Physics in High Schools
Date: Tuesday, July 28
Time: 4:15–6 p.m.

Presiders: Al Gibson, Mark Davids

The Detroit Metro Area Physics Teachers will provide the materials, tools, and expertise and show you how to assemble simple, but effective equipment for student activities and teacher demos. You will assemble devices for demos in sound, light, and E & M.

Drop by the Poster Sessions in Dana Hall

8:30–10 p.m., Monday and Tuesday

Snacks:
Monday: **Smoothie Bar**
Tuesday: **Cupcakes**

The posters will be up all day beginning at 8:30 a.m., but the authors will be present from 8:30 p.m. to 10 p.m.

Wednesday, July 29

Registration *Michigan League Concourse*	8 a.m.–3 p.m.
Great Book Giveaway *Michigan League Concourse*	8–9 a.m.
Plenary: Frank Oppenheimer *Mendelssohn Theater*	9–10 a.m
PER Conference & Banquet *Michigan League Ballroom*	6–10 p.m.

Plenary: Frank Oppenheimer and the World He Made Up

Location: Mendelssohn Theater
Sponsor: AAPT
Date: Wednesday, July 29
Time: 9–10 a.m.

Presider: David Cook

K.C. Cole

"Something Incredibly Wonderful Happens": Frank Oppenheimer and the World He Made Up

K.C. Cole, University of Southern California, Anneberg School of Journalism, Los Angeles, CA 90089; kccole@usc.edu

Few physics teachers are so inspiring that they create addicts for life out of just about anyone who comes in their path. What's the secret? It's part passion; part regarding physics as the "search for the every-juicier-mystery"; part a tolerance for true discovery, risk taking, play, even chaos; part taking the aesthetics of physics seriously and realizing that both artists and scientists are "official noticers of society" and have real contributions to make. It's part rethinking what it means to "understand" something; part resisting the tyranny of "certification" and respecting the power of intuitive learning; part thinking of physics as part of human perception, seeing physics (and all science) as a part of human culture. Underlying it all is the conviction that the discoveries of science change the ways people feel about things and each other; that understanding is serious business—if often best nurtured in playful ways. Without understanding, Frank Oppenheimer used to say, "we'll all be sunk." And so he created a museum of "human awareness" based on honesty, kindness, trust in common people, and the belief that everyone can make a difference. Make no mistake: Frank's *Exploratorium* had a political purpose. In many ways, it was his answer to the atom bomb and the post-war madness that manipulated fear to ruin both individual lives and prospects for peace. His "people's science museum" as an early Chinese delegation called it, was a world he made up where ordinary people could gain the confidence and understanding necessary to help make the world a nicer, safer, place.

Session GA: Panel – Status of Instructional Resource Specialists

Location: Chemistry 1200
Sponsor: Committee on Professional Concerns
Date: Wednesday, July 29
Time: 10 a.m–12 p.m.

Presider: Dean Hudek

This panel discussion will focus on the important and evolving role of Instructional Resource Specialists (IRS)—demonstration managers, instructional lab managers, etc.—in our education system. The required knowledge and instructional responsibilities of IRS are ever increasing. In addition to the more menial tasks commonly associated with these positions, many IRS are increasingly involved with the education of our students; both in the quality of the experiments they provide and by directly instructing students in instructional labs, classrooms and private talks. IRS responsibilities vary widely from department to department and currently there is no certification or standardization for these positions. Educational backgrounds vary from high school diploma to Ph.D. and departmental positions range from hourly staff to regular faculty. IRS salaries are often surprisingly low with little opportunity for advancement; they typically get little recognition and frequently have to navigate a faculty/staff power differential. None of this helps attract the talented and capable people we need. With our country's education system in serious need of improvement and the current push to upgrade instructional labs, we need to attract the best people we can to this important profession and we need to make optimal use of their talents. Our panel—consisting of two regular faculty members and two IRS representatives—will present various sides of this matter for discussion. Please join us as we examine the future of this increasingly important profession.

Invited Speakers:

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

Alexandria Oakes, Eastern Michigan University, Ypsilanti, MI 48197; aoakes@emich.edu

John D. Hopkins, Pennsylvania State University, University Park, PA 16802: jxh22@psu.edu

Ramon O. Torres-Isea, University of Michigan, Ann Arbor, MI 48109; rtorres@umich.edu

Session GB: Getting Started in Physics Education Research

Location: Chemistry 1210
Sponsor: Committee on Research in Physics Education
Date: Wednesday, July 29
Time: 10 a.m–12 p.m.

Presider: Kathy Harper

Four experts in physics education research will give talks related to areas of concern for those wishing to start conducting physics education research of their own.

GB01: 10–10:30 a.m. Research in Conceptual Understanding – Foundations and Future Challenges*

Invited – N. Sanjay Rebello, Kansas State University, Manhattan, KS 66506-2601; srebello@phys.ksu.edu

The goal of this talk is to provide an overview of the general issues pertaining to research of conceptual understanding in physics that might be of interest to a researcher who is getting started in this area. This talk does not seek to provide a comprehensive historical overview of all of the work done in this area. Indeed, such a task cannot be accomplished in a 30-minute talk. Rather, this talk touches on each of the following topics to a limited extent: the various meanings of conceptual understanding in physics education, topics that have been researched so far and general trends, assessments of conceptual understanding, methodologies for investigating conceptual understanding, and ongoing and future areas of interest in this sub-field of physics education research.

* Supported in part by the U.S. National Science Foundation.

GB02: 10:30–11 a.m. Getting Started in Physics Education Research: Problem Solving

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

This presentation is designed to introduce someone new to physics education research to the area of problem-solving research. I will first review some results and basic issues—What is a problem? What are heuristics and what place do they have in learning problem solving? What are problem representations and why are they important?—found from the general problem-solving research and the physics education research on problem solving. The purpose of this review will be to provide a basic background of what has been learned, but no attempt will be made to be in any way exhaustive in this review. As a part of this review, some common techniques used in studying problem solving in physics will be described. With this background in place some potential issues that could merit study will be identified.

GB03: 11–11:30 a.m. How Students Understand Knowledge and Learning*

Invited – David Hammer, University of Maryland, College Park, MD 20742; davidham@umd.edu

Andrew Elby, University of Maryland

Attempting to explain students' successes and difficulties learning physics, researchers typically look at the knowledge and skills students bring to bear, such as (mis)conceptions and problem-solving skills. More recently, researchers have examined how students understand knowledge about knowledge—their intuitive "epistemologies"—in contexts of physics courses. Evidence shows many students treat physics knowledge as disconnected facts, formulas, and algorithms; thinking that way they approach learning as a matter of memorization and practice. Students may also treat physics as an interconnected, coherent web of ideas; thinking that way they work to make sense of the underlying ideas. We'll review research concerning physics students' epistemologies, as well as about expectations (what they expect "counts" in a particular course). We'll also show examples of student reasoning, including video snippets, as a primer on recognizing evidence of epistemologies and expectations in students' statements and behavior.

*Supported in part by the National Science Foundation. Any opinions, findings, and conclusions or recommendations expressed are those of the authors and do not necessarily reflect the views of the Foundation.

GB04: 11:30 a.m.–12 p.m. Legal and Ethical Concerns When Conducting PER

Invited – Thomas Foster, Southern Illinois University Edwardsville, Edwardsville, IL 62025; tfoster@siue.edu

Jessie Antonellis, Sanlyn Buxner, Erik Brogt, Erin Dokter, The University of Arizona

The purpose of this talk is to provide an overview of the ethical issues pertaining to ALL research with human subjects. These are necessary and important issues for anyone who does educational research. Those who fail to abide by these regulations and standards of practice put themselves and their institutions at risk of censure, loss of research privileges, or legal action. This talk will begin with the history of ethical violations in research with human subjects, the guidelines enacted as a result, and particular considerations for education research. This presentation will delve into student privacy laws and their application to PER as well as how other professional organizations have addressed the legal concerns and ethical standards for their membership. The role of Institutional Review Boards (IRB) will be discussed and what to do if your institution does not have an IRB. The talk will conclude with a discussion about conducting your research ethically.

Session GC: Panel – The Changing Community of Physics: Resources and Programs that Promote Inclusion and Diversity

Location: Chemistry 1300
Sponsor: Committee on Minorities in Physics
Date: Wednesday, July 29
Time: 10 a.m–12 p.m.

Presider: Juan R. Burciaga

Promoting the inclusion and retention of under-represented groups in physics requires both knowledge and resources. But where do we go to become more knowledgeable of the barriers facing under-represented groups? How can we effectively reach out to others who may, or may not, be the same as us? What resources, what programs are available to us through our societies? What efforts are under way to define and understand the barriers to, and the challenges of, a diverse, inclusive physics community?

GC01: 10–10:15 a.m. Teaching for Retention

Panel – James H. Stith, 2013 Clearwood Dr., Mitchellville, MD 20721-2511; jstith@aip.org

The American Association of Physics Teachers (AAPT), the American Physical Society (APS), and the American Astronomical Society (AAS) annually hold a workshop for new physics and astronomy faculty at the American Center for Physics (ACP) that is designed to help new faculty understand how students learn physics and astronomy and suggests how this information can impact teaching methods. This workshop is now in its 13th year. Imbedded in this workshop since its inception is a session that has recently been called "Teaching for Retention" which is designed to acquaint the new faculty with issues that impact on a diverse student/faculty population with the ultimate goal of helping to increase the diversity (underrepresented minorities and women) of the physics and astronomy fields.

This talk will describe the content and evolution of that session and the author's perception of its strengths and weaknesses.

GC02: 10:15–10:30 a.m. Programs and Resources of the American Physical Society

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

The American Physical Society (APS) continues to work toward including minorities and women in physics through a variety of targeted efforts. I will discuss these briefly with a special emphasis on a new initiative to address the underrepresentation of minorities in physics at various levels. Our existing programs include: Scholarships for minority students studying physics; professional skills development workshops for women; a site visit program on gender and ethnic diversity; a website on gender diversity of graduate programs; speakers lists for minority and women colloquium speakers; travel grants to support women and minority speakers; and grants to support childcare at APS national meetings.

GC03: 10:30–10:45 a.m. AAPT-Sponsored Activities Supporting Diversity

Panel – Daniel M. Smith, Jr,, South Carolina State University, Orangeburg, SC 29117; dsmith@scsu.edu

Over the years, the AAPT has supported the inclusion of underrepresented groups in the physics community through standing committees and organizations that fall under the committee's umbrella. We will present a review of programs initiated by these committees and by the AAPT that have been successful in highlighting the accomplishments of African-American and women physicists, in providing a forum for addressing the difficulties in recruiting underrepresented groups into physics, and in enhancing the knowledge and skills of teachers of underrepresented students.

GC04: 10:45–11 a.m. Engaging Physics Students in Diversity Conversations with SPS

Panel – Gary White, Society of Physics Students/AIP, One Physics Ellipse, College Park, MD 20740; gwhite@aip.org

Kendra Rand, Society of Physics Students/AIP

How can one engage typical physics students in a conversation about underrepresented groups in physics that doesn't result in rolled-eyes or fingers-in-the-ears? The Society of Physics Students (SPS) has begun an experiment using a jeopardy-like game at physics meetings in an attempt to generate conversations about diversity. The physics jeopardy game is part of a "Future Faces of Physics" kit that includes a variety of materials that are of interest to those wanting to address under-represented audiences in physics, such as video clips exhibiting common physics words in sign language, tactile representations of the lunar surface for blind students, guidelines regarding lab procedures for the wheel-chair bound, and the book, "Einstein on Race and Racism" with a challenge letter directed at participants from the authors. While attempts to assess the impact of the game are modest, we report anecdotally some of the qualitative features seen in the discussions when the game is played. We also strive to indulge in a few physics jeopardy game moments to give a sense of how the game works. If you are hosting a meeting, large or small, and would like to receive this kit for use at your meeting, notify Kendra Rand, SPS Program Coordinator at krand@aip.org.

GC05: 11–11:15 a.m. Issues of Diversity in Physics Education Research: A Report from the 2008 PER Conference

Panel – Mel S. Sabella, Chicago State University, D, Chicago, IL 60628; msabella@csu.edu

John R. Thompson, University of Maine

Nicole Gillespie, Knowles Science Teaching Foundation

In the last 10 years, the use of research-based instructional materials has moved well beyond the traditional research university. In addition, physics education research (PER) is now being conducted at institutions with diverse populations of students. As a first attempt to bring to the fore the issue of diversity in research and instruction, the PER community chose the theme of diversity for the focus of the 2008 Physics Education Research Conference, in Edmonton, Canada. The conference brought together presenters from a variety of disciplines to discuss the issues facing different student populations. In this talk we discuss the motivation for the conference, discuss some of the major outcomes of the conference, and highlight participant comments.

GC06: 11:15–11:30 a.m. Report from AIP Liaison Committee on Underrepresented Minorities in Physics

Panel – Quinton L. Williams, Jackson State University, Jackson, MS 39217; quinton.l.williams@jsums.edu

The Liaison Committee for Underrepresented Minorities (LCURM) in physics was established in 2007 and charged with (a) providing a means to coordinate efforts among American Institute of Physics (AIP) Member Societies and between Member Societies and AIP, and (b) improving opportunities in physics and related fields for underrepresented minorities. LCURM also provides a forum for Member Societies to exchange information with other organizations on their own programs on underrepresented minorities for feedback and potential collaboration. To date, the centerpiece activity of LCURM has been its significant role in delivering affordable online journal access to Historically Black Colleges and Universities and Minority Serving Institutions with physics programs. This activity is expanding rapidly. Other LCURM initiatives will also be presented.

Session GD: Physics Education Research Around the World

Location: Chemistry 1400
Sponsors: Committee on International Physics Education, Committee on Research in Physics Education
Date: Wednesday, July 29
Time: 10 a.m–12 p.m.

Presider: Genaro Zavala

This is a session for people who are working on Physics Education Research from other countries.

GD02: 10–10:30 a.m. Improving Concept Understanding and Attitudes Through Performing Modeling Instruction

invited – Hugo Alarcon, Tecnologico de Monterrey, Av. E. Garza Sada 2501, Monterrey, NL 64849 Mexico; halarcon@itesm.mx

The implementation of active learning methodologies started in 2004 at Tecnologico de Monterrey. Tutorials in Introductory Physics have been used from the beginning and scaled for all our introductory calculus-based courses for engineering. The implementation has been a hard process, but the students' concept understanding and problem-solving skills have increased importantly. Recently we have been interested in promoting the discussion of students and modeling in the classroom in order to approach the students to the scientific work. Modeling Instruction is an active learning methodology with that feature, in which the students work developing models to explain real situations. The implementation of modeling in an introductory mechanics course has permitted good results; the concept understanding of students has increases as well as the problem solving skills. This talk will be focused in the results of our implementation of modeling.

GD03: 10:30–11 a.m. Interactive Laboratory Tutorials: Learning Art of Measurement with Simple Hands-On Activities

Invited – Pratibha Jolly, Miranda House, University of Delhi, Delhi, 110007 India; pratibha.jolly@gmail.com

Mallika Verma, Monika Tomar, Miranda House, University of Delhi

Experiments, demonstrations, and hands-on activities play a pivotal role in creating active learning environments for better conceptual understanding of physics. We have been systematically exploring undergraduate physics students' understanding of the aims of laboratory tasks and design of experiments; variables of measurement and their character; concepts of reliability and validity of data; and how empirical evidence is used to test hypothesis. The findings have been used to propose a model for laboratory instruction and create Interactive Laboratory Tutorials that include a Pre-laboratory Questionnaire to elicit students' understanding about design of experiment, concepts of procedure and the physics of the problem; Experiment Worksheet that provides a guided exposure to the laboratory task; Assessment Rubric integrating research-based concept and data probes; and Bridging Exercises in the form of simple hands-on activities that provide analogous learning for each subtask and help the student make informed choices about the measurement process.

GD04: 11–11:10 a.m. Learning Physics from Public Physics Lectures: A Learning Experiment

Shulamit Kapon, Weizmann Institute of Science, Dept. of Science Teaching, Rehovot, 76100 Israel; shulamit.kapon@weizmann.ac.il

Uri Ganiel, Bat Sheva Eylon, Weizmann Institute of Science

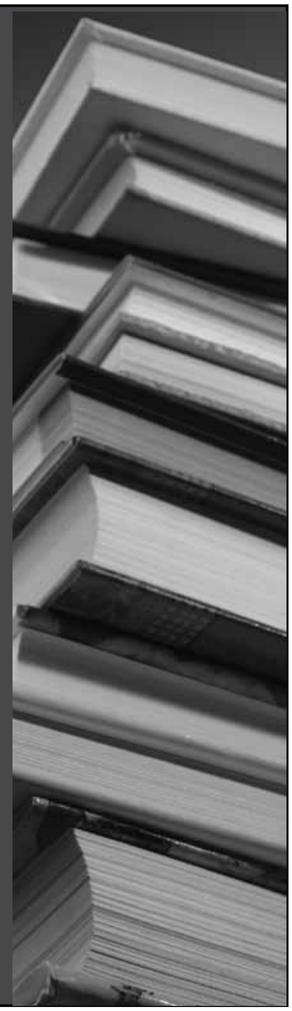
CANCELED

We present results from a learning experiment designed to trace the learning process that takes place in public scientific web lectures accompanied by mediating collaborative learning activities. The activities process the scientific argumentation and analogical reasoning presented in the lectures. Fourteen graduates of a pre-academic physics course (mechanics, electricity & magnetism) were assigned to two groups. The first (second) group watched a public web-lecture on quantum mechanics (astrophysics), engaged in a collaborative learning activity about this lecture and then watched a public web-lecture on astrophysics (quantum mechanics). We tested recall of scientific content and the nature of science (NOS) after each phase of the intervention and after one year. Attitudes toward science were also tested. The results suggest that direct instruction that accompanies public scientific lectures can turn attitudes into a useful resource for studying contemporary science in students who cannot learn these topics in a formal manner due to lack of prior knowledge.

GD05: 11:10–11:20 a.m. Neuroscientific Approach to Science Education About Cognitive Conflict

Kyesam Jung, Seoul National University, Daehak-dong, Gwanak-gu, Seoul,151-742 Korea; kye3@snu.ac.kr

We tried to approach science education with the perspective of neuroscience—the organ that explains functions of a brain. Throughout the perspective of neuroscience, we suggested relationships between science education and neuroscience. It might include more deep explanations about our learning mechanism. In the concrete, brain imaging methods of neuroscience can show activated regions in our brain. If we know activated regions of the brain during the learning process, we can try to make a link between two disciplines—science education and neuroscience. We especially focused on cognitive conflict that was considered an important factor for learning in science education. Conflict is also considered an interesting theme in neuroscience. When we are in conflict situations or states, specific regions in our brain are activated. Therefore, we tried to study conflict within science education and neuroscience based on literature.



GD06: 11:20–11:30 a.m. Cognitive Architecture of Common and Scientific Concepts

Paul Tarabek, Didaktis – member of the European Educational Publishers Group, Hasselager, Denmark, Bratislava, Slovakia, 81104; didaktis@t-zones.sk

The cognitive architecture of concepts is a specific structure consisting of the concept core, concept periphery, the semantic frame, and the relations among all components of this structure. The periphery of a concept is composed of the set of meaning and sense links to the all concepts which can be meaningfully connected with the given concept core in speech or thought. The model of the cognitive architecture and four developmental levels of scientific and common concepts are presented as: primitive, empirical, exact, and formal. The model, previously called the triangular model of concept structure, was corrected in light of the Hestenes' Modeling Theory and a cognitive structure of intelligent agents. The model is built upon Vygotsky's concept theory, Fillmore's semantic frame, and on widespread ideas of the structuring of conceptual systems. The comparison of the model with the Force Dynamics of Talmy, and the p-prims of diSessa are presented.

Session GE: Panel – Tutorials in Intermediate Mechanics

Location: Chemistry 1640
Sponsors: Committee on Research in Physics Education, Committee on Physics in Undergraduate Education
Date: Wednesday, July 29
Time: 10 a.m–12 p.m.

Presider: Michael C. Wittmann

Ongoing research in physics education has demonstrated that physics majors often do not develop a working knowledge of basic concepts in mechanics, even after standard instruction in upper-level mechanics courses. This two-hour panel session will focus on Intermediate Mechanics Tutorials (IMT), a suite of research-based materials that provides an innovative instructional approach that supplements traditional lectures. These materials are designed to address persistent student difficulties and to guide students to make appropriate connections between the physics and mathematics. Participants will learn about recent results from the research and obtain firsthand experience the selected tutorials. Examples of IMT materials, which include conceptual, derivation, and computer-based tutorials, will be given to each participant.

Invited Speakers:

Bradley S. Ambrose, Grand Valley State University, Allendale, MI 49401; ambroseb@gvsu.edu

Carrie Swift, University of Michigan - Dearborn, Dearborn, MI 48128-1491; cmswift@umich.edu

Dawn C. Meredith, University of New Hampshire, Durham, NH o3824: dawn.meredith@unh.edu

Session GF: In-service and Pre-service Teacher Preparation

Location: Dana 1040
Sponsor: Committee on Teacher Preparation
Date: Wednesday, July 29
Time: 10 a.m–12 p.m.

Presider: Dan MacIsaac

GF01: 10–10:10 a.m. Building a Supportive, Sustainable, Science Teaching Community in the Urban Environment

Mel S. Sabella, Chicago State University, Chicago, IL 60628; msabella@csu.edu

Andrea Gay Van Duzor, Chicago State University

Chicago State University (CSU) has been working with inservice and preservice teachers to aid them in implementing innovative instructional environments in the Chicago Public School classroom. For over a decade, the Illinois Board of Higher Education has funded professional development programs at CSU that provide intellectual and material resources to high school science teachers. This program is now serving as the base for the development of Masters and Endorsement Programs at CSU. Recently, through funding from the NSF Robert Noyce Teacher Scholarship Program, CSU has begun enhancing our preservice program to emphasize the professional nature of teaching and more fully support the needs of future science teachers. These two programs offer a unique opportunity to create communities of science educators in which inservice teachers work closely with CSU preservice teachers. In this talk we outline how these two programs utilize best practices to create a model program for teacher education.

*Funded by the Illinois Board of Higher Education and the National Science Foundation (Award #0833251).

GF02: 10:10–10:20 a.m. Research Themes in Physics-Teacher Preparation*

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

A diverse array of themes has characterized research on the preparation of physics teachers during the past 50 years, both in the United States and worldwide. I will review some of these themes and discuss examples of the work that has been reported, including teachers' views of students' ideas, design and evaluation of courses on physics pedagogy, supervised field experiences involving practice teaching, and outcomes evaluations of teacher-preparation workshops and programs.

*Supported in part by APS and AAPT through PhysTEC: NSF PHY-0108787.

GF03: 10:20–10:30 a.m. College Ready: $7M NSF-MSP Project to Prepare Teachers*

Gay B. Stewart, University of Arkansas, Fayetteville, AR 72701; gstewart@uark.edu

John C. Stewart, University of Arkansas

The College Ready in Mathematics and Physics Partnership is composed of 38 school districts, UA Fort Smith, and UA, Fayetteville, which will serve as the lead among these core partners, with supporting partners AAPT, APS, College Board, Mathematical Association of America, Maplesoft, and Northwest Arkansas Community College. College Ready will build vertical and horizontal learning communities among school and college faculty in order to improve major articulation issues that impact the successful transition of students from high school to college, targeting physics. College Ready will achieve these ends through a series of interconnected activities including: vertical alignment of high school and college expectations; intensive content-driven workshops; articulation conferences; university course revisions: the creation of professional learning communities: and the opportunity for teachers to earn advanced degrees and endorsements. It builds on and looks to establish synergy between established efforts of PhysTEC and PMET, and our r Noyce project.

*Funded through NSF DUE 0832091

GF04: 10:30–10:40 a.m. Study on How College Science Courses Influence Elementary School Teachers*

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Mojgan Matloob Haghanikar, Dean A. Zollman, Kansas State University

How much influence do we have? Can we convince elementary education majors that the methods used to teach them science from elementary school to high school may not be the best methods? The National Study of Education in Undergraduate Science (NSEUS) is investigating the impact that college science courses have on pre- and in-service elementary school teachers. As part of this study, we are performing site visits to colleges and universities around the nation along with elementary school classrooms taught by that institution's graduates. The institutions participating in this study were part of the NASA-NOVA project leading to the development of active engagement courses for elementary education majors at the institution. A comparison of the opinions of the faculty and pre- and in-service elementary school teachers regarding the teaching of science will be made.

*Supported by the NSF grant NSF ESI-055-4594

GF05: 10:40–10:50 a.m. Improving In-service Science Teachers' Conceptual Understanding of Force and Motion

Susan E. Ramlo, The University of Akron, Akron, OH 44325-6104; sramlo@uakron.edu

In 2005, a survey of U.S. high school physics teachers revealed that only about one-third had a degree in physics or physics education. This problem is compounded with the findings from numerous studies that have indicated that college students are not learning the concepts of force and motion in traditional courses (McDermott & Redish, 1999; Thornton, 1993, 1996; Thornton & Sokoloff, 1998). Thus, effective professional development is necessary to correct conceptualunderstanding in our science teachers to prevent perpetuating these misunderstandings (Escalada & Moeller, 2006). This presentation details a one-week workshop that utilized physics teaching best practices based upon PER. The Force and Motion Conceptual Evaluation pre- and post-test results indicate that this was an effective workshop for improving teachers' Newtonian views of force and motion. Teacher feedback also indicated that they learned new effective teaching strategies for improving conceptual learning in their own classrooms.

GF06: 10:50–11 a.m. Professional Development Through Parallel Teaching and Learning Experiences

Danielle B. Harlow, University of California, Santa Barbara,Gevirtz Graduate School of Education, Santa Barbara, CA 93106-9490; dharlow@education.ucsb.edu

One of the goals of the Physics & Everyday Thinking (PET) curriculum is for elementary school teachers to learn that they (and their students) learn science similarly to the ways scientists develop new scientific knowledge. I present a case study of a teacher who taught science to her elementary school students using K-5 science lessons that were intentionally designed to mimic the pedagogical approach of PET while she was taking a PET-based professional development course. Her learning in PET and teaching in her elementary classroom co-created a unique learning experience that allowed her to observe that her students were capable of the type of inquiry-based learning that is promoted in PET. This leads to the hypothesis that teaching lessons that are carefully designed to respond to common ideas of children may help new teachers recognize the potential of such instruction.

GF07: 11–11:10 a.m. Effective Use of Data-Loggers to Enhance Teachers' Attitudes Toward Inquiry

Sachiko Tosa, University of Massachusetts Lowell, Arlington, MA 02476; tosa.sachiko@gmail.com

Fred G. Martin, University of Massachusetts Lowell

This study examined how a professional development program that incorporates the use of microcomputer-based data-loggers could impact on science teachers' attitudes toward inquiry-based teaching. The participants were 28 science teachers who attended workshops offered in the United States and Japan. The professional development program emphasized a) guided inquiry activities, b) participants' own explorations, c) instructors' guidance, and d) discussions about instructional strategies. Data sources included field notes, video recordings, artifacts, and survey responses. Findings are presented as three assertions: a) all the elements incorporated in the program contributed positively to participants' engagement in inquiry, b) connections between participants' sensory experiences and graphical representation of data led them to have new understanding of the phenomena under the investigation, and c) there were strong connections between their inquiry experiences and teaching strategies. Applications of the findings into the use of data-loggers in physics classrooms will be discussed.

GF08: 11:10–11:20 a.m. Science Courses for In-service Pre-college Teachers

Walter S. Jaronski, Radford University, Radford, VA 24142; wjaronsk@radford.edu

Over the past several years, the author, a university physics professor, has taught off-campus courses for in-service elementary, middle school, and high school teachers. The science content and level of these courses has varied, from that of an optics course for high school teachers to that of an Earth and space science course for a mixed group, including even kindergarten teachers. In all cases, activities were incorporated as much as possible. The difficulties and rewards of teaching these courses will be discussed. In addition, some of the lessons learned about making courses such as these an effective tool for improving pre-college science education will be presented.

GF09: 11:20–11:30 a.m. Professional Development and the Conceptual History of Physics

Peter Garik, Boston University, Boston, MA 02215; garik@bu.edu*

Andrew Duffy, Luciana Garbayo, Charles Winrich, Boston University

Arthur Eisenkraft, University of Massachusetts Boston

Instruction in the history of science during science instruction is supported by major science standards, including the National Science Education Standards (National Research Council 1999) and the American Association for the Advancement of Science in Science for All Americans (1990). Nevertheless, history is absent from most physics instruction. This may be because teachers teach the way they have been taught, and professional development does not emphasize the teaching of the history of physics. The Improving Teaching of Physics (ITOP) Project has had a unique opportunity to inject the conceptual history of physics (CHOP) into professional development for teachers of physics that are licensed in another field but want physics licensure. In our presentation, we describe original and secondary sources we use to teach CHOP, the activities we have designed to make the learning interactive and inquiry-based, and modeling activities that arise from using this conceptual history.

*Sponsored by Andrew Duffy.

GF10: 11:30–11:40 a.m. A College-wide Graduate Teaching Assistant Training Course

Lili Cui, University of Maryland, Baltimore County, Batimore, MD 21250; lili@umbc.edu

Suzanne H. Braunschweig, University of Maryland, Baltimore County

Graduate teaching assistants from science and mathematics departments share similar experiences in teaching introductory college courses, and training programs from various departments typically cover similar ideas (e.g., student-centered learning, guided inquiry). The College of Natural and Mathematical Sciences at University of Maryland, Baltimore County (UMBC) is creating a one-credit GTA training course for all incoming GTAs. Designed by a group of faculty members from mathematics, chemistry, biology, and physics departments, the course aims to improve participants' pedagogical knowledge rather than content knowledge. In the spring '09 semester, two faculty members co-taught the course as a pilot to 14 experienced TAs nominated by faculty members from various departments. The presentation will cover the rationale, design, execution, outcomes, and lessons learned from this pilot experience.

GF11: 11:40–11:50 a.m. Research on Training Undergraduate and Graduate Student Instructors in Tutorials

Benjamin T. Spike, University of Colorado, Boulder, Boulder, CO 80302; spike@colorado.edu

Noah D. Finkelstein, University of Colorado, Boulder

Our graduate Teaching Assistants (TAs) and undergraduate Learning Assistants (LAs) demonstrate differences in their ability to anticipate common student difficulties, despite participating in the same weekly Tutorial training sessions. In addition, survey responses indicate that TAs and LAs differ in how they perceive aspects of the weekly tutorial training sessions and incorporate them into their teaching. This paper describes how the ability of our TAs and LAs to anticipate common student difficulties evolves as a result of the training session. Comparisons are then made between TAs and LAs, across training environments, and longitudinally from week to week. These findings have implications for how weekly tutorial training sessions should be conducted in order to best prepare our recitation instructors to teach using Tutorials.

GF12: 11:50 a.m.–12 p.m. Analysis of Former Learning Assistants' Views on Teaching and Learning

Kara E. Gray, School of Education, University of Colorado, Boulder, Boulder, CO 80309; kara.gray@colorado.edu

Valerie K. Otero, School of Education, University of Colorado, Boulder

We are currently working to categorize middle and high school teachers' views on students, knowledge construction, group interactions, and assessment. This talk will compare the views of teachers who were formerly involved in the Learning Assistant (LA) program to a similar group of teachers who did not participate in this program. This analysis will allow us to reflect on the effects that this program has had on its graduates' teaching. The LA Program is intended to recruit promising science and math majors to become secondary science and math teachers. LAs are hired to assist in science and math courses at the university and are required to take an education seminar focused on teaching methods. Previous work has already shown that the LA program has improved the learning of students in the introductory science and math courses and has increased the number of science and math majors earning teacher certifications.

Session GG: Upper Division Laboratories: Ideas, Equipment, and Techniques: Part I

Location: Dennison 170
Sponsors: Committee on Apparatus, Committee on Laboratories
Date: Wednesday, July 29
Time: 10 a.m–12 p.m.

Presider: Eric Ayars

GG01: 10–10:10 a.m. Determination of *g* with a Microphone

Fredy Zypman, Yeshiva University, New York, NY 10033; zypman@yu.edu

In the standard analysis of small oscillations about the equilibrium position, it is assumed that the quadratic term is the dominant one and thus the oscillations are harmonic and the corresponding frequencies are amplitude-independent. There are oscillations that do not belong to this category. An interesting example is that of a particle bouncing vertically off the floor. In the real case with dissipation, the height of the ball is reduced in consecutive bounces and the frequency of the motion increases. This gives rise to the common observation of rapid drumming that takes place at small amplitudes, just before the motion halts. We use these ideas, including an expression for the frequency vs. amplitude relation, as a way to measure the value of g. We will show how to select proper balls to reduce drag and how to calibrate the microphone. Finally, as a spin-off we will discuss the information stored in the microphone recording during bouncing.

GG02: 10:10–10:20 a.m. A One-Dimensional Mechanical Analog of the RF Paul Ion Trap

James Rabchuk, Western Illinois University, Macomb, IL 61455; ja-rabchuk@wiu.edu

A mechanical system will be presented whose behavior illustrates the principle present in all ponderomotive particle traps. The system consists of a bearing free to roll along a circular hoop that is rotating with constant angular velocity about a horizontal axis parallel to the diameter of the hoop. When the hoop is made to rotate about an axis passing tangent to its bottom, the motion of the bearing is analogous to that of an ion in an rf ion trap. A working model of the system will be demonstrated, and experimental results will be compared to theory.

GG03: 10:20–10:30 a.m. Determining the Muon Mass in an Instructional Laboratory

John Essick, Reed College Physics Department, Portland, OR 97202; jessick@reed.edu

Chris May, Reed College

Ben Brau, University of Massachusetts, Amherst

An instructional laboratory experiment to measure the muon mass is described. Using coincidence-anticoincidence detection, the decay of a cosmic-ray muon into an electron (or positron) is observed in a multiplate spark chamber, and recorded with a triggered CCD detector. The energy of the charged decay-product particle is then determined by the number of aluminum chamber plates it traverses before being stopped. By running this apparatus under computer-control for several hours, the number of product-particles with various energies is obtained. The muon mass is obtained by fitting this experimentally observed distribution of product-particle energies to the functional form predicted for this distribution by the quantum electrodynamics analysis of muon decay. We present the results for the muon mass we have obtained and discuss the simulation we developed to account for the observed skewing of the product-particle energy distribution due to escape of some of the higher-energy particles from the chamber.

GG04: 10:30–10:40 a.m. Study of Electric and Magnetic Dipole Radiation Via Scattering from Nanoparticles

Natthi L. Sharma, Eastern Michigan University, Ypsilanti, MI 48197; nsharma@emich.edu

Senior and graduate-level students are hardly ever exposed to an experiment on multipole radiation even though it is taught in lecture courses on electrodynamics and nuclear physics. The author has developed a simple laboratory experiment to study angular distribution and polarization of electric and magnetic dipole radiation. This experiment arose out of a recent study [Phys. Rev. Lett. 98, 217402 (2007); *Am. J. Phys.* **71**, 1294 (2003)] on the contribution of higher multipoles to optical scattering in aqueous suspensions of 50-200 nm polystyrene spheres and colloids. This study resulted in the first observation of the breakdown of (electric)-dipole approximation in the visible region. The students learn about particle size and wavelength dependence of scattering and how the atomic-molecular scattering is modified by the presence of nanoscatterers. After performing this lab they can explain why one does not see a (polarized) laser beam in a dark room when looking along its electric field. It is an easily implementable low-cost experiment rich in physics.

GG05: 10:40–10:50 a.m. Introduction to Lock-In Amplifiers in an Advanced Lab Course

Thomas M. Huber, Gustavus Adolphus College, Saint Peter, MN 56082; huber@gac.edu

This talk will focus on the Introduction to Lock-In Amplifiers lab that Gustavus students perform in their advanced laboratory course. The students familiarize themselves with the operation of a lock-in amplifier using a CD that includes sinusoidal waveforms superimposed on white noise. The students then measure the resonance frequencies and modal characteristics of a 3 cm x 1 cm brass cantilever vibrated using a mechanical wave driver. To sense motion, a laser is reflected off the cantilever onto a position-sensitive linear detector. It is not possible to detect the periodic oscillations from this detector using an oscilloscope, but these variations are easily measurable using a lock-in amplifier. The students write a LabVIEW VI to acquire data from the EG&G 5209 lock-in amplifier over the GPIB bus. By moving laser focus and measuring the amplitude and phase, the students also determine whether the motion at each resonance is torsional or transverse.

(*This session is continued as Session HB on Wednesday afternoon.*)

Session GH: Cutting-Edge Research at the University of Michigan

Location: Dennison 182
Sponsor: Committee on Graduate Education in Physics
Date: Wednesday, July 29
Time: 10 a.m–12 p.m.

Presider: Myron Campbell

GH01: 10–10:30 a.m. Theoretical Research at the University of Michigan

Invited – Aaron Pierce, University of Michigan, Ann Arbror, MI 48109; atpierce@umich.edu

I will review theoretical research ongoing at the University of Michigan. These include efforts in particle physics, astrophysics and condensed matter.

GH02: 10:30–11 a.m. Permanent Electric Dipole Moments and the Search for New Physics

Invited – Aaron E. Leanhardt, University of Michigan, Ann Arbor, MI 48109-1040; aehardt@umich.edu

A typical introductory course in electromagnetism covers the behavior of electric and magnetic dipole moments in uniform electric and magnetic fields, respectively. Combining these concepts, this talk will describe how a single particle, namely the electron, would behave in parallel electric and magnetic fields if it possessed both an electric dipole moment and a magnetic dipole moment. The electron's magnetic dipole moment arises from its quantum mechanical spin and is well characterized. However, a permanent electric dipole moment of the electron would violate both parity and time-reversal symmetries and has never been seen. We plan to search for such an effect by monitoring the Larmor precession frequency of the valence electrons in a beam of tungsten carbide molecules passing through electromagnetic fields. This is a laboratory-based, tabletop precision measurement, but it probes some of the same "new physics" that the Large Hadron Collider hopes to discover.

GH03: 11–11:30 a.m. Particle Physics and Astrophysics Research at the University of Michigan

Invited – Gregory Tarlé, University of Michigan, Ann Arbor, MI 48109-1040; gtarle@umich.edu

The particle physics and astrophysics groups at the University of Michigan are engaged in research to understand the fundamental constituents of our universe and their interactions. Particle physics experiments are completing our understanding of physics at the smallest scales by studying the elementary particles that generate and carry the forces of nature. Current experiments may bring an understanding of the origin of mass and reveal new symmetries of nature. Astrophysics experiments approach physics at the largest scales by studying galaxies, stars, planets, cosmic rays, and gravitational radiation. Cosmology brings a unification of physics at both large and small scales. Current cosmological research is leading to an understanding of dark energy and dark matter that together constitute the bulk of our universe. Particle physics and astrophysics research at the University of Michigan provide an ideal environment to train students to train students to carry out fundamental research at the frontiers of knowledge.

GH04: 11:30 a.m.–12 p.m. Condensed Matter Physics at the University of Michigan

Invited – Cagliyan Kurdak, University of Michigan, Ann Arbor, MI 48109; kurdak@umich.edu

In condensed matter physics, we try to understand the emergent properties of interacting matter using principles of statistical physics and quantum mechanics. Many of the phenomena that we study have useful applications and thus, we have strong collaborations with engineers and scientists in other fields. In this talk, I will give an overview of the some of the ongoing research activities in the area of condensed matter physics at the University of Michigan.

Session HA: Panel – High School Teachers at CERN

Location: Chemistry 1200
Sponsor: Committee on Physics in High Schools
Date: Wednesday, July 29
Time: 12:45–2:45 p.m.

Presider: Marla Glover

U.S. teachers have participated in the High School Teacher program at CERN for the past three years. The teachers have worked within the collaborative research environment that exists at CERN and many other research facilities. The experiences that these teachers now bring to their classrooms and schools impact the educational process. This session will look at the lessons learned at CERN, the impact on curriculum, the cultural differences and similarities, and resources that teachers have used after the experience.

Invited Speakers:

Shane Wood, 3439 Garfield Ave., #104, Minneapolis, MN 55408; shane.wood@moundsviewschools.org

Francisco Jurado, 19741 Franjo Rd., Miami, FL 33157; juradof@bellsouth.net

Stacey McCormack, 1927 Linden Ave., Mishawaka, IN 46544; stacymccormack@comcast.net

Session HB: Upper Division Laboratories: Ideas, Equipment, and Techniques: Part II

(This session is a continuation of Session GG)

Location: Chemistry 1210
Sponsors: Committee on Apparatus, Committee on Laboratories
Date: Wednesday, July 29
Time: 12:45–2:45 p.m.

Presider: Eric Ayars

Presentations at this session will address "what," "how," and "why," for the advanced laboratory course. Talks will present new experimental techniques, novel equipment, unusual experiments, and helpful pedagogical approaches to upper-division undergraduate physics lab.

HB01: 12:45–1:15 p.m. Creating, Implementing, and Sustaining an Advanced Undergraduate Laboratory Course

Invited – S. Douglas Marcum, Miami University, Oxford, OH 45056; marcumsd@muohio.edu

Laboratory experiences, very broadly defined, are essential at all levels in the study of physical phenomena. The narrow focus here is on providing an upper-division laboratory course in atomic and molecular spectroscopy to students at Miami University over the past 25 years. More broadly, observations of the roles of the course originator/sustainers, department, division, and funding sources will be described for that case. Examples of advanced laboratory development benefiting second-year modern physics laboratories, and serving as demonstrations in introductory courses will be presented. The idea that underlies the course described here was to assist the student in establishing an understanding of the more fundamental connections between atomic and molecular spectra and the underlying structures that give rise to those spectra. A selection of laboratory experiences supporting that idea, and the equipment and techniques necessary to provide them will be outlined. Seminal support from NSF-ILI grants is gratefully acknowledged.

HB02: 1:15–1:45 p.m. Creating a Relatively Low-Cost Single Photon Interference Device ($3-$5K)

Invited – Dean 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.

HB03: 1:45–1:55 p.m. Students' Motivation Toward Modern Physics Laboratory Experiments

Nilufer Didis, Physics Education Major, Middle East Technical University, OFMAE bol, Egitim Fakultesi, Orta Dogu Teknik Universitesi, Ankara, Turkey 06531; dnilufer@metu.edu.tr

Ali Eryilmaz, Middle East Technical University

During the modern physics period, many physical events about relativistic and quantum physics were explained via laboratory experiments and also thought experiments. A modern physics course is generally a compulsory course at the department of physics at different universities in the world. After the theoretical ideas about concepts were given in this course, students conduct some of the important experiments at the modern physics laboratory course. Atomic spectra, atomic energy levels, photoelectric effect, electron diffraction are some of these experiments. By considering the topics and concepts, this is an compulsory advance laboratory course which is given to third grade level students. In this study, the overall idea about experimental techniques, equipment and experiment processes and also the importance of this course are explained. Finally, students' motivation toward conducting modern physics laboratory experiments is examined. Investigation of student motivation may help the reexamination of other advance level physics laboratory courses.

HB04: 1:55–2:05 p.m. Physics by Inquiry Teaching Method in Modern Physics Experiment Course

Mingnan Chen, Tongji University, 1239 Siping Rd., Shanghai, 200092, PR China; mingnan55@gmail.com

Kai Fang, Chen Ni, Tongji University

The teaching method of Physics by Inquiry (PbI) is a studio course developed to improve abilities of the students who will be teachers. This method can also be used in Method in Modern Physics Experiment Course to the students whose majors are physics. The course includes fourteen experiments such as, Millikan's Oil-Drop Experiment, Zeeman Effect Experiment, etc. The students are separated into several groups. There are three or four members in each group who do the same experiment and talk about the topics and finish the questions which were carefully prepared by the teachers. The key points of the physics theory and experimental method are emphasized during the course of four hours per week.

HB05: 2:05–2:15 p.m. Mastery-Based Assessment in Modern Physics Laboratory

Janet Seger, Creighton University, Omaha, NE 68178; jseger@creighton.edu

The sophomore-level Modern Physics laboratory is the first upper-division laboratory required for physics majors at Creighton. Our introductory physics laboratories do not emphasize laboratory techniques and skills, nor do they use equipment beyond the level of computer-interfaced sensors. Modern Physics is therefore the point in our curriculum where students are expected to master data analysis techniques such as error analysis, error propagation, and graphing, as well as laboratory skills such as reading circuit diagrams, using multimeters and oscilloscopes, and troubleshooting their experimental set-ups. Facility with these basic skills is assumed in our more advanced laboratories. To ensure that students successfully make this transition, we implemented a mastery-based assessment of basic laboratory skills as an integral part of the Modern Physics lab. I will discuss the implementation and impact of these assessments at Creighton.

HB06: 2:15–2:25 p.m. Design and Development on Web-based Virtual Lab Environment

Jing Li, Department of Physics, Tongji University, Shanghai, 200092, PR China; jinglee2008@gmail.com

Zuyuan Wang, Kai Fang, ongji University

Increasing interaction and enhancing its quality have long been important goals for researchers. We are interested in creating an online learning environment similar to that one might experience in an actual university. In this environment, we encourage learners to actively integrate symbolic and dynamic visualizations and interact with them. We present our experience of developing a Web-based Virtual Lab Environments for Physics course "conservation of angular momentum." We use Web3D technology and multimedia tools to support experimental learning. The sense of presence and the feeling of operating in a shared space help students to feel part of what they are experiencing. They are interacting with the learning environment and it is responding, they no longer feel isolated or lonely but are engaged as they interact with the real world. Many of the features are helping stimulate their cognitive processes and lend them to self-guided study before classroom in introductory part.

HB07: 2:25–2:35 p.m. The Application of Computer Network System in Physics Experiment Course

Kai Fang, Dept. of Physics, Tongji University, Shanghai, 200092 PR China; fangkaitj@tongji.edu.cn

Chen Ni, Mingnan Chen, Tongji University

Computers and network technologies are widely used in introductory physics courses and physics experiment courses. A new computer network system, the intellectualized network experimental system, is introduced to collect the data and results of students when they are doing physics experiments in lab. The information will be saved in the database to be analyzed in education research field. Teachers have used this system to manage their teaching and find the difficulties and mistakes of students during the experiment course for several terms. Some analyses are given in this paper, concerning the network structure, communication interface, software, application in experimental teaching and prospect of the intellectualized physical experimental network system. The research-based survey shows the students' attitudes to this system and teaching method.

HB08: 2:35–2:45 p.m. Modifying the Optics Laboratory for Greater Conceptual Understanding

Timothy T. Grove, Indiana University Purdue University Fort Wayne, Fort Wayne, IN 46805; grovet@ipfw.edu

Mark F. Masters, Indiana University Purdue University Fort Wayne

We developed a sequence of optics laboratories that assist the student in understanding critical concepts in optics. Our approach relies upon discussion, direct confrontation of misconceptions, and leading questions as opposed to a series of detailed, cookbook-like instructions. Through the labs we build conceptual understanding in subjects like image formation by lenses and mirrors, ray optics, and ultimately elliptical polarization while fostering laboratory independence. Initial support structure in the laboratory is progressively removed. In the final three weeks, students complete an independent research project. We present details of our laboratory sequence and our impressions of the modifications.

Session HC: Computer Modeling in the Introductory Course

Location: Chemistry 1300
Sponsors: Committee on Physics in Undergraduate Education, Committee on Educational Technologies
Date: Wednesday, July 29
Time: 12:45–2:45 p.m.

Presider: Wolfgang Christian

Although there have been many talks and sessions presenting the results of computer modeling with advanced students, computer modeling can and should be made accessible at all levels. This session explores how to incorporate computer modeling into introductory physics courses using tools such as V-Python, Easy Java Simulations, and Stella.

HC01: 12:45–1:15 p.m. Supporting Multiple Representation Through Dynamic Re-presentation in Physics Models

Invited – Robert M. Panoff, Shodor, 300 W. Morgan St., Durham, NC 27701; rpanoff@shodor.org*

Matt Desvoigne, Shodor

Deeper understanding of fundamental physics concepts and relationships can be achieved by effective use of interactive computer models that link the formulaic, numerical, graphical, and visual representations. Computing power at the desktop/laptop level is now more than sufficient for accurate solution of coupled equations, enabling the student to control the model in real time. By re-computing and re-presenting the model—dynamically—the student is able to use these re-presentations to form a more accurate representation of the physical system and its underlying mathematical formulation. This talk will explore several such model environments developed at Shodor as part of the Computational Science Education Reference Desk, a Pathway portal of the National Science Digital Library.

*Sponsor: Wolfgang Christian

HC02: 1:15–1:45 p.m. Instantiating a New Class – Teaching Computational Physics in Introductory, Calculus-Based Physics

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

Teaching computational methods in introductory physics is useful for: 1) illustrating the reductionist nature of physics—that complex phenomena can be understood through the application of a few fundamental principles; 2) equipping introductory physics students to explore phenomena normally considered too advanced for introductory physics; 3) demonstrating numerical calculus which seems much more conceptual than the Power Rule and is typically a topic covered in calculus courses; 4) connecting theory and experiment by comparing results of a computational model with an analytical solution and experimental results; 5) introducing a computational approach to problem solving where one builds a computational model and uses it to make predictions or solve problems; and 6) exposing students to computational science which plays a critical role in all areas of science. I will describe one possible path for meeting these objectives in a two-semester course using Excel and VPython.

HC03: 1:45–2:15 p.m. Video Modeling with Tracker

Invited – Douglas A. Brown, Cabrillo College (emeritus), 7960 Soquel Dr., Ste. B268, Aptos, CA 95003; dobrown@cabrillo.edu

The Tracker video analysis and modeling program enables students to create simple particle model simulations based on Newton's laws and to compare their behavior directly with that of real-world objects captured on video. Tracker's "model builder" provides a gentle introduction to dynamic modeling by making it easy to define and modify force expressions, parameter values and initial conditions while hiding the numerical algorithm details. Because the model simulations synchronize with and draw themselves right on the video, students can test their models experimentally by direct visual inspection, a process that is both intuitive and discerning. This leads them to move from a paradigm of "problem solving" to one of "model building and testing" that reflects more closely the activities of professional physicists. Tracker is part of the Open Source Physics project. Tracker is available at http://www.cabrillo.edu/~dbrown/tracker/ or from the comPADRE Open Source Physics collection at http://www.compadre.org/OSP/.

*Partial funding was provided by NSF grant DUE-0442581.

HC04: 2:15–2:45 p.m. Computer Modeling in an Introductory Physics Course

Poster – M. Juliana Carvalho, Ryerson University, Toronto, ON M3A 2K4; jcarvalh@ryerson.ca

Maple's powerful capabilities for symbolic computation, programming, and graphical display, make it an excellent tool to teach/learn physics concepts and problem solving techniques. Maple is embedded in the course curriculum of the introductory physics course offered to Computer Science students at Ryerson University. The purpose of this presentation is to show evidence of this tool's usefulness, by demonstrating a few of the most creative student-built Maple simulation simulation projects.

Session HD: Best Practices for Teaching with Technology

Location: Chemistry 1400
Sponsor: Committee on Educational Technologies
Date: Wednesday, July 29
Time: 12:45–2:45 p.m.

Presider: Tim Erickson

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.

HD01: 12:45–12:55 p.m. Implementation of Elements of the Physics Suite at UCF

Dan Maronde, University of Central Florida, Orlando, FL 32816-2385; maronde@physics.ucf.edu

Costas Efthimiou, Enrique Del Barco, University of Central Florida

Tim McGreevy, Embry-Riddle Aeronautical University

Stefanie McCole, McDaniel College

The University of Central Florida Physics Department is completing the second year of an NSF CCLI grant. The project is comparing the learning of students taught using various components of The Physics Suite with the learning of students taught with traditional methods. The amount of student learning is quantified by a normalized-gain comparison between pre- and post-tests. Some of the lecture sections of both Physics I, Mechanics, and Physics II, Electricity & Magnetism, are including Interactive Lecture Demonstrations as part of the instruction. Several of the Lab sections corresponding with Physics I & II are using Real Time Physics. Student performance is compared among four groups: Students who have been taught using both of the applied elements of The Physics Suite, students who have had one component or the other, and students who have learned in a traditional lecture and lab. Statistics have been collected from classes taught from the fall semester of 2007 through the spring semester of 2009. A comparison of student performance in classes including different approaches to the recitation component of the course is in the early stages and early results are presented.

HD02: 12:55–1:05 p.m. Interactive Physics Education with Clickers

Serif Uran, Pittsburg State University, Pittsburg, 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 and for different purposes. I started using clickers in my College Physics I and Engineering Physics II classes to promote participation about three 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.

HD04: 1:05–1:15 p.m. Dynamical Animations of Electric and Magnetic Fields of Multiple Charges

Lawrence B. Rees, Brigham Young University, Provo, UT 84602; Lawrence_Rees@byu.edu

In physics courses we usually ignore one important characteristic of electric and magnetic field lines: field lines are dynamic. That is, fields propagate outward from source charges at the speed of light. While it is reasonably straightforward to animate the fields of individual charges, both stationary and moving, it becomes more difficult to do this for the fields of multiple charges. The most important reason for this is that the total field is the sum of vectors moving in different directions. We present a method of representing the fields of multiple charges in a way that preserves the proper dynamic aspects of the system. We apply the method to simple systems of stationary and moving charges.

HD05: 1:15–1:25 p.m. Analogy Use in PhET Simulation Design

Noah S. Podolefsky, University of Colorado at Boulder, Boulder, CO 80309-0390; noah.podolefsky@colorado.edu

Wendy K. Adams, Kathy K. Perkins, University of Colorado at Boulder

As part of the PhET Interactive Simulations project,[1] we have developed a computer simulation (sim) on wave interference. This highly interactive sim allows users to create patterns of constructive and destructive wave interference with three different wave phenomena: water, sound, or light waves. These three phenomena are treated as analogs and are linked in the sim by the use of similar wave representations. We describe a theoretical framework for incorporating analogies into learning tools such as a computer simulation, and results of interviews with students using the Wave Interference sim. We find that interactivity of the sim, dynamic feedback, and the use of both concrete and abstract representations are three key components of this engaging and educationally effective sim.

1. http://phet.colorado.edu

HD06: 1:25–1:35 p.m. Flash Solutions to Reinforce Problem-Solving Techniques

Collette A. Marsh, Harper College, Palatine, IL 60067; cmarsh@harpercollege.edu

Despite the fact that problem-solving techniques are emphasized and practiced in the classroom, true student success can only be achieved through individual efforts outside of class time. Unfortunately, the approach of many introductory physics students is to attempt to "match the problem to the formulas" given in the text. An innovative method of providing solutions that emphasize problem-solving techniques has been developed using commonly available software for distribution to students. Problems are solved in a sequential manner and presented in a click-through-the-steps manner using Flash. These solutions can then be distributed to students through course management systems or web pages, giving unlimited access.

HD07: 1:35–1:45 p.m. WebTOP: X3D Based Interactive Simulations for Waves and Optics Instruction

Taha Mzoughi, Kennesaw State University, Dept. of Biology and Physics, Kennesaw, GA 30144-5591; tmzoughi@kennesaw.edu

John T. Foley, Mississippi State University

WebTOP is an Open Source project focusing on developing learning activities for teaching and learning optics and waves. It runs as a platform-independent Java application with 3D visualization enabled through the use of X3D, the new standard for displaying 3D computer graphics. Topics addressed by WebTOP include waves, reflection and refraction, polarization, interference, diffraction, lasers, and the photoelectric effect. Each WebTOP module has an interactive simulation, a theory section, sets of examples and exercises, and a scripting feature for recording interactions. We will use the presentation to demonstrate several of the WebTOP modules and the other resources available through WebTOP. WebTOP is sponsored in part by the NSF (DUE 0231217).

HD08: 1:45–1:55 p.m. Measuring Systematic Error with Curve Fits

Mark Rupright, Birmingham-Southern College, Birmingham, AL 35254; mruprigh@bsc.edu

Systematic errors are often unavoidable in the introductory physics laboratory. Such errors can present a fundamental problem for data analysis, particularly when comparing the data to a given model. In many cases, however, we can account for systematic errors by using powerful curve fitting software packages and adjusting the model accordingly. Here I give three examples in which my students use popular curve fitting software to account for, estimate, and even exploit the presence of systematic errors in measured data.

HD09: 1:55–2:05 p.m. Adopt-a-Physicist: Using Technology to Help Students Explore Career Options

Kendra Rand, American Institute of Physics, Society of Physics Students, College Park, MD 20740; krand@aip.org

Lyle Barbato, American Association of Physics Teachers

Physics degree holders have extremely varied careers and career paths—from rocket scientist to science writer to medical physicist. Since 2006, the Adopt-a-Physicist program has aimed to share the career possibilities a physics degree can bring by connecting high school physics classes with physics graduates through online discussion boards. Over a three-week period, students engage in open and informal conversations with "adopted" physicists about life, physics, and careers. We will discuss the program's position as one of many online programs that use technology to help students explore career options and its initial evaluation through program surveys from 2006-2009 and interviews with past participants. We will also discuss plans for a more rigorous assessment of the program's broader impacts, including a discussion of its affect on the attitudes of teachers, students, and physicists involved in the program.

HD10: 2:05–2:15 p.m. Online Assessments Using Blackboard-CE

David R. Klassen, Rowan University, Glassboro, NJ 08028; klassen@rowan.edu

Georgette K. Sahm, Rowan University

For several years now the Department of Physics and Astronomy at Rowan University has been performing content assessments for introductory physics courses and student evaluations for all classes. Doing this "the old-fashioned way" involved considerable personnel time to distribute materials, proctor the assessment or evaluation, compile results from bubble-sheet printouts, and return results to faculty. Additionally, this creates a growing stack of papers to be filed and/or destroyed. In the fall of 2006 the departmental assessment committee decided to expand subject matter assessment and to attempt to increase efficiency by transitioning to an online method of gathering and processing the data. As we had considerable expertise with WebCT (now Blackboard-CE) we chose this platform to present the assessments. In this talk we will describe our experiences in making the transition and plans for future changes based on those experiences.

HD11: 2:15–2:25 p.m. E-Learning in Physical Science Through Sport

Robert Lambourne, The Open University, piCETL, Walton Hall, Milton Keynes, MK6 3AY, United Kingdom; r.j.lambourne@open.ac.uk

E-Learning in Physical Science through Sport (ELPSS) is a three-year project funded by the UK Higher Education Academy through its National Teaching Fellowship Scheme. The aim of the project is to create a large number of reusable learning objects (RLOs), each of about 30 minutes duration, that introduce basic topics in physical science using sporting examples and contexts. The learning objects are highly interactive and include student self-assessment tests. The talk will describe the RLO design principles and programming decisions, examine the choice of physics topics, outline the findings of user tests, and discuss the larger scale testing that will start later this year when approximately 25 of the RLOs will be used for core physics teaching in a course on 'Olympic Science' that will be taken by approximately1000 students per year.

HD12: 2:25–2:35 p.m. Using Document Camera for Interactive Learning

Yuanjia Hong, Miami University, Oxford, OH 45056; hongy2@muohio.edu

A variety of tools, such as Tablet PC, whiteboard, PowerPoint presentation, over-head projector, etc., has been widely used in the classroom, each having advantages and disadvantages in meeting the needs of vivid in-class presentation. Doc-camera, along with screen capturing software, allow presenters to integrate multimedia content with hands-on, minds-on activities in and out of classrooms. Designs and examples of this time-saving and effective tool will be presented.

Session HE: Teaching Physics Around the World: Part II *(This session is a continuation of Session CE)*

Location: Chemistry 1640
Sponsor: Committee on International Physics Education
Date: Wednesday, July 29
Time: 12:45–2:45 p.m.

Presider: Lei Bao

HE01: 12:45–12:55 p.m. Electricity Production Designs in Uganda with Physics of Energy Curriculum

Abigail R. Mechtenberg, University of Michigan, Ann Arbor, MI 48105; amechten@umich.edu

Using 1) experience from teaching physics in U.S. inner-city and rural hard-to-staff high schools to community college and universities, 2) research from the relationships between energy and human development, and 3) curriculum from an innovative physics of energy course, creates a unique intersection of empowering local stakeholders to design and build their own electric energy producing devices in Uganda, Africa. This oral paper presentation will describe the importance of this intersection by focusing on the relationships between electricity and human develop in general and observed in Uganda. Three devices will be described in detail in terms of the physics of energy conceptual maps local technicians drew, as well as the business plans created based on entrepreneurial potential in villages with no access to electricity, and in hospitals where the electric grid is unreliable.

HE02: 12:55–1:05 p.m. Earth Rotating Around Its Axis – How Do We Know?

Ann-Marie Pendrill, Department of Physics, University of Gothenburg, Göteborg, 412 96, Sweden; Ann-Marie.Pendrill@physics.gu.se

CANCELED

How do we know? 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. For example, 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.

HE03: 1:05–1:15 p.m. High School Thermodynamics

Sonia Fernandes, Universidade de Trás-os-Montes e Alto Douro and EASFS, Porto, 4200-072,Portugal; sonia.fernandes@gmail.com

Joaquim Anacleto, Universidade de Trás-os-Montes e Alto Douro

This study focuses on high school thermodynamics, a subject often used in science classes to deal with the compulsory topics of energy and its proficient use. Starting from identifying the concepts selected by government teams, responsible to develop high school curricula around the world, we clarify the theoretical framework supporting governmental choices regarding what to teach and know. Aimed to answer the question "Are high school curricula being developed taking into account the subtleties of thermodynamics," this work also reveals the thermodynamical topics taught around the world, by carrying out a critical and extensive analysis of the documents supporting the high school educative system in several countries around the world, and that are used by teachers to plan and prepare their classes. The differences found allow us to systematize a set of information that we hope teachers will use to enhance the effectiveness of their classes.

HE04: 1:15–1:25 p.m. Understanding Physics[1] – Translation PER Ideas

David Pundak, Ort Braude College, Snunit 51, Karmiel, 21982, Israel; dpundak@gmail.com

Arie Maharshak, ORT Braude College

Substantial efforts have been invested during the last two decades to convert the physics pedagogy from a passive mode of learning to an active one. Physics Education Research (PER) findings were transformed into activities, demonstrations, animations, books, websites, and other media. Despite the emergence of numerous teaching innovations, only a tiny fraction of physics faculty, in the United States and abroad, tends to adopt these new methods. Pursuing the adoption of PER innovations, we tried to apply some of its insights into the Israeli academic arena. Last year we translated 16 chapters from the book *Understanding Physics,* written by PER leading writers, to Hebrew. We also added some specific supplements in order to meet the special needs of the Israeli academia. Our presentation will reflect the difficulties we faced while converting the PER's ideas into a textbook, suitable even to the profile of the traditional physics faculty.

1. Karen Cummings, Priscilla W. Laws, Edward F. Redish, Patrick J. Cooney, *Understanding Physics*, 1st ed. (Wiley, 2004).

HE05: 1:25–1:35 p.m. Multiple Models and Methods for Physics Education in Beijing institute of Technology

HU Haiyun, Beijing Institute of Technology, Haidian District, Beijing, 100081, PR China; huhy@bit.edu.cn

This paper mainly introduces a series of reforms in physics education aimed at students of arts, science, and engineering at a joint program at the Beijing Institute of Technology. Based upon a full-time course and distance learning, the foreign and Sino-British joint program sums up the achievements in the students' innovation ability and includes specific methods designed to stimulate students' interest in physics study and enhance the students' understanding. We put forward new thoughts on the existing problems and share with all physics teachers a better practice of teaching reform.

HE06: 1:35–1:45 p.m. Has Science Teaching Lost Its Soul?

Michael Ponnambalam, University of the West Indies, Kingston, 00007, Jamaica; michael.ponnambalam@uwimona.edu.jm

Science teaching has increasingly become only a transmission of knowledge. It is focusing only on the brain of the student, and not on the whole person. Even on the brain, it is focusing only on the left half, and neglecting the right half. More and more universities are preparing their students only for the job market, and not for life. In the name of efficiency, we have become one dimensional. The modern university is slowly turned into a factory for producing efficient robots, instead of mature human beings. We have forgotten that just as any stable seat needs three legs, so do we need the arts to develop our hearts, the sciences to develop critical thinking, and spirituality for wisdom and enlightenment. Has science teaching lost its soul?

HE08: 1:45–1:55 p.m. Introducing Contemporary Teaching and Learning Methods to Bilingual College Physics in China

Xiaoli Wu, Beijing Institute of Technology, Department of Physics, Beijing Institute of Technology, Beiing,100081, PR China; xlwu@bit.edu.cn*

Haiyun Hu, Zhaolong Liu, Beijing Institute of Technology

In this talk, the current situation of college physics in Beijing Institute of Technology, and the problems that we are facing in teaching and learning, are analyzed. Contemporary teaching and learning methods are introduced into a bilingual college physics course. These approaches make students active participants in the learning process and responsible for their own learning. Students can develop practical skills that they need in the future as well as conceptual understanding of physics through carefully designed learning events in this course.

*Sponsored by Lei Bao

HE09: 1:55–2:05 p.m. Research of Physics Learning and Teaching Supported by Mobile Technology

Helan Wu, Department of Physics, Tongji University, Shanghai, 200092, PR China; hlwu@tongji.edu.cn

Bingyuan Hu, East China Normal University

From the perspective of physics teacher's professional development (TPD), this paper discusses how to use mobile sets in physics learning and teaching. According to our investigation, mobile learning is getting more and more popular in China, but we also found that physics teachers in China encountered many difficulties when they use information technology (IT) in teaching, the utilization of IT in physics teaching is the first step. We will discuss how students can effectively learn physics with a mobile, and how teachers can create the learning situations and learning environment by designing media resources for physics learning on a mobile set.

HE10: 2:05–2:15 p.m. Instructional Design of Physics Experiment Based on Science Workshop System

Chen Ni, Department of Physics, Tongji University, Shanghai, 200092, PR China; nissen@tongji.edu.cn

Kai Fang, Mingnan Chen, Tongji University

The Science Workshop system developed by PACSO is a system of real-time computer measurement of physics experiments that uses different types of sensors to achieve a wide range of physical quantitative measurement and analysis. The equipment has been applied in the physics experiment courses in many Chinese universities and colleges in order to handle the modern techniques of measurement. It has had a positive educational value to improve students' experimental creativity. For several years, we have developed almost 40 physics experiments in the application of the Science Workshop system, such as Coupled Pendulum Experiment, Refractive Index Experiment, RLC Circuits Experiment, etc.

Session HF: Innovations in the Two-Year College Curriculum

Location: Dana 1040
Sponsor: Committee on Physics in Two-Year Colleges
Date: Wednesday, July 29
Time: 12:45–2:45 p.m.

Presider: Paul D'Alessandris

This session includes papers concerning innovations in all aspects of TYC physics: recruitment, retention, pedagogy, transfer articulation.

HF01: 12:45–1:15 p.m. Adaptable Curriculum: Engaging Millennial Generation Students

Invited – Erik N. Christensen, South Florida Community College, Avon Park, FL 33825; christensene@southflorida.edu

Adaptation of pre-existing curriculum can be an invigorating way to energize your teaching and engage your students. Millennial Generation students display specific, predictable traits and characteristics that when integrated into the pedagogy, can result in an engaging classroom environment with vastly improved student learning. This presentation will showcase the adaptation of Spiral Physics in a calculus-based physics course at South Florida Community College and will include an overview of Spiral Physics, the how and why of shifting to an adaptable curriculum, problems encountered, support needed, and a preliminary assessment of student learning results. You will see that adopting adaptable curriculum is not too difficult to implement and the rewards can be astonishing.

HF02: 1:15–1:45 p.m. The Engaging Physics Lab Using LabView

Invited – Kent Reinhard, Southeast Community College, Lincoln, NE 68520; kreinhar@southeast.edu

Students learning physics for the first time are often quickly confronted with their own misconceptions about how the physical world works. Physics labs at Southeast Community College are designed to present the students with direct observations to help reveal how the students think about physical laws. Students are asked to make predictions ahead of time and then use interactive real-time data to reveal the outcome. Students then have the opportunity to evaluate how their predictions compared to the outcome and to work at modifying their thinking if needed. The software package LabView is used to collect this real-time data. This versatile software can be modified in many ways to produce the best fit for the equipment and lab structure that will maximize the student's opportunity for success. Ways of engaging the student with data collection and feedback will be discussed.

HF03: 1:45–1:55 p.m. Using Mini-Investigations, Writing, and Short Presentations to Promote Evidence-Based Reasoning

Alex Azima, Lansing Community College, East Lansing, MI 48826; alex@lcc.edu

The lecture method has been shown to be not very effective as a teaching tool. Rather than listening to lectures, our calculus-based physics students are often engaged in short investigations of the usual lecture topics. These mini-investigations are followed by written analytic papers and/or short presentations, which demand reasoning based on evidence gathered in the investigations. Examples of mini-investigations as well as rubrics for the papers and presentations will be shared.

HF04: 1:55–2:05 p.m. Connecting Math, Physics, Engineering, and Technology*

Frederick J. Thomas, Math Machines, Englewood, OH 45322; fred.thomas@mathmachines.net

Beginning in 1995, math, physics, engineering, and technology faculty at Sinclair Community College in Dayton, OH, have cooperated extensively in an effort to improve connections among their courses. A major feature of this collaboration has been the development and use of brief engineering-style projects within math and physics classes. Unlike traditional engineering projects (which generally focus on the design, construction, and testing of physical PRODUCTS), these math and physics projects focus on the design and testing of mathematical functions to control physical PROCESSES using pre-assembled apparatus. Examples include programming an RGB light emitting diode to oscillate with a frequency that depends on temperature, programming a rotating mirror to deflect a light beam onto a moving target, and programming an "algebraically controlled vehicle" to move with uniform acceleration. These control systems can be implemented with free software using either computers or TI graphing calculators.

*Based in part upon work supported by the National Science Foundation under Grants No. DUE-9454571 and DUE-0202202

HF05: 2:05–2:15 p.m. Using the Box to Help Students Understand Vector Addition

Margaret Geppert, Harper College, Palatine, IL 60067; mgeppert@harpercollege.edu

Students generally have difficulty applying what they have learned about vector addition to the creation of systems of equations involving Newton's Second Law or Conservation of Momentum. The method of vector tables is useful to help students construct these systems of equations. Response to this method has been favorable, with students indicating that the consistency of approach helps them visualize the breakdown of vectors into component parts.

HF06: 2:15–2:25 p.m. Failing the Test

David Weaver, Chandler-Gilbert Community College, Chandler, AZ 85225; david.weaver@cgcmail.maricopa.edu

I am a testing heretic. I believe that grades (and, therefore, tests) are anachronistic and do not truly measure learning. Furthermore, tests exist primarily in the world of education and also in certification exams. My 3.71 GPA (derived mostly from exams) did not indicate how good of a physicist I might be. Good scores on MCAT or LSAT don't assure excellent doctors and lawyers. I passed both Cisco and Novell certification exams and I assert that my passing scores did not measure my ability to be a good network administrator. If tests don't measure authentic learning and don't reflect real life (can't cram for a paycheck), why use them? I don't, should you?

HF07: 2:25–2:35 p.m. Building a Better Learner: Pedagogical Changes Entering TYC Physics

Karim M. Jaffer, John Abbott College, Sainte-Anne-de-Bellevue, QC H9X 3L9; karim.jaffer@johnabbott.qc.ca

Silvia D'apollonia, QEMSAP / Dawson College

Christie Brown, MELS

The Quebec Secondary School curriculum is undergoing a reform toward an emphasis on inquiry-based learning in cross-curricular contexts. While teachers receive pedagogical training, many struggle with the content expertise needed to create curriculum. CEGEP pre-university programs (providing a transition experience equivalent to grade 12 and 1st-year university in other regions) provide instruction in a predominantly lecture-based environment with recent shifts toward project-based learning and more exploratory lab situations, despite a lack of mandatory pedagogical training. CEGEP career programs already present a project-based environment which cuts across traditional disciplines. In Fall '08, 10 collaborative work-teams were established with members from each level with an aim to design curricula for the Secondary 4 (Gr.10) Science & Technology reform programs, with extension modules to be delivered at the CEGEP level.

HF08: 2:35–2:45 p.m. Symmetry and Patterns in Rangolee Art from India

Madhuri Bapat, Eastern Arizona College, Thatcher, Az 85552; durga1950@hotmail.com

Rangolee is an ancienct art of floor decoration from India. Rangolee designs can be classified as traditional or contemporary. They can also be classified based on the method of drawing them. Some are drawn by first drawing dot matrices: rectangular, isometric, fractals, radial or other, such as fractals made by rectangular dot metrices. Designs are drawn by either connecting dots or drawing a line around the dots. They all look beautiful due to reflective or rotational or both symmetris in them. Many mathematical models such as fractals, cyclic orders, mirror curves, recursions and algorithms are seen in the designs. This author uses mirror curves as a tool to reemphasize the laws of reflection in basic physics class. It is said that practicing these designs daily can transfer that logic in children's brain by something called kinesthetic intelligence.

Session HH: Teacher Preparation: Research on Teacher Quality Instruments

Location: Dennison 182
Sponsors: Committee on Teacher Preparation, Committee on Research in Physics Education
Date: Wednesday, July 29
Time: 12:45–2:45 p.m.

Presider: Stamatis Vokos

HH01: 12:45–1:15 p.m. Measuring Teacher Quality With FASCI Instrument: A Multi-University Study

Invited – Valerie K. Otero, University of Colorado at Boulder, Boulder, CO 80309; valerie.otero@colorado.edu

Robert M. Talbot, University of Colorado at Boulder

The Flexible Application of Student Centered Instruction (FASCI) instrument is a scenario-based survey that measures teacher pedagogical knowledge. The instrument has been administered to physics and non-physics teachers and teacher candidates at multiple universities throughout the United States. In this presentation we will report on the development of the survey instrument and we will discuss the new constrained-response version that is currently being developed and tested. We will present quantitative and quantitative validity arguments and discuss the utility and limitations of the instrument. Finally, we will present results from FASCI administration at multiple sites and use these results to compare teacher-certification programs as well as to compare students within programs.

HH02: 1:15–1:45 p.m. Measuring Content Knowledge of Middle Grades Teachers

Invited – Sean Smith, Horizon Research, Inc., Chapel Hill, NC 27278; ssmith62@horizon-research.com

This presentation describes an instrument for measuring teachers' knowledge for teaching force and motion concepts in the middle grades. The measure has content validity, is minimally burdensome, and is situated in instructional practice. Defining the performance space involved specifying both the science content and the domains of teacher knowledge. The latter process was iterative; attempts to write items revealed some domains that did not lend themselves to multiple-choice items. Three types of items were ultimately created: knowledge of science content; using science content to analyze student thinking; and using science content to make instructional decisions. After extensive cognitive interviewing with teachers, 60 items were piloted. Dimensionality analyses revealed that the items were clustered in one group, which we termed content knowledge for teaching force and motion concepts.

HH03: 1:45–2:15 p.m. Assessing Teachers' Formative Assessment Skills and Knowledge*

Invited – Jim Minstrell, FACET Innovations, 1314 NE 43rd St., Ste. 207, Seattle, WA 98105; JimMinstrell@FACETInnovations.com

Ruth A. Anderson, Pamela Kraus, FACET Innovations

Min Li, University of Washington

Stamatis Vokos, Seattle Pacific University

Formative Assessment has been identified as one of the most effective instructional strategies for promoting student learning. We are creating tools for assessing and promoting teachers' understanding and skills of formative assessment related to teaching introductory physics. We envision the tools being used by professional developers or by teachers themselves to assess and develop formative assessment skills. Instruments specifically target the following: teachers' skills at anticipating student responses; skills at interpreting the responses to get at strengths, problematic aspects, and identification of students' cognitive or experiential needs; and skills at designing, or evaluating actions specifically to address the identified students' needs. Findings are expected to contribute to further explication of a theoretical framework of components of effective formative assessment in science instruction. Assessment instruments and preliminary results will be shared in the session.

*This material is based upon work supported by the NSF Grant REESE 0535818. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the view the National Science Foundation.

HH04: 2:15–2:25 p.m. Measuring Physics Teacher Knowledge: Domain-General or Domain-Specific?

Robert M. Talbot, University of Colorado at Boulder, School of Education, Boulder, CO 80309-0249; robert.talbot@colorado.edu

Valerie K. Otero, Derek C. Briggs, University of Colorado at Boulder

The development of reliable and valid measures of science teacher knowledge is essential for the evaluation of teacher education programs. A particular challenge is that most programs serve pre-service teachers with a range of disciplinary specialties. Is it best to measure science teacher knowledge within individuals' science specialty, or can this be measured domain-generally for the sciences? In our physics education research, we investigated this question by developing a physics-specific measure of science teacher knowledge. We then conducted an experiment in which we randomly administered a domain-general measure or the parallel physics-specific measure to a population of pre-service science teachers. We also observed the teaching practices of a subset of participants in order to contribute to the validity of these measures' interpretations. The empirical evidence gathered serves to further develop the Flexible Application of Student-Centered Instruction (FASCI) instrument, and contributes to our understanding of science teachers' pedagogical content knowledge.

Session HI: Post-Deadline Papers

Location: Dennison 170
Date: Wednesday, July 29
Time: 12:45–2:45 p.m.

Presider: Mel Sabella

HI01: 12:45–12:55 p.m. Preparing Undergraduate Physics Majors at Hampton University for Graduate School

Claudia M. Rankins, National Science Foundation, Arlington, VA 22230; crankins@nsf.gov

Doyle Temple, Jan Mangana, Hampton University

The Physics Department at Hampton University revised its curriculum in 2003 in order to include components that prepare its undergraduate students for graduate study. During the freshman and sophomore years, students attend four physics courses whose contents are coordinated to give a thorough experience including physics theory, computational physics, experimental physics, and communication in physics. Students begin working on research projects as early as their freshman year. In their junior year, students refine their physics skills by taking specialized courses covering physics concepts previously learned in greater depth and mathematical complexity. They begin research that will be the basis for their senior thesis. In the senior year, they perform research and write and defend a Senior Capstone Thesis. This talk focuses on the curriculum, but also highlights other activities that prepare undergraduates for graduate school. It presents the results of the curriculum reform as well.

HI02: 12:55–1:05 p.m. Modeling a Water Balloon Slingshot in the Introductory Physics Lab

Benjamin D. Bousquet, Wartburg College, Waverly, IA 50677; ben.bousquet@wartburg.edu

Charles Figura, Wartburg College

At Wartburg College, we have introduced a series of open-ended modeling exercises into the introductory physics laboratory curriculum. Each of these activities provides a framework for students to design their own experiment and plan their data collection and analysis, with the ultimate goal of constructing a mathematical model of a physical system that is capable of producing testable predictions. This presentation will describe one of the more successful and popular examples of these activities in which students attempt to model the behavior of a water balloon slingshot. Variations and follow-up activities that make this exercise suitable for a range of introductory physics courses for both majors and nonmajors will also be presented.

HI03: 1:05–1:15 p.m. Cognition of an "Expert" Tackling an Unfamiliar Conceptual Physics Problem

David Schuster, Western Michigan University, Western Michigan University, Kalamazoo, MI 49008-5252; david.schuster@wmich.edu

Adriana Undreiu, University of Virginia's College at Wise

We have investigated and analyzed in detail the cognition of an "expert" tackling a qualitative conceptual physics problem of an unfamiliar type. The basic but nontrivial task was to find qualitatively, with reasoning, the acceleration direction of an object in curved motion with forces acting; namely a pendulum bob at various stages of its motion. Multiple facets of cognition were revealed. A narrative account will be given of the zigzag thinking paths and interplay of reasoning modes, knowledge elements, principles and case-knowledge involved, and their context- and background-dependence. We interpret the cognitive processes using the following theoretical ideas: case-based, principle-based, and experiential-intuitive reasoning; general strategies; knowledge elements; conceptual schemata; association and transfer; cueing, interference, and side-tracking; metacognition and epistemic frames. Methodology was unusual in using introspection, immediate, and delayed retrospection, discussion, and self-reported metacognition, rather than think-aloud interviewing. Actual cognitive solution paths were very different from the tidy systematic problem solutions we usually present to students. We discuss implications for instruction in problem-solving.

HI04: 1:15–1:25 p.m. Diagnosis of Misconceptions with Multiple-Tier Tests

Derya Kaltakci, Kocaeli University, Department of Secondary Science and Mathematics Education, Middle East Technical University, Ankara, 06531, Turkey; kaderya@metu.edu.tr

Ali Eryilmaz, Middle East Technical University

For measuring student conceptions, different diagnostic tools have been developed and used such as: interviews, multiple-choice tests, and multiple-tier tests (two-tier tests and three-tier tests). Among these tools, interviews have advantages such as flexibility and obtaining in-depth information. However, interviews can be conducted on a limited number of individuals. Multiple-choice tests can be administered to a large number of individuals; but cannot investigate the students' responses deeply. In order to compensate the limitations of interviews and the ordinary multiple-choice tests in diagnosing students' conceptions, researchers extended multiple-choice tests into two- or three-tier tests. In this study a new classification in diagnosing misconceptions with a three-tier test will be presented. Different from the previous studies with three-tier tests, in this classification scientific choice in the test with nonscientific explanation is also classified as misconception. This new classification with multiple-tier tests would be beneficial in diagnosing student misconceptions for physics education research.

HI05: 1:25–1:35 p.m. Fighting Wrong Beliefs: An Assessment on the Students' Understanding of Science vs. Pseudoscience

Kevin H. Thomas, University of Central Florida, Orlando, FL 32826; kevin.h.thomas@gmail.com

Pseudoscience is a growing threat to scientific research and public support of science. Physics In Films is a General Education course at UCF, which promotes science literacy and debunks science misunderstandings and popular pseudo scientific claims. Data were collected via interviews, surveys, essays, and overall student performance. The results of the data gathered were compared against similar NSF findings. Overall, the consensus on the belief of pseudo scientific claims resembled that of the national surveys. However, student performance and essays show the course to be quite successful at persuading students to start questioning ideas presented to them as proven and stop accepting popular claims based only on anecdotal support.

HI06: 1:35–1:45 p.m. Calibrating a Slingshot Using Video Analysis

Matthew P. Perkins, Oak Ridge High School, Oak Ridge, TN 37830; mperkins@ortn.edu

Students attempting to develop a trajectory device for a Science Olympiad competition decided to videotape their device in action and use this data to hit targets more accurately. This session reveals how commonly available software can be used for this task in addition to providing another way to study one- and two-dimensional motion, conservation of momentum, and various other topics.

HI07: 1:45–1:55 p.m. Attitudes of Nonscience Major Undergraduate Students Toward Studying Physics

Greg A. Hollmann, Rend Lake College, Ina, IL 62864; hollmanng@rlc.edu

Vivien M Chabalengula, Frackson Mumba, Southern Illinois University

This study examined the attitudes students have toward studying physics, physics lab, and physics lecture. Thirty-nine students participated in the study, all of which were enrolled in a 100 level physical science laboratory course. The site of the study was a community college located in the Midwestern United States. A 28-item questionnaire was used to assess attitudes in each of the three areas. This survey was originally created at universities in the United Kingdom and South Africa. (Bennett, Rollnick, Green, White, & Mumba, 2001) After the survey was administered, the author coded the responses and ran the following statistical tests: descriptive statistics, Pearson correlation, paired sample t-test, and one way ANOVA. Upon analysis of the mean and standard deviation, the author concludes that students possessed an overall positive attitude toward physics while enrolled in this course. None of the tests found statistically significant correlations or relationships among the data.

HI08: 1:55–2:05 p.m. Physics Formula Recollection Through a Never Before Seen Mnemonic Technique

Shannon A. Schunicht, Texas A&M University, 6773 Bendwood, College Station, TX 77845; mnemonicmind@alpha1.net

While in the Army, the author was involved in a mid-air collision rendering him unconscious for three weeks. Everything had to be relearned, 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 of light" & "z" = "altitude". Note how with this author's mnemonic technique, ANY FORMULA may be algebraically manipulated into a word, or series of words for ease of recollection. Additional letters may be added to the letter combination to enhance their intelligibility, but these additional letters need be consonants only! The transition of complicated formulas into simple acronyms will be shown, as well as those submitted by attendees upon arrival. One common example is the quadratic equation: CAPITAL LETTERS ARE ADDITIONAL CONSONANTS yeS, i buiLD rabbits 4caTS oN 2HaTS (remember Dr. Seuss?) The possibilities of mnemonic technique are limitless as Delta X => 0. With the student's usage, an acronym will become more apropos to the actual formula it actually represents! Sample cards will be handed out upon attendance, as well as formulas submitted will be explored using this author's mnemonic technique to illustrate its applicability to complicated equations submitted by addendees.

Session HG: PERC Bridging Session

Location: Dennison 170
Sponsor: Committee on Research in Physics Education
Date: Wednesday, July 29
Time: 3:30–5:30 p.m.

Presider: Nathaniel Lasry

The uniqueness of Physics Education Research (PER) partly resides in the diverse traditions and frameworks adopted to study learning: Cognitive processes, social and cultural dynamics and a growing interest in neuroscience. In this bridging session, leading researchers in cognitive psychology, in social and cultural studies, and in neuroscience will present how research on learning is approached within their framework. Researchers will present the effectiveness of each approach by identifying its starting assumptions, the question-types it is best suited to address as well as its major constraints.

HG01: 3:30–4 p.m. Bridging Cognitive and Neural Aspects of Classroom Learning

Invited – Michael I. Posner, University of Oregon, Dept. of Psychology, Eugene, OR 97403; mposner@uoregon.edu

A major achievement of the first 20 years of neuroimaging is to reveal the brain networks that underlie fundamental aspects of attention, memory, and expertise. We examine some principles underlying the activation of these networks. These networks represent key constraints for the design of teaching. Individual differences in these networks reflect a combination of genes and experiences. While acquiring expertise is easier for some than others, the importance of effort in its acquisition is a basic principle. Networks are strengthened through exercise, but maintaining interest that produces sustained attention is key to making exercises successful. The state of the brain prior to learning may also represent an important constraint on successful learning and some interventions designed to investigate the role of attention state in learning are discussed. Teaching remains a creative act between instructor and student, but an understanding of brain mechanisms might improve opportunity for success for both participants.

HG02: 4–4:30 p.m. Causality in Pieces: The Construction of Causal Schemes

Invited – Andrea A. diSessa, University of California at Berkeley, Graduate School of Education, Berkeley, CA 94720; adisessa@soe.berkeley.edu

I will present two case studies of different early high school classes constructing (with no direct instruction from teachers) ways of explaining temperature equilibration. Students were asked to explain when a cold glass of milk is left on the kitchen table, how and why does it come to room temperature? The first case study shows an unusually clear example where students build an essentially correct causal explanatory scheme (Newton's law of heating) pretty much simply by combining a number of reasonably well-documented intuitive ideas. The second case study shows a similar construction, but of an incorrect causal scheme. Because the elements used in the first case have been reasonably well-studied, we can determine both what had to change in the pieces and how the pieces were combined. This leads to a list of plausibly general "mechanisms of learning."

HG03: 4:30–5 p.m. Moving Between Discourses: From Learning as Acquisition to Learning as Participation

Invited – Anna Sfard, The University of Haifa, Tel Aviv, 68135, Israel; sfard@netvision.net.il

These days, the times of incessant changes, everything seems to be fluid, including our ways of looking at the world and of talking about it. Although easily noticeable also in "hard" sciences, nowhere is this conceptual fluidity more conspicuous than in research on human learning. In this talk, after a very brief historical review, I will concentrate on two basic metaphors for learning in which current educational research seems to be grounded: the metaphors of learning-as-acquisition and of learning-as-participation. It will be claimed that these metaphors generate discourses that are incommensurable rather than incompatible—discourses that, although seemingly contradictory, can live side by side without any risk to the consistency of the research enterprise. Researchers should be choosing their leading metaphor according to their needs. Using empirical examples as illustration, I will discuss the relative advantages and disadvantages of each of the two options.

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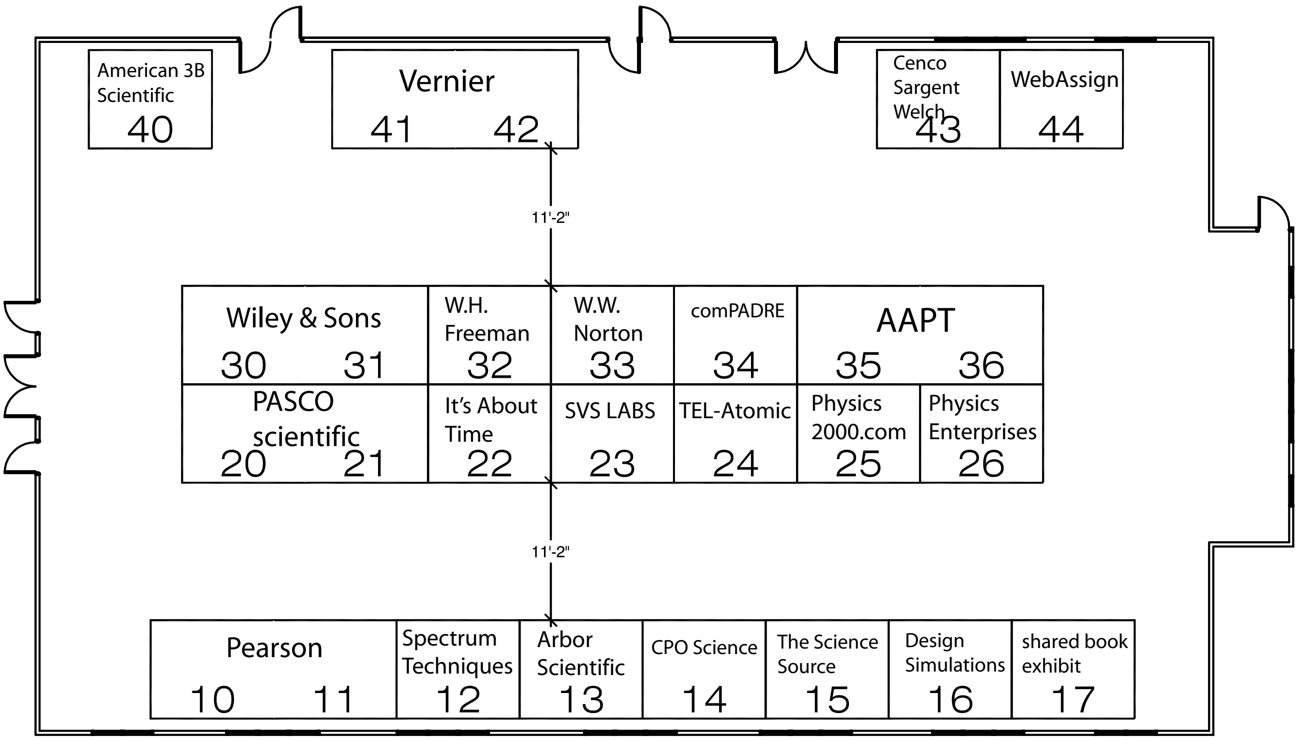

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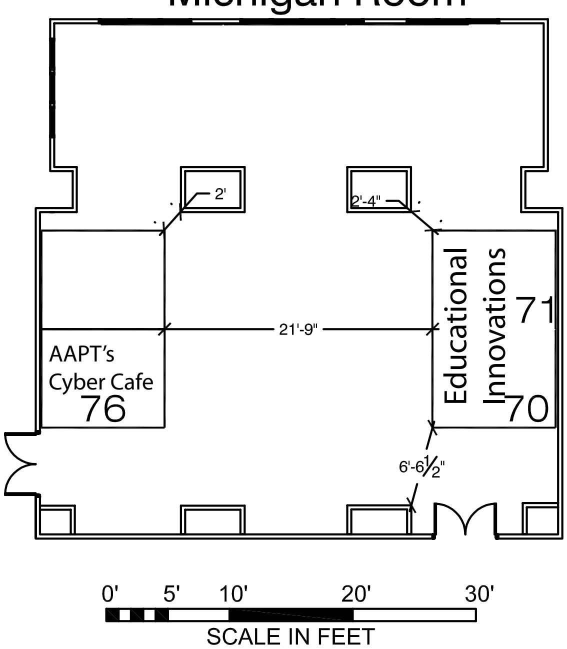

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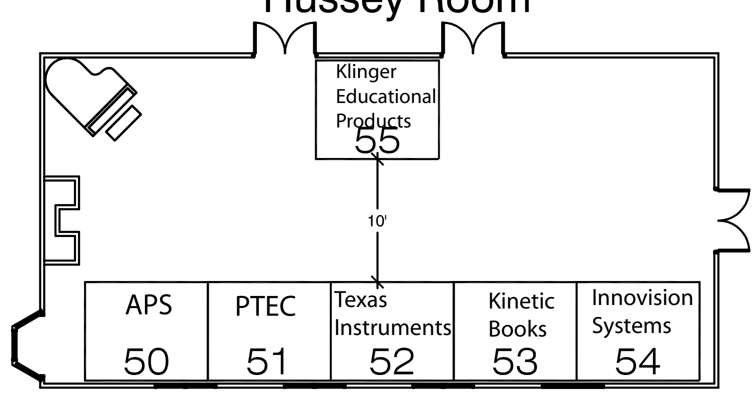

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