AAPT 2008

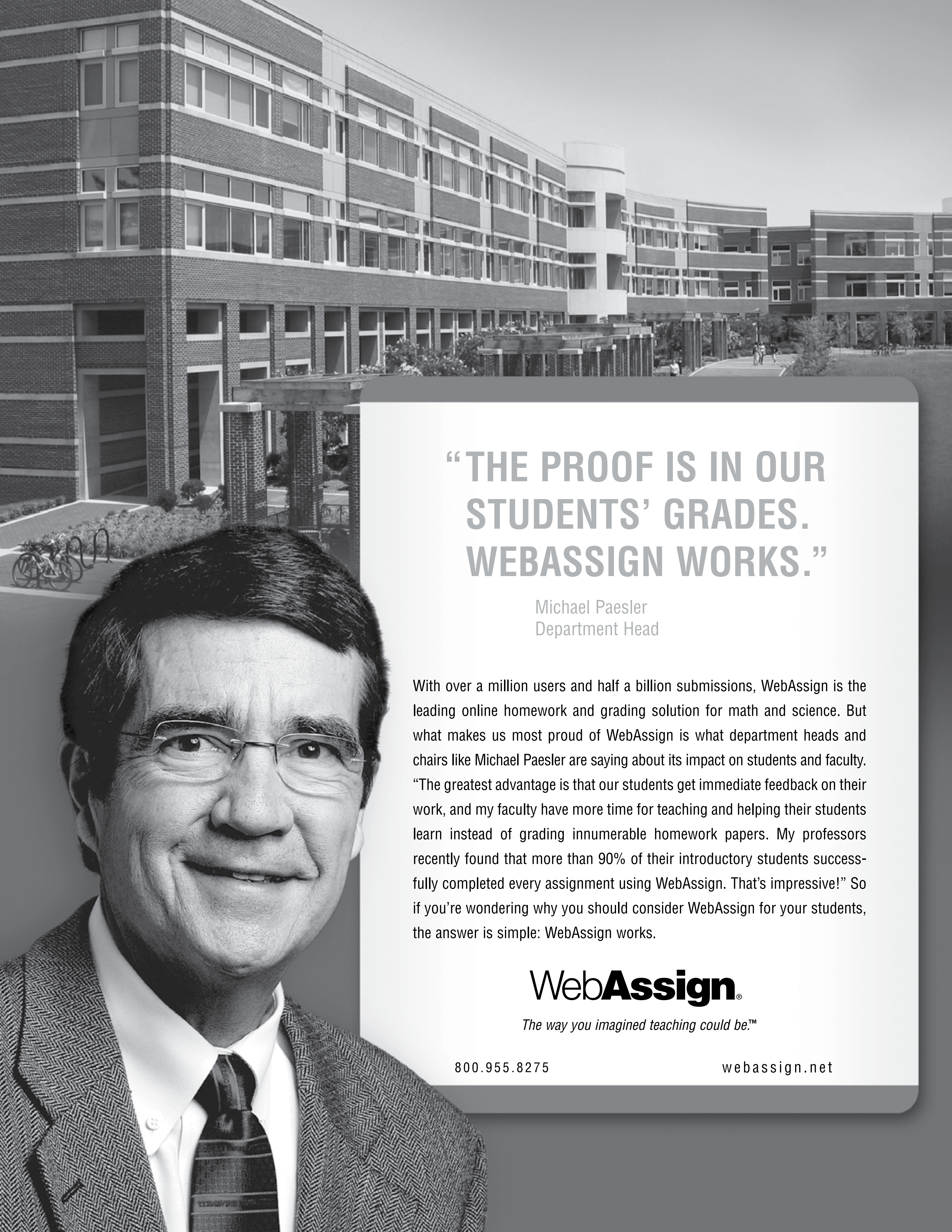
Summer Meeting

July 19–23, 2008

University of Alberta
Edmonton, Alberta, Canada

AAPT PHYSICS EDUCATION

American Association of Physics Teachers
One Physics Ellipse
College Park, MD USA 20740-3845
301-209-3300, fax: 301-209-0845
meetings@aapt.org, www.aapt.org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Welcome to Edmonton!

Welcome to the AAPT Summer Meeting and to beautiful Edmonton, Alberta. I encourage you to take advantage of the long hours of daylight and explore the city, its museums and parks, as well as experience the Taste of Edmonton Festival.

The University of Alberta is celebrating its 100th anniversary. We are grateful for their warm hospitality and look forward to participating in their anniversary activities. Terry Singleton and the entire Physics Department have gone out of their way to make this meeting special.

The theme for the 2008 Summer Meeting is "Physics from the Ground Up," so throughout the meeting there are workshops, sessions, and plenaries on topics such as geophysics, energy, nanotechnology, and astronomy.

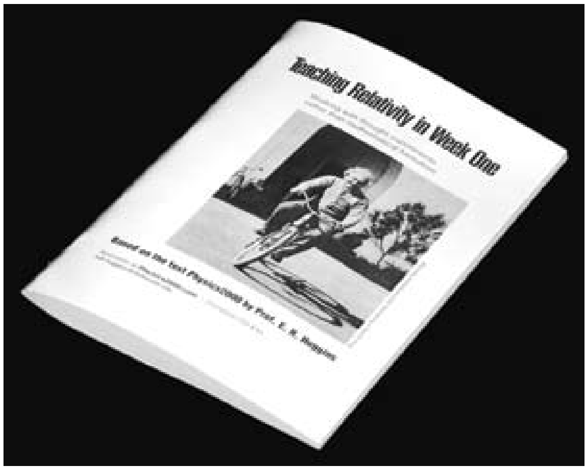
The sessions on Physics Education show the strength of AAPT by serving teachers who are interested in teaching across a wide variety of situations. There are sessions on graduate education, upper-level undergraduate education, introductory college physics education, high school education, teacher preparation, and international physics education. As with most summer meetings, there are excellent sessions sponsored by the Physics Education Research Community. In fact, deciding which session to attend will be difficult.

Finally, I highly recommend the plenary and awards sessions. These should be excellent talks. I am sure we all congratulate the awardees and thank them for all they have contributed to physics education.

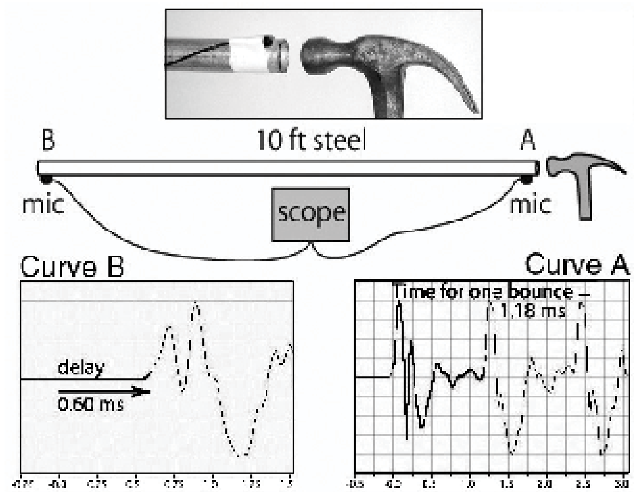
I hope you have a successful and enjoyable meeting. Remember this meeting would not be possible without the hard work of our Central Office staff.

Alex Dickison
AAPT President Elect and Program Chair
Seminole Community College
Sanford, Florida

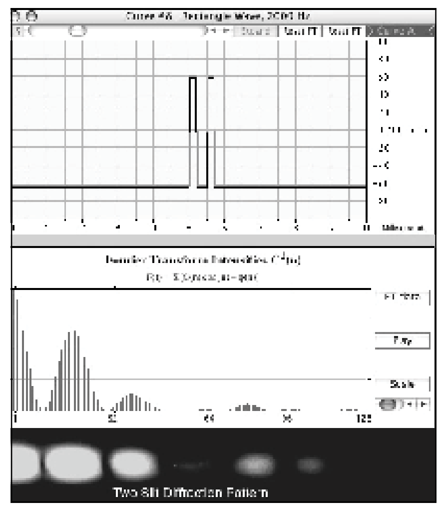
Free Workshop: Physics2000.com



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

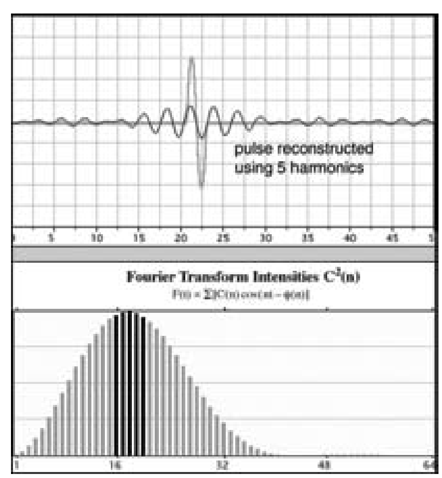


Speed of Sound in a Steel pipe
Using MacScope's stereo input, we find that a sound pulse travels down a 10 ft. (3.048m) steel pipe in .60 milliseconds. We get about the same speed for a compressional pulse in a fine steel guitar string. (See TPT, Jan. 2008 and Mar. 2008.)



Fourier Optics
The Fourier transform of a slit structure is proportional to the diffraction pattern produced by the slits. (See TPT Sept. 2007.)

As calculus is the backbone of classical physics, **Fourier analysis** plays a similar role in understanding **quantum mechanics**. We wrote the free audio oscilloscope program **MacScope II** (for Mac & Windows) to make it easy to use Fourier analysis in your introductory physics course. In the workshop we will show you how to use MacScope to measure the speed of sound in a steel pipe, study Fourier optics, and teach the time-energy form of the uncertainty principle.



Uncertainty Principle
Using MacScope's pulse Fourier transform, we study the harmonic structure of a short pulse. (See TPT, Jan. 2007.)

The workshop is more than free—attendees receive complimentary copies of the Physics2000 CD and volumes I & II of Physics2000.

Central Academic Bldg. 373, Tuesday, 2:30 p.m.

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Special Thanks:

AAPT acknowledges the following members for their dedication and selfless contributions:

– Terry Singleton and the University of Alberta community, for serving as gracious hosts.
– The Paper Sorters: David Cook, Shannon Mandel, Rachel Scherr, Terry Singleton, and Alex Dickison.

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A Speaker Ready Room

Located in the *Natural Resources Engineering Facility (NRE), Room 2-127*. Speakers will bring their materials here; hours are 4–9 p.m. Sunday, and it opens Monday–Wednesday, 7–8:30 a.m., and 12:15–1:45 p.m.

Shuttle Stops and Schedule

1st Stop Westin Edmonton
2nd Stop Coast Plaza Hotel
Final Stop Students' Union Building (SUB) at University of Alberta

Shuttle will run on a 30-minute loop during the following hours of operation:

Friday, July 18
5–8:30 p.m.

Saturday, July 19
6:30–9 a.m., 11 a.m.–1 p.m., 5–7 p.m.

Sunday, July 20
6:30–9 a.m., 11 a.m.–1 p.m., 5 p.m.–11 p.m.

Monday, July 21 - Tuesday July 22
6 a.m. –10 p.m.

Wednesday, July 23
6 a.m.–6 p.m., 8 p.m–10:30 p.m.

Thursday, July 24
7–9 a.m. and 4 –7 p.m.

Car Rental

For AAPT discount car rental, visit the Avis Car Rental Site at: http://tinyurl.com/3dj2c6

Ground Transportation

Edmonton Sky Shuttle: http://tinyurl.com/297lau or call 780-465-8515
Yellow Cab: 780-462-3456
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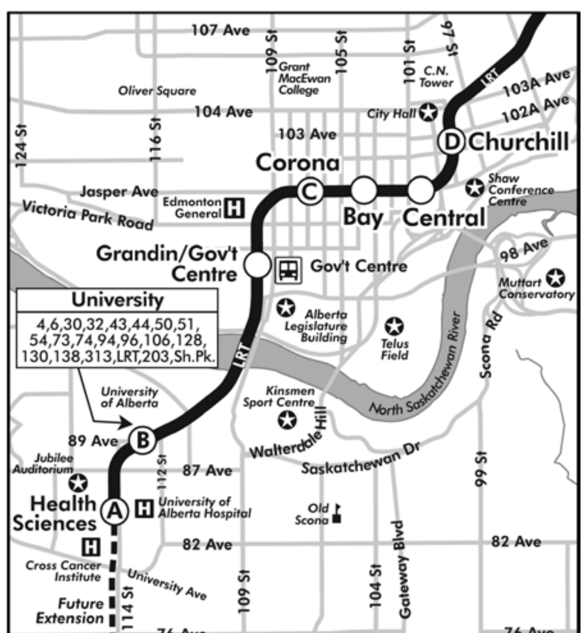
Prestige/Checker Cabs: 780-462-4444
Prestige Limousine: 780-463-5000
Light Rail Transit: For train schedules, and maps visit: http://www.edmonton.ca/portal/server.pt



Edmonton City Center/Connect to Campus
This map of Edmonton's City Center shows major routes and Light Rail Transit to and from the University of Alberta campus.

Welcome to Edmonton – The Festival City

Described as one of the most beautiful places on Earth, Edmonton is part of the Alberta Rocky Mountains in western Canada. The city offers a wide variety of places to go and activities to enjoy at any time of the year. Known as Canada's Festival City (www.festivalcity.ca), Edmonton hosts more than 30 festivals annually that celebrate music, food, culture, sports, theater and more! With lots of blue sky and sunshine throughout the seasons, you can take advantage of many outdoor activities in the city. You will also find Edmonton to be a brilliant educational community that plays an essential role in advancing the economic success of Edmonton and Alberta. The University of Alberta's revolutionary spirit inspires faculty and students to advance knowledge through research, to seek innovation in teaching and learning, and to find new ways to serve the people of Alberta and the world. The university is celebrating its 100th anniversary this year!

Things to do in Edmonton

- **West Edmonton Mall:** The world's largest entertainment and shopping centre and Alberta's number one tourist attraction, featuring more than 800 stores and services, more than 100 eating establishments, plus nine world-class attractions.
- **Elk Island National Park:** Located less than an hour away from Edmonton, Elk Island National Park of Canada protects the wilderness of the aspen parkland, one of the most endangered habitats in Canada. You can find bison, moose, deer and elk roaming freely throughout the park. With the wildlife viewing, hiking, picnicking and overnight camping there is something for everyone.
- **Devonian Botanical Gardens:** This 80-acre garden was established in 1959 and is a component of the Faculty of Agriculture at the University of Alberta. The garden includes an authentic Japanese Garden, attractive floral gardens, collections of native and alpine plants, and ecological reserves, and is situated within a gorgeous rolling landscape of pine trees and wetlands.
- **Royal Alberta Museum:** This museum tells the story of Alberta—the experience of people and places over time and inspires Albertans to discover and understand the world around them. You will find some of the finest cultural and natural history collections.

ATTENTION All AAPT Meeting Attendees!

Show your AAPT badge when you visit one of these two museums and receive an admission discount:
- TELUS World of Science -- For General Admission and IMAX
- The Royal Alberta Museum

AAPT Summer Meeting Special Events

SUNDAY, July 20

- ***FREE TOURS (Sign up at Registration):***
  - ***—National Institute for Nanotechnology*** 12:30–1:15 p.m.
  - ***— National Institute for Nanotechnology*** 1:30–2:15 p.m.
  - ***— National Institute for Nanotechnology*** 2:30–3:15 p.m.
  - ***— Alberta's first Net Zero Energy home*** 3:30–5 p.m. (refer to Session DG)
- ***Exhibit Hall Opening*** 8–10 p.m.
- ***Welcome Reception*** 8–10 p.m.

MONDAY, July 21

- ***Retirees Breakfast*** (ticket) 7–8 a.m.
- ***TYC Breakfast*** (ticket) 7–8 a.m.
- ***First Timers Gathering*** 7–8:30 a.m.
- ***International Breakfast*** 7:30–8:30 a.m.
- ***Photo Contest Viewing,Voting & Video Contest*** 7:30 a.m.–10 p.m.
- ***Exhibit Show*** 8 a.m.–12:30 p.m.
1:45–6 p.m.
- ***PIRA Resource Room*** 9 a.m.–4 p.m.
- ***TYC Resource Room*** 9 a.m.–4 p.m.
- ***Apparatus Competition Viewing*** 9 a.m.–4 p.m.
- ***Spouses' Gathering*** 10–10:30 a.m.
- ***Klopsteg Memorial Award – Michio Kaku*** 4–5 p.m.
- ***Young Physicists' Meet & Greet*** 5:30–7 p.m.

TUESDAY, July 22

- ***Photo Contest Viewing, Voting & Video Contest*** 7:30 a.m.–10 p.m.
- ***Exhibit Show*** 8–11 a.m.
2–5:30 p.m.
- ***PIRA Resource Room*** 9 a.m.–4 p.m.
- ***TYC Resource Room*** 9 a.m.–4 p.m.
- ***Apparatus Competition Viewing*** 9 a.m.–4 p.m.
- ***Millikan Award – Eric Mazur*** 4–5 p.m.
- ***Summer Picnic*** (ticket) 5:45–7:15 p.m.
- ***Demo Show*** 7:15–8:15 p.m.
- ***Demo Show*** (Open to Public) 8:15–9:15 p.m.

WEDNESDAY, July 23

- ***Photo Contest Viewing & Video Contest*** 7:30 a.m.–2 p.m.
- ***Great Book Giveaway*** 8–9 a.m.
- ***Awards – AAPT, AIP*** 11:15 a.m
- ***PERC Banquet*** (ticket) 6–8 p.m.
- ***PERC Poster Session & Reception*** 8–10 p.m.

THURSDAY, July 24

- ***PER Conference*** 8:30 a.m.–7 p.m.

Exhibitors

American Association of Physics Teachers

1 Physics Ellipse
College Park, MD 20740
mlapps@aapt.org
www.aapt.org; www.compadre.org

Visit the AAPT booth and be the first to purchase our new AAPT/PTRA teaching resource, *Teaching Physics for the First Time*. See our line of physics toys and gifts, first-time books from our Physics Store Catalog, new and favorite discounted T-Shirts, and Member-Only items. These items will be available to order at the booth. Pick up copies of AAPT's informational brochures on some of the leading physics education programs such as PTRA and Physics First. Free 2007 AAPT High School Physics Photo Contest Winners posters.

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

AAPT Shared Book

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. Purchase raffle tickets at the AAPT booth or Registration desk for 50 cents before Tuesday at 5 p.m. Proceeds benefit our Excellence in Education Fund.

Booth # 4

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The American Physical Society has free resources for every teacher! Visit the booth to register for our middle school science adventure, adopt physicists for your high school class, learn about minority scholarships, talk with an editor of the peer-reviewed journal *Physics Education Research*, pick up free posters, and much more.

Booth # 22

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Design Simulation Technologies develops physics-based simulation software that is used by students, educators, and engineers. Interactive Physics is used by more than 13,000 schools worldwide to teach and experience the concepts of physics. Working Model 2D is used by universities for teaching about kinematics, dynamics, and machine design and also by professional engineers for simulating the performance of their designs. Dynamic Design Motion is used by CAD designers and engineers to evaluate the performance of their CAD designs before prototype parts are built.

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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 demonstated. This unit works with the X-ray machine, recording 2D-projections, while a computer generates a 3D-object.

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From the beginning in 1970 as a science equipment distributor, Merlan has become a leading supplier in the fields of science, engineering and technology products. For more than 35 years, they have worked with many of the leading education institutions across Canada. Merlan distributes products in three important areas; science, engineering, and technology.

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phethelp@colorado.edu
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The Physics Education Technology (PhET) project is an ongoing effort to provide an extensive suite of simulations for teaching and learning physics and chemistry and to make these resources both freely available from the PhET website and easy to incorporate into classrooms. The simulations are animated, interactive, and game-like environments in which students learn through exploration.

Booth # 17

Physics2000.com

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603-643-2877
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Physics2000 is a college-level introductory physics course that begins with special relativity, ends with quantum mechanics, and in-between covers the usual topics with a 20th century focus. This approach eliminates the great divide between classical and modern physics.

Booth # 12

Physics Teacher Education Coalition

One Physics Ellipse
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PTEC-Physics Teacher Education Coalition—a joint effort of APS, AAPT, and AIP that addresses the critical need for producing more and better prepared physics and physical science teachers. The Coalition disseminates and promotes elements of successful teacher education programs.

Booth # 16

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TeachSpin's hands-on instructional apparatus will intrigue and challenge your students with both classic and modern explorations that can yield research grade data. The "stars" of the show this summer will be two new instruments. The Torsional Oscillator offers explorations of harmonic motion that are visible, tangible, accessible and measurable. From introductory measurements of torsion constants and moments of inertia to varied damping systems and sophisticated forms of driven oscillation, the data from this apparatus is so embarrassingly good that your students will just have to believe the math. We are also bringing Quantum Analogs—acoustic experiments modeling quantum phenomena. Come play with the world's largest "hydrogen atom." First find the frequencies that correspond to the quantum states of a "real" hydrogen atom and then create plots that match the text book pictures of individual orbitals. We can also investigate bonding/antibonding in hydrogen molecules and a wide variety of semiconductor band gaps.

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WebAssign, the premier online homework, quizzing, and testing system, continues to have all of the features you want. Access questions from all major physics and astronomy textbooks, or write your own. Check out our latest offerings with assignable simulations, assignable examples with basic and specific feedback. Give partial credit with conditional weighting. Give group assignments.

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Klopsteg Memorial Award

Michio Kaku, City College of New York

Physics of the Impossible

Monday, July 21, 4–5 p.m., Horowitz Theatre

Michio Kaku is a theoretical physicist, best-selling author, and a major popularizer of science in mainstream media. He holds the Henry Semat Professorship in Theoretical Physics at the City University of New York (CUNY), where he has taught for over 25 years. His latest book, *Physics of the Impossible: A Scientific Exploration of the World of Phasers, Force Fields, Teleportation, and Time Travel*, made the *New York Times* Bestseller list. He has appeared on the BBC's TV series *Time*, and the History Channel's *The Universe*, and he hosts the radio shows *Science Fantastic* and *Explorations in Science.* Michio Kaku's other books include *Parallel Worlds–A Journey Through Creation, Higher Dimensions, and the Future of the Cosmos; Hyperspace: A Scientific Odyssey Through Parallel Universes, Time Warps, and the Tenth Dimension; Visions: How Science Will Revolutionize the 21st Century and Beyond;* and *Einstein's Cosmos: How Albert Einstein's Vision Transformed Our Understanding of Space and Time.* He's the cofounder of string field theory (a branch of string theory), and continues Einstein's search to unite the four fundamental forces of nature into one unified theory.

The Klopsteg Memorial Award honors extraordinary accomplishments in communicating the excitement of physics to the general public. The Klopsteg winner presents a lecture on a physics topic of current significance suitable for non-specialists, in memory of former AAPT President Paul Klopsteg.

Robert A. Millikan Award

Eric Mazur, Harvard University

The Make-Believe World of Real-World Physics

Tuesday, July 22, 4–5 p.m., Horowitz Theatre

Eric Mazur is the Balkanski Professor of Physics and Applied Physics at Harvard University. He is an internationally recognized scientist and researcher, who leads a vigorous research program in optical physics. He has strong interests in education, science policy, outreach, and the public perception of science. He believes that better science education for all—not just science majors—is vital for continued scientific progress. He devotes considerable effort to education research and finding verifiable ways to improve science education. In 1990 he began developing Peer Instruction, a method for teaching large lecture classes interactively. His book, *Peer Instruction* has been read widely, and his methods have a large following among AAPT members and others nationally and internationally. The impact of Peer Instruction on physics teaching has been significant. In 2006 Eric Mazur helped produce the award-winning DVD, *Interactive Teaching*. He is a Fellow of the Optical Society of America, a Fellow of the American Physical Society, author or co-author of over 200 scientific publications, and holder of 12 patents.

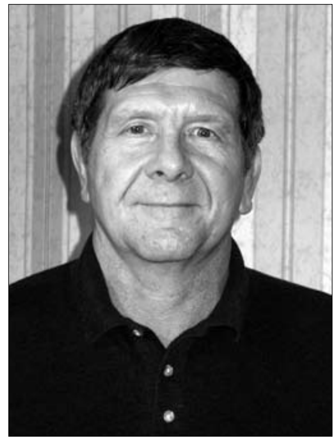
The Robert A. Millikan Award is given annually by AAPT for notable and creative contributions to the teaching of physics.

Excellence in Pre-College Physics Teaching Award

Mark Davids, Grosse Pointe South High School

Best Practices

Wednesday, July 23, 11:15 a.m.–12:15 p.m., Horowitz Theatre



Mark Davids has been a prime mover in the Michigan Section of AAPT, the Detroit Metropolitan Area Physics Teachers, and the Detroit and Michigan Science Teachers Associations. In 2001, he received a Presidential Award for Excellence in Science Teaching from the White House and National Science Foundation. In 2002-03, he served as an Einstein Fellow in the office of Washington's U.S. Senator Maria Cantwell, working on key issues related to education, science, and technology. Recently, he was chosen by the Michigan Science Teachers Association as its 2008 Outstanding High School Teacher. Mark coauthored *Physics: Principles and Problems* with Paul Zitzewitz and Robert Neff, and *Teaching About Lightwave Communications* with Paul Zitzewitz. He developed a curriculum for high school teachers on the physics of cell phones, to reinforce traditional physics topics and introduce students to information theory, all within an exciting context. Mark's workshops have covered Optics and Shadows, Modeling, Lasers—including holography, and other areas. Mark Davids is an enthusiastic teacher with a storehouse of physics demonstrations and great skills as a presenter.

Excellence in Undergraduate Physics Teaching Award

Corinne Manogue, Oregon State University

The View From the Other Side of the Mountains: Exploring the Middle Division

Wednesday, July 23, 11:15 a.m.–12:15 p.m., Horowitz Theatre

Corinne Manogue has been a leader in the development and implementation of the Paradigms in Physics Project at Oregon State University. The goals of this project have been a ground-breaking new upper-division curriculum designed to improve students' analytical and problem-solving skills—emphasizing connections between the fields of physics, and incorporating student-centered activities. Corinne has headed the project, developing junior-year modules on Symmetries and Idealizations, Static Vector Fields, and Central Forces. She also developed the senior-year course, Capstone on Mathematical Methods. After a decade of development and use, the Paradigms project has attracted attention at national meetings of both AAPT and APS in sessions on "Revitalizing Undergraduate Physics." Corinne coauthored an article in *Physics Today* on the Paradigms project, and one in the *American Journal of Physics* on how computational activities are woven into the new Paradigms project courses, which are now being disseminated nationally. She has supervised undergraduate, Master's, and Ph.D. students doing research in physics education.

2008 AIP Science Writing Award, Broadcast Media Category

Wednesday, July 23, 11:15 a.m.–12:15 p.m., Horowitz Theatre

Bob McDonald is one of Canada's best-known science communicators. He is in his 16th season as host of *Quirks & Quarks,* Canada's national weekly radio science program. He is also science correspondent for CBC TV's *The National*, and a weekly science commentator for CBC Newsworld. He has won many honors for communicating science, including the Michael Smith Award for Science Promotion from NSERC, and the Sandford Flemming Medal from the Royal Canadian Institute. He has been awarded honorary degrees from three Canadian universities for his work in promoting science.

Pat Senson is a producer with the Canadian Broadcasting Corporation's national radio science program, *Quirks & Quarks*. This is his second time winning the AIP broadcast award, the first was for his look at the physics of time. Physics has always been a secret passion of Pat's, although his scientific credentials lie more in the field of biology, where he honed his scientific skills running many a DNA profile. As well as working behind the scenes at *Quirks & Quarks*, Pat can also be heard weekly across the country on CBC's afternoon shows as their regular science contributor, where he'll discuss anything from the latest discoveries from CERN to the problems of government funding for science. Pat lives in Toronto, Ontario.

Jim Handman has been the Executive Producer of *Quirks & Quarks*, Canada's national weekly radio science program, for the past nine years. He has been a journalist and radio producer at CBC Radio for more than 20 years. Jim has shared in many awards for science journalism, including the prestigious Walter Sullivan Award from the AGU, and was co-winner of the Science Writing Award from AIP in 2003. He also teaches radio broadcasting at Ryerson University Journalism School in Toronto.

Damian Pope, Perimeter Institute for Theoretical Physics

Teaching Dark Matter to High School Students

Monday, July 21, 11:15 a.m.–12:15 p.m., Horowitz Theatre

Damian Pope is the Senior Manager of Scientific Outreach at Perimeter Institute for Theoretical Physics in Waterloo, Ontario, Canada. He studied in Australia and holds a Ph.D. in theoretical physics from the University of Queensland. After this, he engaged in two years of postdoctoral research in quantum information and the foundations of quantum theory at Griffith University.

Damian also has over a decade of experience in outreach explaining physics to students, teachers, and the general public. Most recently, he has been focusing on creating a collection of video-based resources designed to help high school teachers introduce modern physics to their students.

Robert Wolkow, National Inst. for Nanotechnology & University of Alberta

The Ruse and the Reality of Nanotechnology

Tuesday, July 22, 11:15 a.m.–12:15 p.m., Horowitz Theatre

Robert Wolkow directs research into using scanning tunneling microscopy (STM) and other theoretical methods to examine and control molecules on semiconductor surfaces.

He is a pioneer in STM techniques and instrumentation. At IBM, he pioneered STM for studying surface chemistry. At the NRC Steacie Institute for Molecular Sciences (NRC-SIMS), he and his colleagues used STM and modeling to understand the behavior of organic molecules on semiconductor surfaces. Eventually, they demonstrated self-directed fabrication of organic nano-scaled structures on silicon.

The multidisciplinary Molecular Scale Devices researchers have continued to advance nanoscale structure fabrication, with creation of a single molecule transistor and a reliable method of producing single atom tip probes.

Controlled fabrication of nanoscale structures and devices combining organic chemistry/biological functions with semiconductor-based processors is the goal. Variable-temperature, ultra-high vacuum STM now makes atomic-scale surface chemistry research possible.

Products of Interest to Physics Educators

Kinetic Books' *Virtual Physics Labs* (NVT-11)

This DVD contains virtual labs covering topics ranging from one-dimensional motion to special relativity, and will augment any physics teacher's toolkit. Contains 16 virtual labs, each one taking 45 to 60 minutes to complete.
Produced by Kinetic Books.

Members: $23.95
Student Members: $18
Nonmembers: To order, contact Kinetic Books at www.kineticbooks.com.

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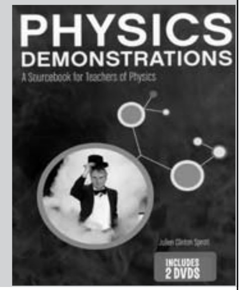
Show AAPT pride with a Navy blue polo shirt with white embroidered AAPT logo. Comes in M, L, XL. Please specify size..

TS-10

Members: $17
Nonmembers: $22

***Physics Demonstrations: A Sourcebook for Teachers of Physics* (NB-47)**

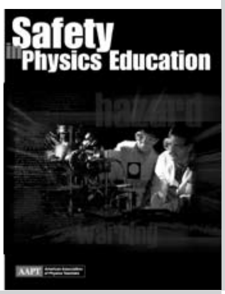
Julien Clinton Sprott shares demonstrations from his popular lecture series, "The Wonders of Physics." Organized to teach the six major areas of classical physics—motion, heat, sound, electricity, magnetism, and light.
Published by Univ. of Wisconsin Press. (290 pp.) hardcover
ISBN: 0-299-21580-6



Members: $38
Student Members: $28
Nonmembers: $45

Safety in Physics Education (OP-67)

Edited by the AAPT Committee on Apparatus. *Safety in Physics Education* is intended to create an awareness of safety, to encourage safe habits, and to teach respect for potential safety hazards. It can be used across the spectrum of experimental and demonstration activities —from elementary to advanced undergraduate laboratories. (121 pp.)
ISBN 1-931024-01-4



Members: $21.95
Student Members: $17

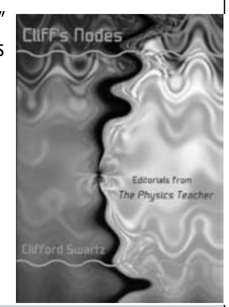
***Twin Views of the Tacoma Narrows Bridge Collapse* (NVT-13)**

NOW ON DVD! Contains two video segments: 1) Tacoma Narrows Bridge Collapse by Franklin Miller, Jr. (1963). 2) The Puzzle of the Tacoma Narrows Bridge Collapse by R.G. Fuller, D.A. Zollman, & T.C. Campbell (1979).ct.

Members: $48.95
Nonmembers: $61

***Cliff's Nodes: Editorials from The Physics Teacher* (NB-46)**

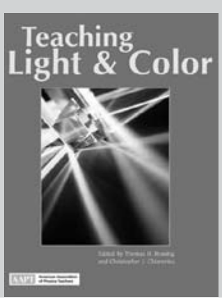
From the pages of T*he Physics Teacher* comes a collection of editorials by its longtime editor, Cliff Swartz, a passionate advocate of better physics teaching, based on a curriculum that is quantitative and includes experiments "with a purpose."
Published by Johns Hopkins University Press. (338 pp.)
ISBN: 0-8018-8307-5



Members: $21
Student Members: $16
Nonmembers: $25

***Teaching Light & Color* (RB-74)**

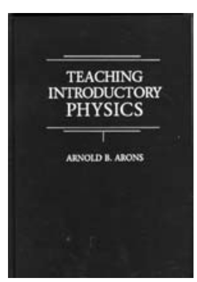
Edited by Thomas D. Rossing and Christopher J. Chiaverina, this collection of scientific papers, articles, and brief excerpts from books is intended to provide teachers with source material for teaching light and color. It also contains references to some 281 books, papers and websites.
(250 pp.)
ISBN 1-931024-02-2



Members: $15
Student Members: $11
Nonmembers: $20

***Teaching Introductory Physics* (NB-23)**

Written by Arnold B. Arons, this guide to teaching introductory physics, from high school to calculus-based college courses, presents systematic observations based upon research into how students learn and reason. Includes many test questions and homework problems. Published by John Wiley & Sons, Inc. (816 pp.) paperback
ISBN 0-471-13707-3



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Members: $8
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Committee Meetings

SUNDAY, July 20

Meetings Committee	8–11 a.m.	Lister Centre, Prairie
Publications Committee	8–11 a.m.	Lister Centre, Glacier
Programs Committee I	4–6 p.m.	Lister Centre, Prairie
Nominating Committee	4–6 p.m.	Lister Centre, Glacier
Section Officers' Exchange	5–6 p.m.	Lister Centre, Maple Leaf
Section Representatives	6:30–8 p.m.	Lister Centre, Maple Leaf
Teacher Preparation Committee	6:30–8 p.m.	Lister Centre, Glacier
Graduate Education Committee	6:30–8 p.m.	Lister Centre, Prairie
Apparatus Committee	6:30–8 p.m.	Lister Centre, Alberta

MONDAY, July 21

Pre-High School Committee	7:30–9 a.m.	CEB 123
Educational Technologies Committee	7:30–9 a.m.	CEB 442
Membership & Benefits Committee	9:30–11 a.m.	CEB 103
Two-Year College Committee	12:15–1:45 p.m.	NRE 1-001
Nominating Committee	12:15–1:45 p.m.	CEB 103
Interest of Senior Physicists Committee	12:15–1:45 p.m.	CEB 442
Bauder Fund Committee	12:15–1:45 p.m.	CEB 123
International Education Committee	5:15–6:45 p.m.	NRE 1-001
PIRA Business Meeting	5:15–6:45 p.m.	ETLC E2-001
Minorities in Physics Committee	5:15–6:45 p.m.	CEB 123
PERTG	5:15–6:45 p.m.	CEB 442
High School Committee	5:15–6:45 p.m.	ETLC E1-017

TUESDAY, July 22

Governance Committee	7–9 a.m.	CEB 103
Science Ed. for the Public Committee	7:30–9 a.m.	CEB 123
Investment Advisory Committee	9:30–10:30 a.m.	CEB 103
Laboratories Committee	12:15–1:45 p.m.	CEB 442
Professional Concerns Committee	12:15–1:45 p.m.	ME 2-3
History and Philosophy Committee	12:15–1:45 p.m.	CEB 123
Physics & Undergraduate Education Committee	12:15–1:45 p.m.	NRE 1-003
SI Units & Metric Ed. Committee	12:15–1:45 p.m.	NRE 2-003
RQEHSPT	12:15–1:45 p.m.	ETLC E1-017
Awards Committee	12:15–1:45 p.m.	ETLC E2-001
Nominating Committee II	12:15–1:45 p.m.	CEB 103
RIPE (Research in Physics Education)	8–10 p.m.	ETLC E1-013
Women in Physics Committee	8:30–10 p.m.	CEB 123
Space Science & Astronomy Committee	8:30–10 p.m.	CEB 442

WEDNESDAY, July 23

Programs Committee II	7–9 a.m.	CEB 442
Physics Bowl Advisory Group	7:30–9 a.m.	CEB 123
Venture Fund	7:30–8 a.m.	CEB 103

KEY:

ETLC – Engineering Teaching and Learning Complex
NRE – Natural Resources Engineering Facility
CEB – Civil Engineering Building

Monday, July 21 – Session Schedule

Time	ETLC E1-013	ETLC E1-001	ETLC E1-017	ETLC E2-001	NRE 1-001	NRE 1-003	NRE 2-001	NRE 2-003	ME 2-3	SUB Horowitz	ETLC Solarium
7:00 a.m. – 8:30											AJ: TYC Physics Classroom
9:00 – 10:30	AA: Clickers in the Classroom	AB: Session Honoring Alan Van Heuvelen	AC: State of Physics Teaching in the U.S.	AD: Tutorials in Intermediate Mechanics	AE: Research-Based Physics Curricula	AF: Hot Topics in Geo-physics	AK: Under-graduate Student Research	AH: PER Around the World	AI: Physics Demonstra-tions with a Biological Flavor		PST1: Poster Session I
11:00 – Noon										Plenary: Damian Pope	
12:30 p.m. – 1:30			BA: Crkbl: Professional Concerns of H.S. Teachers	BB: Crkbl: Prof. Concerns Instruct. Specialists			BC: Crkbl: Web Resources for Teaching Astronomy	BD: Crkbl: Physics and Society Education			
2:00 – 3:30	CA: The Art of Physics Demon-stration	CB: Resources in Physics Education	CC: Reports by CASTLE Teachers	CD: Physics of Our Hobbies	CE: Master Teachers Preparing Teachers of Physics	CF: Gordon Research Conf.: Computation in Physics Curriculum	CG: Innovations in Teaching Astronomy	CH: Teaching Physics Around the World	CI: Energy and the Environ-ment		
4:30										Klopsteg: Michio Kaku	
5:30 – 6:30											PST2: Post-dead-line Posters
7:30 – 9:30	DA: PER: Instruc-tional Reform	DB: Physics Education Research	DC: Assessment in H.S. Physics		DD: Hollywood and Science Literacy	DE: Upper Div. Lab Experience	DF: Teacher Preparation	DG: Alternative Energy	DH: High Energy Physics Projects		

Key:
ETLC -- Engineering Teaching and Learning Complex
NRE -- Natural Resources Engineering Facility
ME -- Mechanical Engineering Building
SUB -- Students' Union Building

Tuesday, July 22 – Session Schedule

Time	ETLC E1-013	ETLC E1-001	ETLC E1-017	ETLC E2-001	NRE 1-001	NRE 1-003	NRE 2-001	NRE 2-003	ME 2-3	SUB Horowitz	ETLC Solarium
8:00											PST3: Poster Session III
9:00	EA: PER: Assessing Student Understanding	EB: The Art and Science of Teaching	EC: AP Physics B Redesign Update	ED: Interactive Lecture Demonstrations	EE: NSF-Supported Projects in Preparing Teachers	EF: Canadian Women in Science	EG: Best Practices for Teaching with Technolgy	EH: Grad. Education in Physics: "Which Way Forward?"	EI: Teaching Upper-Level Electricity and Magnetism		
11:30										Plenary: Robert Wolkow	
12:30 p.m.	FA: Crkbl: Professional Concerns of PER Solo Faculty				FB: Crkbl: Under-represented Minorities in Physics		FC: Crkbl: There Ought to Be... (Technologies I Wish I Had)				
2:00	GA: PER: Cognition and Problem Solving	GB: Transforming University Physics Departments	GC: Voices from the Classroom	GD: Incorporating Writing in the Laboratory	GE: Culturally Responsive Physics Teaching	GF: Seeing the Universe Without Our Eyes	GG: Educational Technology	GH: Rethinking the Upper-Level Curriculum	GI: 400 Years Since Galileo		
4:30										Millikan: Eric Mazur	
5:30											Poster Session IV

Key:
ETLC -- Engineering Teaching and Learning Complex
NRE -- Natural Resources Engineering Facility
ME -- Mechanical Engineering Building
SUB -- Students' Union Building

Wednesday, July 23 – Session Schedule

	ETLC E1-013	ETLC E1-001	ETLC E1-017	ETLC E2-001	NRE 1-001	NRE 1-003	NRE 2-001	NRE 2-003	ME 2-3	SUB Horowitz	
7:00 a.m.											
7:30											
8:00											
8:30											
9:00		HA: Down From the Ivory Tower: Educators as Activists	HB: Middle and High School Teaching Strategies	HC: Scientific Commun-ication and Writing	HD: College Physics	HE: Historical Experi-ments in Physics	HI: Post -Dead-line Paper Session	HF: K-12 Part-nerships and Community Outreach	HG: Physics Teacher Preparation Around the U.S.		
9:30											
10:00											
10:30											
11:00										Awards: AAPT AIP	
11:30											
Noon			IA: Crkbl: Professional Concerns of PER Faculty	IB: Crkbl: Professional Concerns of PER Grad. Students							
12:30 p.m.											
1:00											
1:30		Plenary: Physics at Univ. of Alberta									
2:00											
2:30											
3:00											
3:30		JA: PERC: Bridging Session									
4:30											
5:30											
6:30											

Key:
ETLC -- Engineering Teaching and Learning Complex
NRE -- Natural Resources Engineering Facility
ME -- Mechanical Engineering Building
SUB -- Students' Union Building

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 Alberta.

KEY: **ETLC**–Engineering Teaching and Learning Complex **NRE**–Natural Resources Engineering Facility **Ed**–Education Centre **SUB**–Students' Union Building **CEB**–Civil Engineering Building **Lister**–Lister Centre **C-W**–Chemistry West **CAB**–Central Academic Building **ME**–Mechanical Engineering

FRIDAY, July 18

6–8 p.m.		PRE-REGISTRATION PICK-UP	ETLC, Solarium
7 a.m–6 p.m.		PhysTEC	Lister, Alberta

SATURDAY, July 19

7 a.m.–4:30 p.m.		REGISTRATION	ETLC, Solarium
7 a.m–6 p.m.		PhysTEC	Lister, Alberta
8 a.m.–12 p.m.	W01	TELS–An Online Inquiry-Based Environment	CEB 128
8 a.m.–12 p.m.	W02	Falsification Labs	CEB 127
8 a.m.–5 p.m.	W04	InterActions in Physical Science	Ed S 366
8 a.m.–5 p.m.	W05	Lecture Demonstrations I	CEB 325
8 a.m.–12 p.m.	W06	Photon Quantum Mechanical Labs	CEB 123
8 a.m.–5 p.m.	W07	Exploring Atoms & Molecules Using Molecular Workbench	CEB 324
8 a.m.–5 p.m.	W08	Historical Experiments in the Classroom	Ed S 367
8 a.m.–5 p.m.	W09	Piaget Beyond Piaget: At the Heart of Inquiry	Ed S 358
8 a.m.–5 p.m.	W10	The Classroom of the Future	CEB 114
9 a.m–5 p.m.	W11	Learning Physics While Practicing Science	CEB 442
10 a.m–12 p.m.	T01	Mining the Hidden Web	CEB 536
1–5 p.m.	W12	Introductory Instructional Labs	CEB 225
1–5 p.m.	W13	Inquiry-Based Learning for High School Teachers	CEB 126
1–5 p.m.	W14	Newtonian TIPERs	CEB 123
1–5 p.m. CANCELLED	W15	Negotiating a Successful Science Career	CEB 231

SUNDAY, July 20

7 a.m.–4 p.m.		REGISTRATION	ETLC, Solarium
8–11 a.m.		Publications Committee	Lister, Glacier
8–11 a.m.		Meetings Committee	Lister, Prairie
8 a.m.–12 p.m.	W16	Effectively Addressing Diversity in Science Courses	CEB 123
8 a.m.–12 p.m.	W17	EJS and Tipers	CEB 114
8 a.m.–12 p.m.	W18	Preparing Pre-College Teachers to Teach Physics by Inquiry	CEB 442
8 a.m.–5 p.m.	W19	Lecture Demonstrations II	CEB 325
8 a.m.–5 p.m.	W20	Using RTOP to Improve Physics and Physical Science Teaching	Ed S 366
8 a.m.–5 p.m.	W22	Low-Cost High School Physics Labs	CEB 129
8 a.m.–5 p.m.	W23	Research-Based Alternatives to Problem Solving	Ed S 358
8 a.m.–5 p.m.	W24	Using Research-Based Curricula and Tools	CEB 126
8 a.m.–5 p.m.	W25	Physics and Performance	CEB 336
8 a.m.–5 p.m.	W26	Teaching Astronomy with Technology	C-W-150
9 a.m–5 p.m.		Photo Contest Setup	NRE Lower Foyer
9 a.m.–5 p.m.		PIRA Resource Room and Apparatus Competition Setup	ETLC, Solarium
9 a.m.–5 p.m.		TYC Resource Room Setup	ETLC, Solarium
11 a.m.–4:30 p.m.		Executive Board	Alumni House, Aon Rm.
12:30–1:15 p.m.		Tour of National Institute for Nanotechnology	See Campus Map
1:30–2:15 p.m.		Tour of National Institute for Nanotechnology	See Campus Map
2:30–3:15 p.m.		Tour of National Institute for Nanotechnology	See Campus Map
3:30–5 p.m.		Tour Alberta's first Net Zero Energy home	
1–5 p.m.	W27	Open Source Physics–Statistical and Thermal Physics	CEB 114
1–5 p.m.	W28	Exploring Easy and Effective Ways to Use PhET	CAB 335
1–5 p.m.	W29	Advanced and Intermediate Instructional Labs	CEB 225
1–5 p.m. CANCELLED	W30	Physics Front: Capabilities and Possibilities	CAB 341
1–5 p.m.	W31	New Physics at the LHC and in Your Classroom	CAB 331
1–5 p.m.	W32	Physics and Toys II	CAB 281
1–5 p.m.	W33	Energy in the 21st Century	CEB 128

1–5 p.m.	W34	Using Visualization in Teaching Introductory E&M	CEB 324
1–5 p.m.	W35	Tutorials in Introductory Physics	CEB 442
1–5 p.m.	W36	Designing a Diagnostic Learning Environment	CEB 127
1–5 p.m.	W37	What Every Physics Teacher Should Know	CEB 123
1–5 p.m.	W38	Developing Physics Teacher Knowledge	Ed S 367
4-6 p.m.		Nominating Committee I	Lister, Glacier
4-6 p.m.		Programs Committee I	Lister, Prairie
4–9 p.m.		Speaker Ready Room	NRE 2-127
5–6 p.m.		Section Officers' Exchange	Lister, Maple Leaf
5:30–7:30 p.m.		SPS/AAPT Poster Reception	Lister, Aurora
6–8 p.m.		High School Share-a-thon	Lister, Wild Rose
6:30–8 p.m.		Section Representatives	Lister, Maple Leaf
6:30–8 p.m.		Teacher Preparation Committee	Lister, Glacier
6:30–8 p.m.		Apparatus Committee	Lister, Alberta
6:30–8 p.m.		Graduate Education Committee	Lister, Prairie
7–9 p.m.		REGISTRATION	ETLC, Solarium
8–10 p.m.		Exhibit Show Opens	SUB, Dinwoodie
8–10 p.m.		WELCOME RECEPTION	
8:45–9 p.m.		Prize Drawing	SUB, Dinwoodie

MONDAY, July 21

7–8 a.m.		Retirees Breakfast (ticket)	Alumni House, Aon Room
7–8 a.m.		TYC Breakfast (ticket)	Jubilee Aud., Meeting Rm.
7–8:30 a.m.		First Timers Gathering	Jubilee Aud., Banquet Rm.
7:30–8:30 a.m.		International Breakfast	Lister, Alberta
7:30–9 a.m.		Pre-High School Committee	CEB 123
7:30–9 a.m.		Educational Technologies Committee	CEB 442
7:30 a.m–5 p.m.		REGISTRATION	ETLC, Solarium
7:30 a.m.–10 p.m.		Photo Contest Viewing & Voting & Video Contest	NRE Lower Foyer
8 a.m.–12:30 p.m.		Exhibit Show Open	SUB, Dinwoodie
8–9 a.m.	AJ	Favorite Activities/Lessons in the TYC Physics Classroom	ETLC, Solarium
8–9 a.m.		Exhibit Show – Refreshments	SUB, Dinwoodie
8–9 a.m.	PST1	Poster Session I	ETLC, Solarium
9–11 a.m.	AA	Clickers in the Classroom	ETLC E1-013
9–11 a.m.	AB	Session Honoring Alan Van Heuvelen	ETLC E1-001
9–11 a.m.	AC	State of Physics Teaching in the U.S.	ETLC E1-017
9–11 a.m.	AD	Tutorials in Intermediate Mechanics	ETLC E2-001
9–11 a.m.	AE	Research-Based Physics Curricula	NRE 1-001
9–11 a.m.	AF	Hot Topics in Geophysics	NRE 1-003
9–11 a.m.	AH	PER Around the World	NRE 2-003
9–11 a.m.	AI	Physics Demonstrations with a Biological Flavor	ME 2-3
9–11 a.m.	AK	Undergraduate Student Research	NRE 2-001
9 a.m.–4 p.m.		PIRA Resource Room/ Apparatus Competition Viewing	ETLC, Solarium
9 a.m–4 p.m.		TYC Resource Room	ETLC, Solarium
9:30–11 a.m.		Membership and Benefits Committee	CEB 103
10–10:30 a.m.		Spouses' Gathering	Alumni House, Aon Room
10–11:30 a.m.	CW04	Vernier Software: New Data Collection Tools for Physics	CAB 373
10–11:30 a.m.	CW09	Design Simulation Tech: Hands-on, Minds-on Interactive Phys.	CAB 377
11:15 a.m.–12:15 p.m.		PLENARY: Damian Pope	SUB, Horowitz
12:15–1:45 p.m.	BA	Crackerbarrel: Prof. Concerns of High School Teachers	ETLC E1-017
12:15–1:45 p.m.	BB	Crackerbarrel: Prof. Concerns of Instruct. Resource Specialists	ETLC E2-001
12:15–1:45 p.m.	BC	Crackerbarrel: Web Resources for Teaching Astronomy	NRE 2-001
12:15–1:45 p.m.	BD	Crackerbarrel: Physics and Society Education	NRE 2-003
12:15–1:45 p.m.		Bauder Fund	CEB 123
12:15–1:45 p.m.		Nominating Committee	CEB 103
12:15–1:45 p.m.		Interest of Senior Physicists Committee	CEB 442
12:15–1:45 p.m.		TYC Committee	NRE 1-001
12:30–2 p.m.	CW05	Kinetic Books: Experience Digital Curriculum	CAB 377
12:30–2 p.m.	CW08	Cenco Physics: Strangeness and Charm in Your Classroom	CAB 373
1:45–3:45 p.m.	CA	The Art of Physics Demonstration	ETLC E1-013
1:45–3:45 p.m.	CB	Resources in Physics Education	ETLC E1-001
1:45–3:45 p.m.	CC	Reports by CASTLE Teachers	ETLC E1-017
1:45–3:45 p.m.	CD	Physics of Our Hobbies	ETLC E2-001
1:45–3:45 p.m.	CE	Master Teachers Preparing Teachers of Physics	NRE 1-001

1:45–3:45 p.m.	CF	Gordon Research Conf.: Computation in Physics Curriculum	NRE 1-003
1:45–3:45 p.m.	CG	Innovations in Teaching Astronomy	NRE 2-001
1:45–3:45 p.m.	CH	Teaching Physics Around the World	NRE 2-003
1:45–3:45 p.m.	CI	Energy and the Environment	ME 2-3
1:45–6 p.m.		Exhibit Show Open	SUB, Dinwoodie
2:30–4 p.m.	CW10	Pearson: Using Online Homework to Increase Student Learning	CAB 373
4–5 p.m.		KLOPSTEG AWARD: Michio Kaku	SUB, Horowitz
5–6 p.m.		Exhibit Show with refreshments	SUB, Dinwoodie
5:15–6:45 p.m.		PERTG	CEB 442
5:15–6:45 p.m.		High School Committee	ETLC E1-017
5:15–6:45 p.m.		PIRA Business Meeting	ETLC E2-001
5:15–6:45 p.m.		International Education Committee	NRE 1-001
5:15–6:45 p.m.		Minorities in Physics Committee	CEB 123
5:15–6:45 p.m.	PST2	Poster Session II – Post Deadline Posters	ETLC, Solarium
5:30–7 p.m.		Young Physicists' Meet and Greet	Faculty Club
7–9 p.m.	DA	PER: Issues in Instructional Reform	ETLC E1-013
7–9 p.m.	DB	Getting Started in Physics Education Research	ETLC E1-001
7–9 p.m.	DC	Assessment in High School Physics	ETLC E1-017
7–9 p.m.	DD	Hollywood and Science Literacy	NRE 1-001
7–9 p.m.	DE	The Future of Upper Division Lab Experience	NRE 1-003
7–9 p.m.	DF	Teacher Preparation	NRE 2-001
7–9 p.m.	DG	Alternative Energy	NRE 2-003
7–9 p.m.	DH	High Energy Physics Projects	ME 2-3

TUESDAY, July 22

7–9 a.m.		Governance Committee	CEB 103
7:30 a.m.–5 p.m.		REGISTRATION	ETLC, Solarium
7:30–9 a.m.		Science Education for the Public Committee	CEB 123
7:30 a.m–10 p.m.		Photo Contest Viewing & Voting & Video Contest	NRE Lower Foyer
8–9 a.m.	PST3	Poster Session III	ETLC, Solarium
8–9 a.m.		Exhibit Show & refreshments	SUB, Dinwoodie
8–9:30 a.m.	CW06	Cenco Physics: Bringing the Universe into Your Classroom	CAB 373
8–11 a.m.		Exhibit Show Open	SUB, Dinwoodie
9–11 a.m.	EA	PER: Assessing Student Understanding	ETLC E1-013
9–11 a.m.	EB	The Art and Science of Teaching	ETLC E1-001
9–11 a.m.	EC	AP Physics B Redesign Update	ETLC E1-017
9–11 a.m.	ED	Tutorial: Interactive Lecture Demonstrations	ETLC E2-001
9–11 a.m.	EE	NSF-Supported Projects in Preparation of Physical Sci. Teachers	NRE 1-001
9–11 a.m.	EF	Canadian Women in Science	NRE 1-003
9–11 a.m.	EG	Best Practices for Teaching with Technology	NRE 2-001
9–11 a.m.	EH	Graduate Education in Physics: "Which Way Forward?"	NRE 2-003
9–11 a.m.	EI	Teaching and Learning Upper Level Electricity and Magnetism	ME 2-3
9 a.m.–4 p.m.		PIRA Resource Room/ Apparatus Competition Viewing	ETLC, Solarium
9 a.m–4 p.m.		TYC Resource Room	ETLC, Solarium
9:30–10:30 a.m.		Investment Advisory Committee	CEB 103
10–11:30 a.m.	CW07	Cenco Physics: Sick of the Same Old Labs?	CAB 373
10–11:30 a.m.	CW11	Kinetic Books: Experience Digital Curriculum	CAB 377
11:15 a.m.–12:15 p.m.		PLENARY: Robert Wolkow	SUB, Horowitz
11:30 a.m.–12:30 p.m.		Exhibitors' Lunch	Faculty Club, Saskatchewan
12:15–1:45 p.m.	FA	Crackerbarrel: Professional Concerns of PER Solo Faculty	ETLC E1-013
12:15–1:45 p.m.	FB	Crackerbarrel: Underrepresented Minorities in Physics	NRE 1-001
12:15–1:45 p.m.	FC	Crackerbarrel: There Ought to be... (Technologies I Wish I Had)	NRE 2-001
12:15–1:45 p.m.		History and Philosophy Committee	CEB 123
12:15–1:45 p.m.		RQEHSPT	ETLC E1-017
12:15–1:45 p.m.		Awards Committee	ETLC E2-001
12:15–1:45 p.m.		Nominating Committee II	CEB 103
12:15–1:45 p.m.		SI Units and Metric Education Committee	NRE 2-003
12:15–1:45 p.m.		Committee on Physics and Undergraduate Education	NRE 1-003
12:15–1:45 p.m.		Professional Concerns Committee	ME 2-3
12:15–1:45 p.m.		Laboratories Committee	CEB 442
12:30–2 p.m.	CW01	Modus Medical Devices: Medical Imaging Physics	CAB 377
1:45–3:45 p.m.	GA	PER: Cognition and Problem Solving	ETLC E1-013
1:45–3:45 p.m.	GB	Transforming University Physics Departments	ETLC E1-001

1:45–3:45 p.m.	GC	Voices from the Classroom: Past, Present, and Future	ETLC E1-017
1:45–3:45 p.m.	GD	Incorporating Writing in the Laboratory	ETLC E2-001
1:45–3:45 p.m.	GE	Culturally Responsive Physics Teaching	NRE 1-001
1:45–3:45 p.m.	GF	Seeing the Universe Without Our Eyes	NRE 1-003
1:45–3:45 p.m.	GG	Educational Technology	NRE 2-001
1:45–3:45 p.m.	GH	Rethinking the Upper-Level Curriculum	NRE 2-003
1:45–3:45 p.m.	GI	400 Years Since Galileo	ME 2-3
2–5:30 p.m.		Exhibit Show Open	SUB, Dinwoodie
2:30–4 p.m.	CW02	WebAssign: And You Thought It Was About Homework	CAB 377
2:30–4 p.m.	CW03	Physics 2000.com Free Workshop	CAB 373
4–5 p.m.		MILLIKAN AWARD: Eric Mazur	SUB, Horowitz
4:30–5:30 p.m.		Exhibit Show with refreshments	SUB, Dinwoodie
5–6 p.m.		Poster Session IV	ETLC, Solarium
5:45–7:15 p.m.		Summer Picnic (ticket)	Business Quad
7:15–8:15 p.m.		Demo Show	SUB, Horowitz
8:30–9:30 p.m.		Demo Show (open to public)	SUB, Horowitz
8–10 p.m.		RIPE (Research in Physics Education)	ETLC E1-013
8:30–10 p.m.		Women in Physics Committee	CEB 123
8:30–10 p.m.		Space Science and Astronomy Committee	CEB 442

WEDNESDAY, July 23

7–9 a.m.		Programs Committee II	CEB 442
7:30–8 a.m.		Venture Fund	CEB 103
7:30 a.m.–5 p.m.		REGISTRATION	ETLC, Solarium
7:30–9 a.m.		Physics Bowl Advisory Group	CEB 123
7:30 a.m.–2 p.m.		Photo Contest Viewing	NRE Lower Foyer
8–9 a.m.		Great Book Giveaway & refreshments	ETLC, Solarium
9–11 a.m.	HA	Down from the Ivory Tower: Teachers as Activists	ETLC E1-001
9–11 a.m.	HB	Middle School and High School Teaching Strategies	ETLC E1-017
9–11 a.m.	HC	Scientific Communication and Writing	ETLC E2-001
9–11 a.m.	HD	College Physics	NRE 1-001
9–11 a.m.	HE	Historical Experiments in Physics	NRE 1-003
9–11 a.m.	HF	K-12 Partnerships and Community Outreach	NRE 2-003
9–11 a.m.	HG	Physics Teacher Preparation Around the U.S.	ME 2-3
9–11 a.m.	HI	Post-Deadline Paper Session	NRE 2-001
9–11 a.m.		PIRA Resource Room/ Apparatus Competition Viewing	ETLC, Solarium
9–11 a.m.		TYC Resource Room	ETLC, Solarium
11:15 a.m.–12:15 p.m.		AWARDS CEREMONY, AAPT and AIP	SUB, Horowitz
12:15–1:45 p.m.	IA	Crackerbarrel: Professional Concerns of PER Faculty	ETLC E1-017
12:15–1:45 p.m.	IB	Crackerbarrel: Professional Concerns of PER Graduate Students	ETLC E2-001
1:45–3:15 p.m.		PLENARY: Physics at the University of Alberta	ETLC E1-017
3:30–5:30 p.m.	JA	PERC Bridging Session	ETLC E1-001
5:30–10 p.m.		Executive Board III	Westin Hotel
6–8 p.m.		PERC Banquet	SUB, Dinwoodie Lounge
8–10 p.m.		PERC Contributed Poster Session	SUB, Horowitz foyer

THURSDAY, July 24

8:30 a.m.–5 p.m.		PER Conference	Telus Centre

Workshop Abstracts

Note: All the workshops will be held on the University of Alberta campus. Key of building abbreviations is below.
Please note *that there will be an additional $10 fee for registering for the workshops onsite.*

SATURDAY, July 19, 2008

W01: TELS – an Online Inquiry-Based Environment for Modeling and Simulation

Sponsor: Committee on Educational Technologies
Time: 8 a.m.–12 p.m. Saturday
Member Price: $70 **Non-Member Price:** $95
Location: CEB 128

S. Raj Chaudhury, Dept. of Physics and CSE, Christopher Newport University, Newport News, VA 23601; schaudhury@cnu.edu

Come and learn how you can engage your students in context-rich scenarios within inquiry-driven curriculum modules that use powerful modeling and simulation tools. Appropriate for both high school honors, AP, IB and introductory college courses, the TELS modules are based on an extensive research base in using visualization to help students learn abstract topics in science. Modules in high school chemistry and middle school physical science will also be showcased. Participants will gain hands-on experience with the modules and the lessons learned from existing implementations in schools. This project is part of the larger TELS Center, http://telscenter.org/ and participants are encouraged to explore the learning environment at http://wise.berkeley.edu/.

W02: Falsification Labs

Sponsor: Committee on Laboratories
Time: 8 a.m.–12 p.m. Saturday
Member Price: $70 **Non-Member Price:** $95
Location: CEB 127

Eric Ayars, Campus Box 202, Physics Department, Chico, CA 95929-0202; 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.

W04: InterActions in Physical Science: A Coordinated Set of Curriculum and Professional Development Materials

Sponsor: Committee on Physics in Pre-High School Education
Time: 8 a.m.–5 p.m. Saturday
Member Price: $65 **Non Member Price:** $90
Location: Ed South 366

Robert H. Poel, 3140 Wood Hall, Western Michigan University, Kalamazoo, MI 49008; bob.poel@wmich.edu

InterActions in Physical Science is an NSF-supported, standards-based, guided inquiry physical science curriculum that was built using the research on the teaching and learning of science. In this workshop, participants will be introduced to the InterActions curriculum, experience several activities, watch and analyze video from InterActions classrooms, and work through part of the professional development materials that support teachers and help students do inquiry at the middle-school level. Emphasis will be placed on how these materials can be used to help students understand the nature of scientific inquiry and how scientists make and support their claims. Time will also be scheduled to discuss strategies of how to engage pre-high school students in interactive learning environments.

W05: Lecture Demonstrations I

Sponsor: Committee on Apparatus
Time: 8 a.m.–5 p.m. Saturday
Member Price: $145 **Non-Member Price:** $180
Location: CEB 325

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

Sam Sampere

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

W06: Photon Quantum Mechanical Labs

Sponsor: Committee on Apparatus
Cosponsor: Committee on Laboratories
Time: 8 a.m.–12 p.m. Saturday
Member Price: $65 **Non-Member Price:** $90
Location: CEB 123

Enrique J. Galvez, Dept. of Physics & Astronomy, Colgate U., 13 Oak Drive, Hamilton, NY 13346; egalvez@mail.colgate.edu

Mark Beck

This is a workshop aimed at introducing the theoretical and the practical aspects of a new type of experiment with correlated photons that we have developed.[1,2] The experiments illustrate fundamental concepts of quantum mechanics at the undergraduate level. This four-hour workshop will involve discussions on the fundamentals of the experiments and our experience in implementing them for curricular purposes. It will include a discussion on equipment and costs.

1. Thorn et al. *Am. J. Phys.* **72**, 1210 (2004)
2. Galvez et el. *Am J. Phys* **73**, 127 (2005).

Key:
CEB–Civil Engineering Building
Ed–Education Centre
C-W–Chemistry West
CAB–Central Academic Building

W07: Exploring Atoms & Molecules Using Molecular Workbench

Sponsor: Committee on Educational Technologies
Time: 8 a.m.–5 p.m. Saturday
Member Price: $110 **Non-Member Price:** $135
Location: CEB 324

Robert Tinker, 25 Love Lane, Concord, MA 01742; bob@concord.org

This workshop will focus on using, customizing, and authoring with the Molecular Workbench, a free, open source software environment based on molecular dynamics (http://mw.concord.org). MW is used to create a wide range of learning activities based on the atomic-scale mechanisms of basic phenomena in physics. MW has some unique features including chemical bonding, photon-matter interactions, and smart surfaces, so it can produce a very wide range of emergent phenomena such as phase changes, latent heat, diffusion, solubility, osmosis, and black body radiation. The MW platform can be used to create complete learning activities that consist of linked multimedia pages that include MW models. Students can save their productions in an electronic portfolio, create a report, and submit it for grading. Hundreds of activities for college and pre-college science courses have been created and tested that use MW, including a group that supports a "Physics First" curriculum and another for technicians.

W08: Historical Experiments in the Classroom

Sponsor: Committee on History & Philosophy of Physics
Time: 8 a.m.–5 p.m. Saturday
Member Price: $85 **Non-Member Price:** $110
Location: ED South 367

Donald E. Metz, Faculty of Education, 515 Portage St., Winnipeg, Manitoba R3J 3C1; d.metz@uwinnipeg.ca

Every experiment in physics education contains an historical perspective that is usually neglected in favor of the practical elements of the experiment. Consequently, students lack a context for the performance of the experiment. In this workshop, we will re-introduce the context of history back into student experimentation with the use of the interrupted storyline. Many examples including Ohm's law and Rumford's experiments on heat will be presented and participants will experiment with simple apparatus that can easily be constructed to foster an historical approach to teaching physics.

W09: Piaget Beyond Piaget: At the Heart of Inquiry

Sponsor: Committee on Physics in Pre-High School Education
Cosponsor: Committee on Teacher Preparation
Time: 8 a.m.–5 p.m. Saturday
Member Price: $80 **Non-Member Price:** $105
Location: ED South 358

Dewey I. Dykstra Jr., Physics Dept, MS 1570, Boise, ID 83725-1570; 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 participant will learn about Piaget's equilibration theory. This theory challenges the traditional view of teaching. In the style 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 workers.

W10: The Classroom of the Future: Human Interaction in an Age of Technology

Sponsor: Committee on Physics in Undergraduate Education
Cosponsor: Committee on Research in Physics Education
Time: 8 a.m.–5 p.m. Saturday
Member Price: $75 **Non-Member Price:** $100
Location: CEB 114

Calvin Kalman, 37-695 MIT, 77 Massachusetts Ave., Montreal, Quebec H4B 1R6; Calvin.Kalman@Concordia.ca

Participants take part in five "miniclasses":

1. Use of reflective writing to engage students before class.
2. Critical thinking — Feyerabend's view.
3. Use of collaborative groups to promote critical thinking.
4. Critique: a writing tool to enhance critical thinking skills.
5. The course dossier: a supplement to or a replacement for a final essay/examination.

Based upon my book *Successful Science and Engineering Teaching in Colleges and Universities*, this workshop utilizes research in the classroom that I have been conducting and publishing for many years using qualitative and quantitative methods. Participation in reflective writing as a self-dialogue between the learner's prior knowledge and new concepts in the text was consistently reported in interviews. Comparison of pre- and post-tests indicate that in doing written critiques, students are not only more likely to undergo conceptual change, but also increase their critical thinking skills and thus are led to reevaluate their entire conceptual framework.

W11: Learning Physics While Practicing Science

Sponsor: Committee on Physics in Undergraduate Education
Cosponsor: Committee on Teacher Preparation
Time: 9–5 p.m. Saturday
Member Price: $85 Non-Member Price: $110
Location: CEB 442

Eugenia Etkina, 10 Seminary Place, New Brunswick, NJ 08901; Etkina@rci.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 30 or more activities per textbook chapter for use with any textbook in lectures, recitations and homework; (b) a CD with more than 200 videotaped experiments and associated questions for use in lectures, recitations, laboratories, and homework; and (c) a set of labs with inexpensive equipment that can be used to construct, test, and apply concepts to solve practical problems. During the workshop, we will illustrate how to use the materials not only in college and high school physics courses, but also in courses for future physics teachers to have an explicit emphasis on using the processes of science and various cognitive strategies.

T01: Mining the Hidden Web

Sponsor: Committee on Professional Concerns
Cosponsor: Committee on Physics in Undergraduate Education and Committee on Graduate Education in Physics
Time: 10 a.m.–12 p.m. Saturday
Member Price: $35 **Non-Member Price:** $60
Location: CEB 536

Pat Viele, 286 Clark Hall, Cornell University, Ithaca, NY 14853-2501; ptv1@cornell.edu

The Internet and the World Wide Web are growing at an amazing rate. This tutorial is designed to give participants skills for fast, efficient searching of the Internet. In this digital age, skill in evaluating the information one finds on the Internet is essential. This tutorial will also offer some guidelines for evaluating information.

W12: Introductory Instructional Labs

Sponsor: Committee on Laboratories
Cosponsor: Committee on Apparatus
Time: 1–5 p.m. Saturday
Member Price: $165 **Non-Member Price:** $190
Location: CEB 225

Van D. Bistrow, 5720 S. Ellis Ave., Chicago, IL 60637; vanb@uchicago.edu

This workshop is appropriate for college and university instructional laboratory developers. At each of six stations, presenters will demonstrate an approach to an introductory laboratory exercise. Each presenter will show and discuss the apparatus and techniques used. Attendees will cycle through the stations and have an opportunity to use the apparatus. Handouts will be provided containing sample data and ideas on how to construct or where to purchase the apparatus.

W13: Inquiry-Based Learning for High School Teachers

Sponsor: Committee on Physics in High Schools
Time: 1– 5 p.m. Saturday
Member Price: $85 **Non-Member Price:** $110
Location: CEB 126

Maxine C. Willis, Department of Physics and Astronomy, Dickinson College, Carlisle, PA 17313; willism@dickinson.edu

Priscilla Laws, Marty Baumberger

This is a hands-on workshop designed for teachers interested in using curricular materials that will engage their students in inquiry-based active learning. Participants will work with activities from kinematics, dynamics, energy and optics from the updated Activity-Based Physics High School CD (ABP HSCD). These student-centered modules are based on the outcomes of physics education research and are linked to the national standards. They make extensive use of computers for data collection and analysis using probes and interfaces and/or video analysis. The outcome of this approach is that students learn physics by doing physics. 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 utilize both PASCO and Vernier Software systems.

W14: Newtonian TIPERs

Sponsor: Committee on Physics in Two-Year Colleges
Cosponsor: Committee on Research in Physics Education
Time: 1–5 p.m. Saturday
Member Price: $55 **Non-Member Price:** $80
Location: CEB 123

Curtis J. Hieggelke, Joliet Junior College, 1215 Houbolt, Joliet, IL 60431; curth@jjc.edu

Steve Kanim

This workshop will deal with various alternative task formats that can be used to make instructional materials that impact and improve student learning and understanding of physics concepts in mechanics. These exercises are based, in part, on efforts in Physics Education Research and thus are called TIPERs (Tasks Inspired by Physics Education Research). Such tasks support active learning approaches and can be easily incorporated into instruction in small pieces. This workshop will feature new TIPERs in area of mechanics but the techniques can be deployed in all areas of physics. The first part of the workshop will explore various formats, their characteristics, and how they can be used. Participants will work in groups to develop a set of TIPERs that address a concept, principle, or relationship in mechanics. These TIPERs sets will be shared with and critiqued by the group. This workshop will also include new TIPER "clickers." This work is supported in part by a CCLI grant #0632963 from the Division of Undergraduate Education of the National Science Foundation.

W15: Negotiating a Successful Science Career

CANCELLED

Sponsor: Committee on Women in Physics
Cosponsor: Committee on Professional Concerns
Time: 1–5 p.m. Saturday
Member Price: $62 **Non-Member Price:** $87
Location: CEB 231

Marina Milner-Bolotin, Ryerson University, 350 Victoria St., Toronto, Ontario M5B 2K3, Canada; mmilner@ryerson.ca

This workshop will discuss ways to successfully navigate the job market.

SUNDAY, July 20, 2008

W16: Effectively Addressing Diversity in Science Courses: Resources and Examples

Sponsor: Committee on Minorities in Physics
Time: 8 a.m.–12 p.m. Sunday
Member Price: $40 **Non-Member Price:** $65
Location: CEB 123

Christine Pfund, Associate Director, Delta Program in Research, Teaching and Learning, University of Wisconsin, Madison, WI 53706; cepfund@wisc.edu

Brett Underwood

Engage in four separate activities and leave with an increased awareness of and access to approaches and resources to improve your ability to embrace diversity in your undergraduate and graduate science classrooms. We will work through complex issues of diversity and learn how to address them effectively.

W17: EJS and Tipers

Sponsor: Committee on Physics in Two-Year Colleges
Time: 8 a.m.–12 p.m. Sunday
Member Price: $95 **Non-Member Price:** $120
Location: CEB 114

Tom O'Kuma, Lee College, Baytown, TX 77522; tokuma@lee.edu

Karim Diff, Anne J. Cox

TIPERs (Tasks Inspired by Physics Education Research) are a type of problem that is designed to probe student conceptual understanding and help students build their problem-solving skills. Easy Java Simulations (EJS) are modeling and authoring tools that can be used to create dynamical simulations of physical phenomena for teaching. These simulations can be used for computer demonstrations or virtual laboratories, or serve as programming examples and tasks for computational physics. These two pedagogical tools fit together to provide enhanced interactive engagement for students in the classroom. Participants in this workshop will learn how to use and design TIPERs exercises using EJS for their own students.

W18: Preparing Pre-College Teachers to Teach Physics by Inquiry

Sponsor: Committee on Research in Physics Education
Cosponsor: Committee on Teacher Preparation
Time: 8 a.m.–12 p.m. Sunday
Member Price: $80 **Non-Member Price:** $105
Location: CEB 442

Lillian C. McDermott, University of Washington, Department of Physics, Box 351560, Seattle, WA 98195-1560; 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,[1] 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.[2] 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.

1. L. C. McDermott and the Physics Education Group at the University of Washington, *Physics by Inquiry: An Introduction to Physics and Physical Science*, Volumes I and II (Wiley, New York, 1996). Development was supported, in part, by the National Science Foundation.
2. Physics by Inquiry: A Video Resource (WGBH, Boston, 2000). Development was supported, in part, by the National Science Foundation.

W19: Lecture Demonstrations II

Sponsor: Committee on Apparatus
Time: 8 a.m.– 5 p.m. Sunday
Member Price: $140 **Non-Member Price:** $165
Location: CEB 325

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

Sam Sampere

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

W20: Using RTOP to Improve Physics and Physical Science Teaching

Sponsor: Committee on Teacher Preparation
Cosponsor: Committee on Physics in Undergraduate Education
Time: 8 a.m.– 5 p.m. Sunday
Member Price: $75 **Non-Member Price:** $100
Location: ED South 366

Kathleen A. Falconer, Buffalo State College, 1300 Elmwood Ave, Buffalo, NY 14222; 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.

W22: Low-Cost High School Physics Labs

Sponsor: Committee on Physics in High Schools
Time: 8 a.m.– 5 p.m. Sunday
Member Price: $105 **Non-Member Price:** $130
Location: CEB 129

Diane Riendeau, Deerfield High School, 1959 Waukegan Rd., Deerfield, IL 60015; driendeau@dist113.org

Shannon Mandel, Jim Hicks

Do you want to increase the time your students spend exploring without blowing your budget? If so, then this workshop is for you. You will leave the workshop with a wealth of experiments you can implement as soon as you get back to school. These experiments will employ everyday items or equipment you already have gathering dust in your storeroom. We will make pieces of equipment during the workshop that you can take home with you. This workshop will not only present the labs, but give participants the opportunity to "try out" each lab. The labs will cover many topics from waves to electricity to mechanics. The emphasis of the labs will be good physics without costly equipment.

W23: Research-Based Alternatives to Problem Solving in General

Sponsor: Committee on Research in Physics Education
Time: 8 a.m.–5 p.m.
Member Price: $75 **Non-Member Price:** $100
Location: Ed South 358

Kathleen A. Harper, Department of Physics, The Ohio State University, 191 W. Woodruff Ave., Columbus, OH 43210; harper.217@osu.edu

Thomas M. Foster, David P. Maloney

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

W24: Using Research-based Curricula and Tools to Revitalize Your Introductory Course

Sponsor: Committee on Research in Physics Education
Cosponsor: Committee on Educational Technologies
Time: 8 a.m.– 5 p.m. Sunday
Member Price: $125 **Non-Member Price:** $150
Location: CEB 126

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

Ronald Thornton, Priscilla Laws

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

W25: Physics and Performance

Sponsor: Committee on Science Education for the Public
Time: 8 a.m. –5 p.m. Sunday
Member Price: $90 **Non-Member Price:** $115
Location: CEB 336

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

Wendy Sadler, Colin Funk

This workshop is intended for those who want to take a Physics Road show a step further by adding performance to physics presentations. Stanley Micklavzina has been incorporating dance, circus art, poetry, music, and story telling into public physics demonstration shows. Wendy Sadler runs her own science communication company in the U.K. called "science made simple," (www.sciencemadesimple.co.uk) promoting physics and engineering to schools and public audiences. One performance-based approach has recently been touring the U.K. and Europe with great success. Acting coach Colin Funk is well known for his ability to artfully assist individuals, teams, and organizations to enhance their capacity for creativity and innovation. This workshop will be aimed at developing skills, ideas, and themes for the stage. Successful output product(s) of this workshop will be performed at the Demonstration Show Tuesday night. Bring your ideas and maybe even a favorite stage demo and together lets develop a show!

W26: Teaching Astronomy with Technology

Sponsor: Committee on Space Science and Astronomy
Time: 8 a.m. –5 p.m. Sunday
Member Price: $90 **Non-Member Price:** $115
Location: C-W–150

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

David Kriegler, Todd Young

This workshop will survey a variety of educational technologies useful for engaging students in both high school and introductory college classrooms. Special emphasis will be placed on simulation usage and peer instruction. Participants will work on computers gaining familiarity with the astrophysical simulations of the Nebraska Astronomy Applet Project (NAAP) and its web-based assessment capabilities. Participants will also design peer instruction sequences to be used in the classroom using the computer-based modules of the ClassAction Project. A lighter emphasis will be placed on using computerized ranking tasks and on comparing available options for online homework, astronomy laboratories, and desktop planetariums. All participants will receive NAAP, ClassAction, and computerized ranking task materials on CD.

W27: Open Source Physics–Statistical and Thermal Physics

Sponsor: Committee on Educational Technologies
Cosponsor: Committee on Physics in Undergraduate Education
Time: 1–5 p.m. Sunday
Member Price: $70 **Non-Member Price:** $95
Location: CEB 114

Wolfgang Christian, Davidson College Physics Department, Box 6926, Davidson, NC 28035; wochristian@davidson.edu

Mario Belloni, Anne Cox, Harvey Gould, Jan Tobochnik

This workshop presents recently developed computer-based curricular material that helps to improve the understanding of statistical and thermal physics concepts and that makes many inaccessible topics accessible to students. Participants will receive a CD containing curricular material from the Statistical and Thermal Physics (STP) project as well as a collection of ready to run Java programs from the Open Source Physics (OSP) project. All programs are feely distributable under the GNU GPL license. This workshop will benefit anyone teaching statistical and thermal physics as well as computational physicists wishing to adopt the OSP Java libraries for their own teaching and research. We will discuss the general pedagogical and technical issues in the design of interactive computer-based tutorials as well as how OSP programs can be adapted to your local institution. Information can be obtained from www.opensourcephysics.org/.

Partial funding for this work was obtained through NSF grant DUE-0442581.

W28: Exploring Easy and Effective Ways to Use PhET's Web-based Interactive Simulations in Your Physics Course

Sponsor: Committee on Educational Technologies
Cosponsor: Committee on Research in Physics Education
Time: 1–5 p.m. Sunday
Member Price: $65 **Non-Member Price:** $90
Location: CAB 335

Katherine Perkins, UCB 390, Physics Department, Boulder, CO 80305; Katherine.Perkins@colorado.edu

Wendy Adams, Noah D. Finkelstein, Archie Paulson

The Physics Education Technology (PhET) Project has developed more than 65 simulations for teaching and learning introductory physics at the high school and college levels. These research-based simulations 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. The simulations are free, and can be run from the PhET website (http://phet.colorado.edu) or downloaded to a local computer for off-line use. In this workshop, participants will work with these simulations and explore how they can be used effectively in lecture, lab, and as part of homework assignments to improve both student learning and engagement.

W29: Advanced and Intermediate Instructional Labs

Sponsor: Committee on Laboratories
Cosponsor: Committee on Apparatus
Time: 1–5 p.m. Sunday
Member Price: $190 **Non-Member Price:** $215
Location: CEB 225

Van D. Bistrow, 5720 S. Ellis Ave., Chicago, IL 60637; vanb@uchicago.edu

This workshop is appropriate for college and university instructional laboratory developers. At each of six stations, presenters will demonstrate an approach to an advanced or intermediate laboratory exercise. Each presenter will show and discuss the apparatus and techniques used. Attendees will cycle through the stations and have an opportunity to use the apparatus. Handouts will be provided containing sample data and ideas on how to construct or where to purchase the apparatus.

W30: Physics Front: Capabilities and Possibilities

CANCELLED

Sponsor: Committee on Physics in High Schools
Time: 1– 5 p.m. Sunday
Member Price: $60 **Non-Member Price:** $85
Location: CAB 341

Cathy Ezrailson, 218 A Delzell, University of South Dakota, Vermillion, SC 57069; Cathy.Ezrailson@usd.edu

Caroline Hall

The Physics Front offers K-12 teachers a place online to find and share high-quality physics teaching resources including lesson plans, labs, simulations, and reference materials. All these materials are organized by subject, grade level, and course type. This website also gives teachers the tools to collaborate and share expertise. Topics covered in this workshop will include: collecting, organizing, and sharing resources from the collection; submitting new resources; navigating and building Physics Front topical units; and Physics Front discussions, comments, and reviews. Participants wishing to actively engage, hands-on, in the workshop should bring their own laptop computers; we hope to have enough participants with computers so that they can work online in pairs. Wireless internet connections will be provided.

W31: New Physics at the LHC and in Your Classroom

Sponsor: Committee on Physics in High Schools
Time: 1–5 p.m. Sunday
Member Price: $75 **Non-Member Price:** $100
Location: CAB 331

Kenneth Cecire, Graduate Physics Research Center, Hampton University, Hampton, VA 23668; ken.cecire@hamptonu.edu

Kris Whelan

The Large Hadron Collider (LHC) at CERN is already ramping up. With a center-of-mass energy of 14 TeV, it is expected to produce new science at the frontiers of particle physics. High school teachers and students can and should be involved in ways that enhance classroom learning. In this workshop, you will learn about LHC physics and about LHC-related investigations that you can bring to your students. The emphasis will be on what can work in your classroom so that students are exposed to particle physics at the horizon of new discovery in a way that engages the very skills, methods, and concepts that you cover in class.

W32: Physics and Toys II: Energy, Momentum, Electricity and Magnetism

Sponsor: Committee on Physics in Pre-High School Education
Cosponsor: Committee on Science Education for the Public
Time: 1–5 p.m. Sunday
Member Price: $53 **Non-Member Price**: $78
Location: CAB 281

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

Ray Turner

This hands-on workshop is designed for teachers at all levels in search of fun physics demonstrations, lab experiments, and interactive materials, through the use of ordinary children's toys. More than 50 toys will be demonstrated, and the physical principles related to these toys will be discussed. This workshop will concentrate on toys that illustrate the concepts of kinetic and potential energy, linear and angular momentum, electricity and magnetism, pressure and temperature, and properties of materials. 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. The same toys can also be used for informal presentations to public groups of all ages.

W33: Energy in the 21st Century

Sponsor: Committee on Physics in Two-Year Colleges
Cosponsor: Committee on Science Education for the Public
Time: 1–5 p.m. Sunday
Member Price: $70 **Non-Member Price:** $96
Location: CEB 128

Pat Keefe, 1653 Jerome Ave., Astoria, OR 97103; pkeefe@clatsopcc.edu

Greg Mulder

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. Participants of this workshop will be introduced by way of experience to two different group projects that involve designing energy systems. These modeling exercises look at past energy consumption patterns and develop a plan for energy usage in the 21st century. Other considerations such as population, costs and efficiencies are also used to further expand the discussion and decision making that takes place.

W34: Curricular Materials for Using Visualization in Teaching Introductory E&M

Sponsor: Committee on Research in Physics Education
Time: 1–5 p.m. Sunday
Member Price: $65 **Non-Member Price:** $85
Location: CEB 324

John Belcher, Physics Department/Concordia University, 7141 Sherbrooke St. W., Cambridge, MA 02139; jbelcher@mit.edu

Carolann Koleci, Sahana Murthy, Peter Dourmashkin, Jennifer George-Palilonis

Electromagnetism is one of the most troublesome topics for students to learn. In this workshop, we present an integrated introductory electricity and magnetism curriculum that features three-dimensional visualizations embedded in a guided inquiry environment. Workshop participants will explore a suite of stunning visualizations [http://web.mit.edu/8.02t/www/802TEAL3D/] and will be actively engaged in group work assignments that bridge a pictoral representation to a facet of knowledge. Our goal is to introduce physics educators to these visually enhanced curricular materials and to encourage physicists everywhere to adopt some of these learning modules in their classrooms. Supported under NSF Grant DUE-0618558.

W35: Tutorials in Introductory Physics: A Research-Based Approach to Increasing Student Learning

Sponsor: Committee on Research in Physics Education
Time: 1–5 p.m. Sunday
Member Price: $80 **Non-Member Price:** $105
Location: CEB 442

Lillian C. McDermott, University of Washington, Department of Physics, Box 351560, Seattle, WA 98195-1560; peg@phys.washington.edu

Tutorials in Introductory Physics[1] 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 *Tutorials in Introductory Physics* will be provided to participants.

1. L.C. McDermott, P.S. Shaffer, and the Physics Education Group at the University of Washington, *Tutorials in Introductory Physics,* First Ed. (Prentice Hall, 2002). Development was supported, in part, by the National Science Foundation.

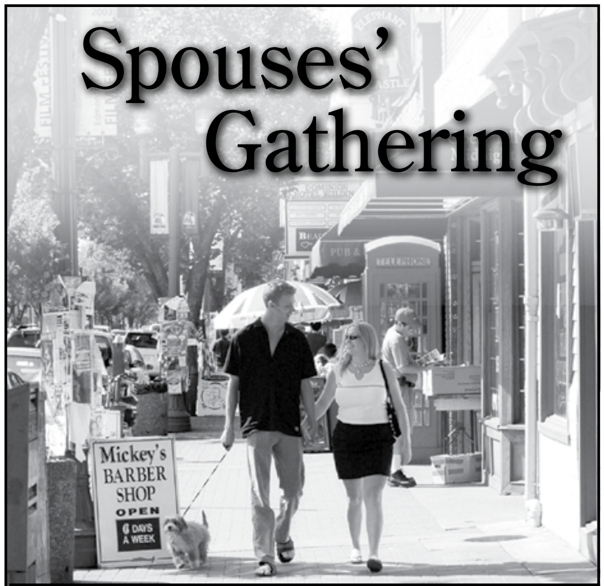
W36: Designing a Diagnostic Learning Environment: A Workshop for Teacher Educators

Sponsor: Committee on Research in Physics Education
Cosponsor: Committee on Teacher Preparation
Time: 1–5 p.m. Sunday
Member Price: $70 **Non-Member Price:** $95
Location: CEB 127

Stamatis Vokos, Physics Department, STE 307, Seattle Pacific University, Seattle, WA 98119-1957; vokos@spu.edu

Lane Seeley, Pam Kraus

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 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.



Meet friends; Learn about Edmonton

Monday, July 21 at 10 a.m.
Aon Room @ Alumni House

W37: What Every Physics Teacher Should Know About Cognitive Research

Sponsor: Committee on Research in Physics Education
Time: 1–5 p.m. Sunday
Member Price: $50 **Non-Member Price:** $75
Location: CEB 123

Chandralekha Singh, Department of Physics, University of Pittsburgh, Pittsburgh, PA 15260; 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 is guaranteed to be useful for all physics teachers. Those involved in physics education research are particularly encouraged to attend.

W38: Developing Physics Teacher Knowledge

Sponsor: Committee on Teacher Preparation
Time: 1–5 p.m. Sunday
Member Price: $50 **Non-Member Price:** $75
Location: Ed South 367

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

Lee Shulman identified pedagogical content knowledge (PCK) as a necessary component of teacher knowledge—a blend of content and pedagogy that distinguishes the understanding of a content specialist from that of the pedagogue. PCK involves knowing students' original ideas and potential difficulties, alternative ways to represent those ideas, and various effective instructional and assessment methods within a particular discipline. What constitutes physics PCK and how can prospective and practicing physics teachers construct and improve theirs? What specific activities help physics teachers develop their PCK? How does one assess physics PCK? In this interactive workshop participants will tackle the above questions, reflect on their own PCK, and develop some strategies for incorporating the building of teacher PCK into their physics courses, methods courses, and teacher preparation programs. The workshop is intended for those who wish to improve their own PCK and for those who are involved in teacher preparation.

Commercial Workshops

All Commercial Workshops (Free) will be held in the Central Academic Building (CAB)

CW01: Medical Imaging Physics: Vista-Cone Beam Optical CT Scanner

Sponsor: Modus Medical Devices
Date: Tuesday, July 22
Time: 12:30–2 p.m.
Room: CAB 377

Leader: John Miller

The last few decades have seen rapid growth in the use of X-Ray Computed Tomography (CT) in health care. Widespread use and rapid innovation in CT have contributed to the need for improved training for physicists and related health-care professionals. The physical principles of Computed Tomography (CT) are difficult to demonstrate in a teaching environment. In this workshop we will demonstrate some of the capabilities of the Vista Scanner and discuss the content of prepared student labs. Scanner demonstrations will include: Acquisition – projection images (analogous to digital radiography) of a translucent object, detector characteristics, multiple projection angles for CT, fan and cone angles. Image Review – pretreatment of images for CT reconstruction, filtering, sinograms, corrections for scattering. Reconstruction – Feldkemp back projection, image resolution and voxel dimensions, data management. 3D Image – interact with the reconstructed image, artefacts, dynamic range.

CW02: And You Thought It Was About Homework: The Way You Imagined Teaching Could Be

Sponsor: WebAssign
Date: Tuesday, July 22
Time: 2:30–4 p.m.
Room: CAB 377

Leaders: John Risley, Peg Gjertsen, Chris Hall

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. Over 240,000 students are using WebAssign. Find out why. Visit us at http://webassign.net.

CW03: Physics2000.com Free Workshop

Sponsor: Physics2000.com
Date: Tuesday, July 22
Time: 2:30–4 p.m.
Room: CAB 373

Leader: Elisha Huggins

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. As calculus is the backbone of classical physics, Fourier analysis plays a similar role in understanding quantum mechanics. In the workshop we use the free MacScope II program and its Pulse Fourier Transform capability to teach the time-energy form of the uncertainty principle. The workshop is more than free—attendees receive complimentary copies of the Physics2000 CD and printed volumes I and II of Physics2000, the basic Introductory Physics course.

CW04: Vernier Software: New Data Collection Tools for Physics

Sponsor: Vernier Software & Technology
Date: Monday, July 21
Time: 10–11:30 a.m.
Room: CAB 373

Leaders: David Vernier, John Gastineau, Rick Sorenson

Attend this hands-on, drop-in workshop to learn about new data collection tools from Vernier Software & Technology. Work with the new Vernier LabQuest, our color touch-screen handheld science tool. Use LabQuest for standalone data collection and analysis, or connect it to a computer and control it from Logger Pro software. LabQuest and Logger Pro are both available in French. Check out our low-cost Rotary Motion Sensor and its rotational dynamics accessories. Experiment with our new Digital Radiation Meter. Use the Vernier Spectrometer to collect emission spectra of LEDs and other lamps. Find Planck's constant with a quick experiment, measuring both threshold energy and wavelength. Use our newly redesigned Vernier Force Sensor and some lab and demonstration ideas you probably have not seen before. Use our Wireless Dynamics Sensor System to collect force, acceleration and altitude data without wires. Try out some Vernier products for engineering or physics projects: The Vernier NXT Adapter allows our sensors to be used with the LEGO NXT Robotics system, and SensorDAQ, a USB interface for use with LabVIEW. Explore the video capabilities of Logger Pro.

CW05: Experience Digital Curriculum that Helps Students to See and Explore More Physics

Sponsor: Kinetic Books
Date: Monday, Jul y 21
Time: 12:30–2 p.m.
Room: CAB 377

Leader: Mark Bretl

Learn how a fully intergrated digital physics curriculum can aid your instruction. Application of multiple learning styles and inquiry-based learning in a self-paced package provide students experimentation and involvement. We truly believe that the long-term future of textbooks will be similar to the Encarta comparison to printed encyclopedias: provide a more interactive learning experience at lower cost. We've just done it in the subject of physics. Join us for an overview of the design and use of our products along with many subject highlights.

CW06: Bringing the Universe into Your Classroom

Sponsor: Cenco Physics
Date: Tuesday, July 22
Time: 8–9:30 a.m.
Room: CAB 373

Leaders: Bob Reiland, Ted Zaleskiewicz

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.

CW07: Sick of the Same Old Labs?

Sponsor: Cenco Physics
Date: Tuesday, July 22
Time: 10–11:30 a.m.
Room: CAB 373

Leader: Ben Pearson

This is an open workshop session where you can stop in and try new and different physics labs and technology for your classroom. Labs will cover the following topics: Newton's Laws, Electricity and Magnetism, Spectroscopy, Quantum Mechanics and more. An example of one of the labs you can expect in this workshop will be the Cenco Quantum Particle in a Box. A great lab for college or high school students, you use digital spectroscopy to measure the wavelength of fluorescence from four solutions that all contain quantum dots of different diameters. Using the theory of a particle in a box one can calculate the diameter of the quantum dots. This is the first easy to do, quantitative quantum mechanics experiment students can do in the classroom.

CW08: Strangeness and Charm in Your Classroom

Sponsor: Cenco Physics
Date: Monday, July 21
Time: 12:30–2 p.m.
Room: CAB 373

Leaders: Bob Reiland, Ted Zaleskiewicz

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 nad 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.

CW09: Hands-on, Minds-on Interactive Physics

Sponsor: Design Simulation Technologies
Date: Monday, July 21
Time: 10–11:30 a.m.
Room: CAB 377

Leader: Dr. Paul Mitiguy

Interactive Physics is the world's leading software for demonstrating, teaching, and experiencing the concepts of physics. It is in use by more than 13,000 schools worldwide. This workshop will provide you with an opportunity to see the software in action, obtain hands-on experience, and learn how the world of physics can come to life for your students. Dr. Paul Mitiguy, a long-time driving force behind the product, will conduct the workshop. In addition to discussing the software, he will also review the over 200 experiments that are part of the product and the innovative curriculum he developed to complement classroom use. Design Simulation Technologies develops physics-based simulation software that is used by students, educators, and engineers. Interactive Physics is used by more than 13,000 schools worldwide to teach and experience the concepts of physics. Working Model 2D is used by universities for teaching about kinematics, dynamics, and machine design and also by professional engineers for simulating the performance of their design. Dynamic Design Motion is used by CAD designers and engineers to evaluate the performance of their CAD designs before prototype parts are built.

CW10: Using Online Homework to Increase Student Learning

Sponsor: Pearson
Date: Monday, July 21
Time: 2:30–4 p.m.
Room: CAB 373

Leaders: Andrea Pascarella, Claire Masson

Homework is an integral component of an introductory physics course. However, studies show that adding traditional, end-of-chapter exercises to standard lecture courses does not increase student learning of concepts, nor does it enhance the development of problem-solving skills. This workshop will interactively engage participants in a discussion of effective and efficient ways to integrate online homework into introductory physics courses. MasteringPhysics is an online homework and assessment system that allows for multi-part, multi-step free-response problems, with an unparalleled variety of specific wrong-answer feedback and individualized help (composed of hints or simpler sub-problems available upon student request). Instructors use the diagnostic capabilities of MasteringPhysics to employ pedagogies such as Just-in-Time-Teaching; they can quickly see where students are struggling and then adjust their lectures to be more successful. The individualized help provided by the system allows students to study more effectively. The immediate feedback advances the development of students' metacognitive abilities.

CW11: Experience Digital Curriculum that Helps Students to See and Explore More Physics

Sponsor: Kinetic Books
Date: Tuesday, July 22
Time: 10–11:30 a.m.
Room: CAB 377

Leader: Mark Bretl

Learn how a fully intergrated digital physics curriculum can aid your instruction. Application of multiple learning styles and inquiry-based learning in a self-paced package provide students experimentation and involvement. We truly believe that the long term future of textbooks will be similar to the Encarta comparison to printed encyclopedias: provide a more interactive learning experience at lower cost. We've just done it in the subject of physics. Join us for an overview of the design and use of our products along with many subject highlights.

SUNDAY, July 20

Registration *ETLC, Solarium*	7 a.m.–4 p.m. and 7–9 p.m.
H.S. Share-a-Thon *Lister Centre, Wild Rose*	6–8 p.m
Welcome Reception	8–10 p.m

Session SUN: Undergraduate Student Research (Poster)

Location: Lister Centre, Aurora
Sponsor: Committee on Physics in Undergraduate Education
Date: Sunday, July 20
Time: 5:30–7:30 p.m.

Presider: Gary White

SUN01: 5:30–7:30 p.m. Lighting Research Using a 20 MHz Yagi Antenna

Poster - Erick P. Agrimson, The College of St. Catherine, St. Paul, MN 55105; epagrimson@stkate.edu

Alyona V. Haritonova, Onna O. Roosmalen, Terry F. Flower

Lightning strikes are composed of stroke events of rather short duration but with voltages of the order of 10^8 Volts and currents as much as 10^4 Amperes. We use a 20 MHz radio antenna to estimate power developed in a typical thunderstorm and the temporal distribution of its intensity. Integration of the energies involved suggests the enormous potential should these electrical energies be harvested for large scale electricity production.

SUN02: 5:30–7:30 p.m. Measurement of Earth's Magnetic Field Using Magnetic Torque Method

Poster - Misganaw Getaneh, University of Tennessee at Martin, Martin, TN 38237; mgetaneh@utm.edu*

Wallis A. Wimbish

A cylindrical neodymium magnet with axial magnetic dipole moment is suspended from a thin vertical string with its axis horizontal. In the absence of other magnetic fields it settles along the Earth's magnetic north-south line. A Helmholtz coil set was placed around the magnet, with its symmetry axis parallel to the Earth's field and with the magnet at its center. Rotating the magnet about an axis through the string results in a restoring torque, which when released, results in oscillations of the magnet with frequency that depends on current in the coil. The frequency was measured for several coil currents. The resulting frequency versus current data is used to determine the magnet's dipole moment and the horizontal component of the Earth's local magnetic field. The measurement for the Earth's field thus obtained is in very good agreement with measurement obtained using other methods.

* Dr. Dereje Seifu, Physics Department, Morgan State University, Baltimore, MD

SUN03: 5:30–7:30 p.m. Fractals, the Abstraction of Nature

Poster - Lingling Meng, Chien-Shiung Wu College, Southeast University, Nanjing, China; mlling_anfeng@yahoo.cn

Jinguo He, Jianbing Jiang

Having experienced the "Introduction to Bilingual Physics" course of Prof. Yun's as freshmen, we are totally attracted by its concept "Do some research and read English materials as early as possible." At the end of this course, we were required to write an essay and do a presentation.Our group came up with the topic of "Fractals" (a new and original science) as we were fascinated by its miraculousness. In our essay, the first part gives fractals coming into being, the second part tells of its definition and typical set (such as Mandelbrot Set) and the third is concerned with its wide applications. In the end, the essay will show how fractals connect literae humaniores with natural science perfectly.

SUN04: 5:30–7:30 p.m. Comparison of Teaching Styles in High School Physics Classes

Poster - Melissa M. Nemeth, Loyola University Chicago; mnemeth@luc.edu

Gordon P. Ramsey

The recent reports from the U.S. government indicate that our high school science students are behind most industrialized countries. Attributing factors include ill-prepared teachers, outdated curriculum, and ineffective pedagogy. In this project, we compare the effectiveness of teaching styles used in high school physics classes. The data will be analyzed to determine successful and unsuccessful methods for different demographics of students. Our research is based upon information from surveys sent to Illinois high school physics teachers, physics education research articles on teaching pedagogy, and AIP statistics on high school physics students and standardized test scores. We expect the results of this project to reflect teaching methods that involve a lot of teacher-student and student-student interaction. The results from this study will help teachers focus on the most effective teaching strategies for high school physics courses.

SUN05: 5:30–7:30 p.m. Developing a Concept Inventory Web-based Information and Tools Environment (WITE)

Poster - Robert L. Smigiel, Southern Illinois University Edwardsville, Edwardsville, Il 62026-1654; rsmigie@siue.edu*

Rebecca S. Lindell

Because of the complexity and diversity of the Physics and Astronomy Concept inventories, faculty often find the selection of inventories very difficult to understand and the data retrieved extremely time-consuming to analyze. To meet this need we have begun to develop a physics and astronomy concept inventory web-based information and tools environment (WITE) consisting of 1) Resources for choosing appropriate Concept Inventories, 2) Concept Inventory Data Analysis Center, 3) Concept Inventory National Databases, and 4) Concept Inventory Discussion Forums. With completion of this electronic environment, faculty worldwide will have access to this information and tools, thus eliminating much confusion and difficulty concerning the use of concept inventories. Preliminary results of this project will be presented.

*Sponsored by R. Lindell.

SUN06: 5:30–7:30 p.m. Gravitational Wave—After the Course of "Introduction to Bilingual Physics"

Poster - Tengxiang Zhang, Chien-Shiung Wu College, Southeast University, Nanjing, China; ztxdhr@sina.com

Wankai Tang, Xiaolong Xu

As freshmen of Chien-Shiung Wu College, Southeast University, we took the course of Introduction to Bilingual Physics and studied gravitational wave as a group. In the first part of this essay, we introduce the origin of G-wave briefly and compare G-wave with electromagnetic wave. The second part tells the efforts people put into detecting G-wave. The last part is about the application of G-wave and the outlook on the detection of G-wave both in China and all around the world. By writing this essay, we achieve the goal set by professor Yun—to read some English materials as early as possible and to do some research work as early as possible and really benefit from it a lot.

SUN07: 5:30–7:30 p.m. Cooling and Trapping Atoms with Laser Light

Poster - Hongying Huang, Software Engineering, Southeast University, Nanjing, China; hhy71107102@yahoo.com.cn

Mengyu Chu, Yue You, Hong Zhang

Introduction to Bilingual Physics is an unusual course that we had experienced. This course is open to freshmen in Southeast University. We are required to write an essay in English at the end of this course as a way to achieve the goal of doing research as early as possible. The essay is about the experiment that won the 1997 Nobel Prize in Physics. The first part gives the basic theory of this experiment, the second part tells of the experiment, and the third part is concerned with the applications of this discovery and our own understanding.

SUN08: 5:30 –7:30 p.m. University Efforts in Transforming K-12 Education

Poster - Portia Wolf, 1024 Marine St. #22, Boulder, CO 80302; portia.wolf@colorado.edu

Noah D. Finkelstein, Erin Wood, Laurel Mayhew, Valerie Otero

This poster presents two separate efforts by the University of Colorado to improve the quality of physics and astrophysics education. The University of Colorado's Laboratory for Atmospheric and Space Physics (LASP) Education and Public Outreach office seeks to inspire the next generation of scientists and engineers while improving K-12 science education as it relates to atmospheric and space science. Using state-of-the-art resources and innovative curricula designed to meet national standards, we wish to increase students' exposure to the excitement of space and Earth science. The second program, The Colorado Learning Assistant program seeks simultaneously to increase the number and preparation of future physics teachers and to support the transformation of undergraduate physics courses. We report on the implementation and success of the LA program in the physics department and recent efforts to develop community partnership activities that are designed to increase children's interest, access and ability in physics.

SUN09: 5:30–7:30 p.m. The Application of Superconduction in Power Transmission

Poster - Zexi Zhang, College of Software Engineering, Jiangning Campus, Southeast University, Nanjing ,Jiangsu, P.R. China 211189; zzx_71107122@yahoo.com.cn

Hao Gu

As freshmen of Software Engineering, Southeast University, we were told to write a paper and do a presentation in the name of our group during the "Introduction to Bilingual Physics" course. We intend to write something about a new technology—superconduction. In this paper, the concept and discovery of superconduction are first introduced; the second part is about the principle of an important effect of superconduction—the zero-resistance effect. At last we focus on the applications and prospect of using superconduction in power transmission.

Young Physicists' Meet and Greet *(Gen Xers mix and mingle)*

Monday, July 21 • 5:30 p.m. to 7:00 p.m. • Faculty Club

MONDAY, July 21

Registration 7:30 a.m.–5 p.m.
Engineering Teaching and Learning Complex (ETLC) Solarium

Klopsteg Award – Michio Kaku 4–5 p.m.
Students' Union, Horowitz

First Timers Gathering 7–8:30 a.m.
Jubilee Auditorium Building, Banquet Rm.

Exhibit Show 8 a.m.–12:30 p.m. and 1:45–6 p.m.
Students' Union, Dinwoodie

Young Physicists' Meet and Greet 5:30–7 p.m.
Faculty Club

Session PST1: Poster Session I—Reaching Out to the Public/Pre-College/Introductory College Physics/Advanced Physics

Location: Engineering Teaching & Learning Complex
Date: Monday, July 21
Time: 8–9 a.m.

PST1-01: 8–9 a.m. What Every Physics Department Should Do: Find Funding for PTRA!

Gay B. Stewart, University of Arkansas; gstewart@uark.edu

Many physics departments do some sort of professional development for area teachers, often summer workshops or summer courses. A program that is of high quality, already developed and perfect for teachers is already available, AAPT's PTRA. State MSP funding requires careful evaluation, and the PTRA program is already set up to do this sort of evaluation, both of teacher and student learning gains, as well as teacher confidence and use of technology. The professional growth of teachers involved in the program is amazing, and it is much easier to host PTRA workshops than to try to develop something at your own institution from scratch. Assistance was even made available from AAPT/PTRA in preparing a proposal for the state. Some of our experiences in hosting PTRA workshops and pursuing state funding will be shared.

PST1-02: 8–9 a.m. Outreach Activities of the British Columbia Association of Physics Teachers

Rachel F. Moll, University of British Columbia; rfmoll@gmail.com
Sarah D. Johnson

The British Columbia Association of Physics Teachers (BCAPT), a local section of the AAPT, is involved in a variety of outreach activities. These activities primarily involve outreach to high school, college, and university physics educators and students. We create and present well-regarded professional development opportunities such as workshops and conferences, often in partnership with local universities, colleges, national laboratories and industry. We also sponsor a prize that is given out at several science fairs in the area and a yearly prize for a promising physics student. The BCAPT is seen by other organizations as the best means to reach physics educators in BC. We will describe a sample of the outreach efforts we have presented in the past few years as well as our plans for the future.

PST1-03: 8–9 a.m. Delivering State-of-the-Art Laboratory Experiences to High School Classrooms

Stan Hart, University of Alabama in Birmingham; stanhart@uab.edu
Tommi Holsenbeck, Chuck Hanke

Alabama Science in Motion is a revolutionary program that delivers state-of-the-art science labs to public schools throughout Alabama. Learning science requires an understanding of the scientific method which is acquired through hands-on laboratory activities. Equipment, knowledge of the discipline, preparation time, and motivation are essential elements of an effective laboratory program. Alabama Science in Motion (ASIM) is a network of teacher resources designed to provide the all of the above. Technology without support and training is useless. ASIM provides 10-15 days of summer training in technology, content, and pedagogy for high school science teachers. Summer training provides updated content knowledge, to familiarize teachers with the use and operation of ASIM equipment, and to model teaching strategies that are successful with a broad range of students. ASIM provides classroom teachers with state-of-the-art equipment and resources that is out of the reach of most any school budget.

PST1-04: 8–9 a.m The Physics Laboratories "Science for Fun" and Other Initiatives Offered by the Museum and the University of Trento

Neva Capra, Natural Science Museum of Trento, Italy; neva.capra@mtsn.tn.it
Stefano Oss

The Natural Science Museum and the Department of Physics at the University of Trento, Italy, for a decade have collaborated at activities and events aimed to disseminate the scientific culture and to improve the quality of physics teaching in schools. Ten years ago we introduced hands-on laboratories that allow students to experience science in a funny way. In addition to proposals that explicitly recall the contents of ministerial programs, recent additions are laboratories that tell the principles of modern physics to classes of junior high students or the fascination of art and science brought together through the exploration of the physics in music. Beginning in 2001, we have offered to the public many hands-on exhibitions: on energy, on astronomy, on modern physics, during the WYP, and on the physics of flight in an exhibition on the history of flight simulation.

PST1-05: 8–9 a.m. Effectiveness of Physics by Inquiry Programs for K-12 Teachers*

Robert J. Endorf, University of Cincinnati; Robert.Endorf@UC.edu

Don Axe, Kathleen M Koenig, Amy Girkin, Jeffrey Radloff

Results will be presented from a study on the effectiveness of Physics by Inquiry professional development programs conducted at the University of Cincinnati for K-12 teachers. During each summer since 1996, a four-week 120-hour graduate course in Physics by Inquiry has been held for teachers in grades 5-12 and a separate two-week 60-hour course has been held for teachers in grades K-5. More than 400 teachers have successfully completed one of these summer courses, using the Physics by Inquiry[1] modules developed by Lillian McDermott and the Physics Education Group at the University of Washington. An evaluation of pre-test and post-test data will be presented which demonstrates that the 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. L.C. McDermott and the Physics Education Group at the University of Washington, *Physics by Inquiry* (Wiley, 1996).

PST1-06: 8–9 a.m. High School Physics and Biology Teacher Preparation at UNC-CH*

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

Laurie E. McNeil, Mark Enfield

At UNC-CH the College of Arts & Sciences and the School of Education have partnered together to develop a new teacher preparation program called UNC-BEST (University of North Carolina Baccalaureate Education in Science and Teaching). 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. Scholarship support for students in the program has been obtained from the Burroughs-Wellcome Foundation. The first students are anticipated to graduate from the program in May 2009.

*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.

PST1-07: 8–9 a.m. Assessing the Impact of Physics Modeling Workshops on H.S. Teachers*

Jeff Saul, Florida International University; saulj@fiu.edu

Vashti Sawtelle, Eric Brewe

What impact do workshops have on participants? The Center for High Energy Physics Research, Education, and Outreach (CHEPREO) at Florida International University has been running Hestenes-style Physics Modeling workshops[1] for High School math and science teachers for the past four summers. Workshop assessment and evaluation found participants substantially improve teacher content knowledge as measured in both pre-/post- and post-only nationally normed tests such as FCI, TUG-K, and MBT. Last year, we extended our assessment to see (1) what effect the workshops had on how the teachers think about teaching and (2) how teachers are using what they learn in the workshop(s) in their classrooms. This study uses standard pre-/post- assessments, interviews, and classroom observations in the 2006-08 school year. We will also report on the challenges the teachers faced in implementing an activity-based curriculum and the adaptations they made to meet these challenges.

1. D. Hestenes, "Modeling Games in the Newtonian World," *Am. J. Phys.* **60**, 732-748, (1992). D. Hestenes, "Modeling Methodology for Physics Teachers" in E.F. Redish and J.S. Rigden (Eds) *Proceedings of the International Conference on Undergraduate Physics Education* (Pt. 2, p. 935) Woodbury, AIP (1996).

*Work supported by NSF Award #0312038.

PST1-08: 8–9 a.m. Development of Strategy and Materials for Teaching Electric Current by Using Solution

Lee Jheong Sook, Korea National University of Education; lydia102@hanmail.net

Min Chae, Jung Bog Kim

This paper describes an experiment designed to show the electrical current flowing in NaCl solution. Two copper electrodes are immersed in and set vertically inside the plastic container (bowl). These two copper electrodes are connected in serial to an external battery and current sensors. We measured the current flowing through solution. The area of the copper electrodes is similar to resistances in parallel, and the separation is analogous to resistances in series. We can help the students to understand current in depth.

PST1-09: 8–9 a.m. ATE Program for Physics Faculty: Year Two

Thomas L. O'Kuma, Lee College; tokuma@lee.edu

Dwain M. Desbien

The ATE Program for Physics Faculty has finished its first two years during which eight workshops and one conference have been conducted. In the past year, five different workshops were held at Mt. San Antonio College (CA), Howard Community College (MD), Lee College (TX) and Estrella Mountain Community College (AZ). The conference, The New Faculty Training Conference for Two-Year College Physics Faculty, was held March 6-8, 2008, at Delta College in MI. In this poster, we will show results from these workshops and conference, including some developed materials by the participants.

PST1-10: 8–9 a.m. Technology to Engage Underrepresented K12 Students in Science

Laurel M. Mayhew, Univ. of Colorado, Physics Education Research; Laurel.Mayhew@colorado.edu*

Noah D. Finkelstein

We describe the University of Colorado Partnerships for Informal Science Education in the Community (PISEC) program in which university students participate in classroom and after school science activities with K-12 students in the local community. Novel educational technologies (digital stop action motion movies, computer simulations, PhET, and video-based mentoring) provide avenues to engage a diverse group of K-12 students, promote a deeper understanding of physics, and enhance their understanding of the nature of science. We present a model of the university-community partnerships and pedagogical approaches shown to increase children's engagement and understanding of science, as well as university partner's understanding and engagement in education.

*Sponsored by Noah D. Finkelstein.

PST1-11: 8–9 a.m. Physics Union Mathematics—A New Middle/High School Physics Curriculum*

Eugenia Etkina, Rutgers University; etkina@rci.rutgers.edu

Hector Lopez, Jeff Goett, Suzanne Brahmia, Eva Thanheiser, Alan Van Heuvelen

Physics Union Mathematics is a new curriculum that spans through middle school and high school and attempts to bridge the gap between physics and mathematics. It is based on the Investigative Science Learning Environment system (ISLE) which was found to help students learn physics and develop scientific abilities at the college level. The main feature of ISLE is that students learn physics by mirroring the processes physicists use to construct knowledge. Now a group of Rutgers faculty, graduate students, and local teachers are working on adapting the existing activities to bring the ISLE spirit into middle and high school. The goal is not only to help students learn physics through ISLE but also to enhance their mathematical reasoning and strengthen connections between physics and mathematics. This poster provides an overview of the curriculum goals, describes the module structure, and provides examples of activities from different modules.

*Partially funded by NSF DRL-0733140.

PST1-12: 8–9 a.m. BEST Robotics

Steven J. Maier, Northwestern Oklahoma State University; sjmaier@nwosu.edu

The BEST robotics program (Boosting Engineering, Science & Technology) is managed by a nonprofit organization that offers an impressionable "high-tech" robotics competition to middle school and high school students at no cost to the students or schools. BEST Robotics Inc. (BRI) is the official national non-profit organization to which local hubs are a party of. Many but not all local hubs are run and operated through colleges and universities by volunteering faculty and community members. One of BEST's greatest virtues is that participating schools are provided all of the same "kit" materials free of charge-allowing schools of even the most modest of enrollments and financial resources an opportunity to participate. At this poster session, information will be made available for those interested in becoming involved by forming a local hub or establishing a team with their students.

Useful links: www.nwosu.edu/BEST http://www.bestinc.org/MVC/

PST1-13: 8–9 a.m. Physics in Solar and Wind Power for Gifted and Talented Students in Middle Schools

Hang Deng-Luzader, Frostburg State University; hluzader@frostburg.edu

Sponsored by the Maryland State Department of Education, Frostburg State University (FSU) offered the gifted and talented middle school students a Summer Center for Physics in Solar and Wind Power in the summer of 2008. In the one-week residential center, students conduct a research projected based on the WiSE Wind and Solar Energy) solar array and wind turbine installed on FSU campus. By measuring the power from small solar panels on a model house under controlled lighting and the power produced by a miniature windmill placed in FSU's 40-foot wind tunnel, students learn basic principles of solar and wind power and predict how much energy can be produced by the WiSE solar panels and wind turbine, and study the economic and environmental aspects of residential solar and wind systems.

PST1-14: 8–9 a.m. Physics First, Year 2 Data, Comparing Juniors and Freshmen

Mary M. Cunningham, Argo Community High School, Darien, IL 60561; phunmmc@aol.com

We have completed our second year of physics first. We are teaching the same conceptual physics course to both freshmen and juniors, tracking responses on FCI, semester exams and Terra Nova Testing. We are also comparing students in the traditional BCP sequence to those in the PCB sequence. Illinois NCLB testing will be the final component. This test is administered in spring of students Junior year. Preliminary results will be presented.

PST1-15: 8–9 a.m. Everyday Physics: White-Light Diffraction Patterns from Windows and Railings

Todd G. Ruskell, Colorado School of Mines; truskell@mines.edu

Patrick B Kohl, Vince Kuo

The south-facing windows in the building that houses our Physics Learning Studio for introductory physics have a masking treatment designed to reduce glare. What was not appreciated until recently is that the resulting slit sources provide an excellent opportunity to view white-light diffraction effects. The Sun's elevation alters the effective size of the white-light sources, changing the visibility of fringes due to edge diffraction from a railing and other obstacles. In this poster we explore the variety of effects visible to the naked eye and compare the results to theoretical expectations. We also discuss the applicability of this natural and predictable hallway demonstration to teaching wave phenomena to physics students at all levels.

PST1-16: 8–9 a.m. Complex Numbers in the Context of Vectors

Lidia Julieta Royval, University of Juarez, Mexico; lroyval@uacj.mx*

Sergio Flores, Luis Leobardo Alfaro

Complex numbers is the final topic teachers must cover during the Algebra course at the University of Juarez in Mexico. Most of these teachers complain because they do not have time enough to go through this material at the end of the semester. In this sense, teachers from the research group named Physics and Mathematics in Context have developed an instructional proposal to teach complex numbers in the context of vectors at the middle of the semester. They claim that complex numbers could be learned more significantly in a physical context than in their own context of complex numbers.

*Sponsored by Sergio Flores.

PST1-17: 8–9 a.m. Rumble Strips and the Doppler Shift

Lawrence B. Rees, Brigham Young University; Lawrence_Rees@byu.edu

Rumble strips, the periodic grooves cut into road surfaces to warn drivers when they leave their lanes, provide an excellent way for students to visualize the Doppler shift. Since one pulse is produced each time a car encounters a groove, students can see exactly where each pulse is produced. Given that information and the speed of sound, it is easy to determine when each pulse arrives at an observer. Furthermore, the velocity of the source can be deduced from the frequency of the sound, so there is no need for an independent measurement of the source velocity. The details of the model and its application to a "speed trap" laboratory are described.

PST1-18: 8–9 a.m. Determining the Terminal Velocity and Drag Coefficient of an Object

David A. Spero, Long Trail School, Dorset, VT 05251; dspero@long-trailschool.org

Stephan Boas, Katheryn Chen, Nora Fiore, Andrew Kim

Falling objects are subject to the influence of gravity and an opposing drag force that increases with velocity. With increasing velocity, there is a point at which the drag force equals the gravitational force and the object reaches terminal velocity. Our study describes a system for accurately determining the terminal velocity of objects (golf ball, tennis ball, and baseball) using a force-based approach. In our system, the object is suspended from a force sensor recording the force of gravity. Simultaneously, air, with wind speeds ranging from 0 to 50 m/s, is directed upward through a pipe onto the object. The wind speed at which the net force is zero is the terminal velocity. Drag coefficients were calculated from terminal velocity measurements and results were consistent with previously published values. In conclusion, this apparatus lends itself to teaching important physical concepts such as net force, terminal velocity, and drag coefficient.

PST1-19: 8–9 a.m. On-Line Assessments: How Useful for Evaluating Teaching of Large Classes?

George A. Kuck, California State University Long Beach; galbertk@aol.com

Online computer assessments can be a powerful part of your teaching bag of tricks. Computer assessments allowed me to track what students learned over many semesters with minimum effort. By giving the same test at the beginning and at the end of the semester, the impact of my teaching changes were quantitatively evaluated. To minimize precious class time, computer assessments were given as homework using the assumption that my large classes were similar from semester to semester. Technology changes evaluated included the use of Power Point presentations vs real time hand written overhead transparencies, online (WebAssign) homework vs submitted but minimally checked homework, email and discussion boards vs. extended office hours, clicker quizzes vs. 3X5 card quizzes, and computer-based demonstrations and simulations vs limited demonstrations. My conclusion is that any technology changes made in the class are overwhelmed by increases in class size as classes grow to 100 students.

PST1-20: 8–9 a.m. Radial Motion of Particles Subject to an Inverse-Square Force

Carl E. Mungan, U.S. Naval Academy; mungan@usna.edu

In introductory physics, one typically solves force problems for particles moving in response to a constant force (such as projectiles), a Hookean force (simple oscillators), a centripetal force (uniform circular motion), and possibly a simple drag force (exponential approach toward terminal speed or decay in the amplitude of oscillations). Absent from this list is a treatment of particles experiencing an inverse-square force, despite its ubiquity throughout physics (notably in gravity and electrostatics). Restricting attention to the case of bound one-dimensional motion due to attraction of two particles released from rest, I consider some approximate methods to analyze the motion at an introductory level and compare them to the exact results.

PST1-21: 8–9 a.m. Vectors—Equations, Signs, Relationships, and Graphical Representation

Tom A. McMath, Kwantlen University College, Surrey, BC V3W2M8; tom.mcmath@kwantlen.ca

J. Michael Coombes

Vectors and vector equations are a staple of first year physics courses. Much emphasis is put on the mathematical mechanics of adding or subtracting vectors. However, lower level skills such as interpreting a vector diagram as a relationship between vectors (and vice versa) are often missing.

PST1-22: 8–9 a.m. Geometry Animation Contribution to the Understanding of Vectors

Sergio Flores, University of Ciudad Juarez, Mexico; sergiflo@hotmail.com

Luis Leobardo Alfaro, Juan Ernesto Chavez, Angel Armando Hernandez

Most students have learning difficulties related to vectors in different contexts during introductory mechanics courses. These understanding difficulties are found not only in the context of vectors, but also with other contexts as forces and acceleration. The research group called Physics and Mathematics in Context from the University of Ciudad Juarez has developed an instructional proposal to detect these understanding difficulties and to improve the significant learning of vectors. The instructional modification is based on the geometry software named Cabri.

PST1-23: 8–9 a.m. What's (at) the Point?

Brandon R. Lunk, North Carolina State University; brlunk@ncsu.edu

Jon D.H. Gaffney, Mary Bridget Kustuch, Shawn A. Weatherford, Robert J. Beichner

Physics students often struggle with the distinctions made between quantities that can be tacitly defined at a point and those defined over an interval. For instance, we all have experience observing speed at specific points in time by using a speedometer even though the instrument itself actually measures small displacements over intervals of time. Subtleties like these tend to be lost on students, contributing to their confusion between quantities and rate changes in those quantities. While the distinctions made between points and intervals can lead to deep philosophical discussions on their true nature, we are primarily interested in how these concepts are being presented to students in introductory classes. Within this context, we present an examination of how some popular introductory textbooks and the research literature address specific time-dependent quantities.

PST1-24: 8–9 a.m. Applying a Framework to Analyze Student Textbook Summary Writing

Michael Low, Oregon State University; dedra.demaree@gmail.com

Dedra Demaree, Saalih Allie, Julian Taylor

The majority of "special access" students at the University of Cape Town are also second-language English speakers for whom reading the physics textbook is daunting. As a strategy (a) to encourage meaningful engagement with the text and (b) to prime students for class activity students wrote textbook summaries due the day the material was covered in class. The summaries were returned, and they were encouraged to use them while studying. They could also bring their summaries to their final examination. Using a framework developed for analyzing student summaries, the summaries were analyzed in detail to give a deep view of how summary writing changed with practice and how the quality of summaries varied across the student population. The quantitative analysis of textbook summary writing will be presented. The study was carried out in the 2007 spring semester of the "Foundation Physics Course," a component of the special access program.

PST1-25: 8–9 a.m. Non-Science Major Labs Revisited

Mark I. Liff, Philadelphia University; iffm@philau.edu

Labs remain an important component of an introductory nonscience major physics course. In a typical course, labs occupy 40% of the total class-time. Traditional labs draw criticism for not contributing enough to the student's learning of physics. There were successful efforts to update traditional introductory labs, e.g. the Real Time Physics labs. At the same time, further research and development in introductory labs is needed. This presentation will discuss the changes that can be made to some traditional labs to enhance their output, efficacy and attractiveness for the students. The changes do not involve new equipment. The principles for reshaping of the labs are similar to those normally applied by PER and are based on student active engagement.

PST1-26: 8–9 a.m. Demonstrations for Newton's Law

Yeonho Choi, Korea National University of Education, South Korea; yuno0154@hanmail.net

JaeSeong Park, Jaesool Kwon, Beomki Kim

Most students and even many teachers believe that the Newton's second law can be applied to only the cases that the force acts on the center of mass of a rigid body. However, it covers all situations; rigid or flexible, fast or slow, spinning or rest, force acting on center or edge. We have developed experimental modules to show that it should be applied to all situations, which would help students or teachers to have a scientific conception on the second law.

PST1-27: 8–9 a.m. Using a New Type of Graph to Teach the Special Relativity

Min Chae, Korea National University of Education; bachmin@gmail.com

Jung Bog Kim

From time to time, we use a graph to understand states of events and to solve some problems, because a graph is a good method to help students' understanding of physics. Also, one graph involves a lot of information. We use a space-time (time versus position) graph to teach special relativity. However, we cannot know the space-time interval by using only the space-time graph. We have to calculate the space-time interval from the time interval and the displacement. We suggest that we can use a new type of graph to apply the special relativity. Space-time interval versus position graph lets us not only know space-time interval and position, but also time interval.

PST1-28: 8–9 a.m. Turning a Common Lab Exercise into a Challenging Lab Experiment

Joseph C. Amato, Colgate University; JAmato@Colgate.edu

Roger E. Williams

A common lab exercise in introductory mechanics employs a low-friction cart (of mass M) pulled along a horizontal track by a string which passes over a pulley to a hanging mass m. The apparatus is routinely used to verify Newton's second law. If, instead, the track is tilted by a small unknown angle 952; THETA, students are required to derive separate equations of motion for the acceleration up and down the track, devise an effective experimental strategy, and use the totality of their collected data to determine: (a) the effective friction force; (b) the mass M; (c) the angle 952; (with uncertainties). Results for M can be surprisingly accurate.

PST1-29: 8–9 a.m. Activities for a "Physics of Superheroes" Course

Kristi D. Concannon, King's College, Wilkes Barre, PA18711; kristiconcannon@kings.edu

Special interest courses are becoming an increasingly popular means of teaching physics to nonscience majors. During the spring 2008 semester, a Physics of Superheroes course was instituted for the first time at King's College as part of the natural science requirements in the general-education curriculum. The course content was centered on the text *The Physics of Superheroes* by James Kakalios and examined the primary conceptual areas of physics—kinematics, force, energy, heat, properties of matter, electricity and magnetism—as a means of investigating a superhero's special abilities. On a regular basis, the students performed an in-class activity as an extension of the week's discussion. The activities ranged from the interpretation of film clips to "mini-labs" using simple and readily available materials. This poster will present the learning objectives, procedures and outcomes for a few of the students' favorite exercises.

PST1-30: 8–9 a.m. Old Physics Demonstration Equipment

Bob Powell, University of West Georgia; bpowell@westga.edu

Robert Moore, Jr.

Physicists at the University of West Georgia have preserved several old items, such as a manual vacuum pump, large whistle, resonance apparatus, electrostatic generator, and ray tracing apparatus. Some of these items were used in a display of early physics equipment at the University of West Georgia during its centennial year of 2006-2007. Several papers and posters were presented at the 2007 AAPT Summer Meeting at Greensboro, NC, about physics equipment used in the early 1900s or earlier. The authors realized some of the displayed equipment was likely to be much older than they thought. This poster shows pictures of some of the equipment and describes attempts to date the items.

PST1-31: 8–9 a.m. Students' Understanding of the Greenhouse Effect

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

As a consequence of global warming making headlines, the mass media has played a role in informing the public about the greenhouse effect. Using the Greenhouse Effect Concept Inventory developed by Dr. John Keller, we conducted a survey to assess Japanese students' understanding of the greenhouse effect. The survey revealed that their understanding was influenced to a greater degree by information attained via the media rather than via the classroom, despite the fact that 80% of the surveyed students had been educated about this topic in high school. The pre-test, with a 37% correct response rate, revealed that many students believed that global warming was a recent phenomenon. While the incoming ultraviolet radiation from the Sun stayed the same, the infrared radiation from the Earth was decreasing, due to an entrapment of the infrared radiation by anthropogenic CO_2 in the atmosphere. The post-test, conducted in an earth systems course that employed simulations by the Physics Education Technology and Lecture Tutorials for introductory astronomy, revealed a 59% correct response rate, indicating that students' knowledge—but not their understanding—had improved substantially.

PST1-32: 8–9 a.m. Quantum Optics and Quantum Information Teaching Laboratory*

Svetlana G Lukishova, The Institute of Optics, University of Rochester; sluk@lle.rochester.edu

Carlos R. Stroud

We are developing a set of interdisciplinary experiments for undergraduates in the field of photon quantum mechanics. We will describe four teaching experimental setups built at the Institute of Optics and taught in the Fall semesters 2006 and 2007 as Quantum Optics and Quantum Information Laboratory: 1. Entanglement and Bell's Inequalities, 2. Single-photon interference (using Young.s double slit and Mach-Zehnder interferometer), 3. Confocal microscope imaging of single-emitter fluorescence, 4. Hanbury Brown and Twiss setup. Fluorescence antibunching. The main strength of our course is the use of real equipment of modern quantum optics and quantum information to teach the students.

*This work is supported by the U.S. National Science Foundation under Grant No. 0633621.

PST1-33: 8–9 a.m. Teaching Quantum Physics: What Is An Electron?

Art Hobson, University of Arkansas; ahobson@uark.edu

Quantum field theorists have understood for decades that electrons and other material "particles" are quanta of the electron-positron field and other fields, just as photons are quanta of the electromagnetic field, and that a field quantum is a discrete and irreducible portion (or "chunk," or "bundle") of a field, occupying an extended spatial region. But this understanding has not seeped through to most teachers and textbook writers at the introductory or undergraduate levels. Hence, there is still much discussion, and perplexity, about the supposed wave-particle paradox. But there is no paradox. Electrons are field quanta, extending spatially throughout the delta-x of the uncertainty principle, not particles. I will present a simple experiment-based method of teaching these quantum fundamentals. The experiments are the double-slit experiment for light and for electrons using intense beams (demonstrating interference) and dim beams (demonstrating discrete interactions).

PST1-34: 8–9 a.m. A Lab Component for Quantum Mechanics

Enrique J. Galvez, Colgate University; egalvez@mail.colgate.edu

A lab component to an undergraduate-level course on quantum mechanics has been implemented at Colgate University. The lab experiments were based on a table-top setup with correlated photons that we developed[1,2]. The experiments included single-photon interference, two-photon interference, entanglement, and Bell inequalities. The experiments help students understand the operations and fundamentals of quantum mechanics.

1. E.J. Galvez et al., *Am. J. Phys*. **73**, 127 (2005).

2. Funded by NSF grant DUE-0442882.

PST1-35: 8–9 a.m. Determining Saturation Intensities in Rubidium

Robert DeSerio, University of Florida; deserio@phys.ufl.edu

Saturated absorption spectroscopy in Rb is a common advanced lab experiment that is rich in opportunities to explore atomic physics and atom-field interactions. A simple measurement of single-beam absorption vs. laser intensity will be described that provides a determination of the saturation intensity—an atomic property describing the laser field strength where stimulated emission occurs at the same rate as spontaneous emission. At low laser intensities, the ground and excited state populations are relatively unperturbed and the fractional absorption remains constant. As the intensity increases past the saturation intensity, the populations start to equilibrate and the absorption fraction drops. The laser intensity is determined from power and area measurements and varied using neutral density filters. The laser frequency is scanned to obtain single-beam absorption spectra and determine the absorption fraction on resonance. Graphs of the absorption fraction vs. laser intensity are used to determine the saturation intensity.

PST1-36: 8–9 a.m. Differential Equations in the Context of Recipients with Liquids

Karla Carmona, University of Juarez, Mexico; carmona.karla@gmail.com*

Sergio Flores, Luis leobardo Alfaro, Maria Dolores Gonzalez

We have worked with the concepts of flow, velocity and emptying times in containers with different area. The research group named Physics and Mathematics in Context from the University of Juarez in Mexico wanted to experiment with the relationship between the geometry of the containers and their time of discharge. To do this we built two different sets—one where the cross area is constant: prisms with bases of different geometries, and another area with cross area variable: cone, sphere and cylinder. This served to achieve a better understanding of differential equations and to introduce the concept of viscosity, exchanging liquids in containers.

*Sponsored by Sergio Flores.

PST1-37: 8–9 a.m. A Capstone Project: Assembling, Characterizing, and Modeling a Stirling Engine

Ernest R. Behringer, Eastern Michigan University; ebehringe@emich.edu

PHY 420 Capstone Project is a course that is intended to develop and augment a variety of student skills, including searching the literature, designing and conducting experiments, designing and constructing theoretical and computational models, and communicating technical information using written, verbal, and graphical means. During winter 2008, students taking PHY 420 assembled, characterized, and modeled a PASCO Model SE-8590 Stirling Engine. These students presented the results of their investigations at the Eastern Michigan University Undergraduate Symposium as well as to the Department of Physics and Astronomy. The nature of the project also enabled reflection upon the physical constraints that influence the fulfillment of societal needs. A detailed description of the course and its impact on the students will be given.

PST1-38: 8–9 a.m. A New Text for Waves

David H. Kaplan, Southern Ilinois University Edwardsville; dkaplan@siue.edu

A primary reason for loss of undergraduate physics students is the formidable transition between elementary and upper-division physics. Success in the latter relies on strong foundational knowledge of wave physics and intuition about Fourier analysis usually not provided in the introductory sequence. Thus, we have introduced a second-year course dedicated to wave physics and Fourier. The current lack of a suitable text has led the author to developing a new text manuscript. The main goal is to provide, in a manner understandable to today?s average second-year physics student, a solid introduction to the critical ideas of superposition, completeness, Fourier synthesis and analysis and approximation in a classical wave physics setting so that in later courses such as quantum mechanics the student can concentrate on the novel physics without the undermining distraction of unfamiliarity with classical wave physics and Fourier technique. Aspects and goals of the text manuscript are briefly discussed.

PST1-39: 8–9 a.m. Implementing Real Time Physics at the University of Central Florida

Timothy F. McGreevy, University of Central Florida; tmcgreevy@physics.ucf.edu*

Costas Efthimiou, Dan Maronde

One of the key questions in physics education is the effectiveness of the teaching methods. A relatively new method at UCF is that of Real Time Physics (RTP). It is a three part student interactive format that has met with success at other universities. As of the spring 2008 semester we have completed two semesters using RTP in some classes while keeping a traditional format in others. Similarly, some classes were taught with Interactive Lecture Demonstrations (ILDs) and the remaining sections were taught without ILDs. Using a pre and post semester test, as well as student interviews, the preliminary data so far indicates a successful project at UCF. This will hopefully continue in the future.

*Sponsored by Dr. Costas Efthimiou

Session AA: Clickers in the Classroom(?)

Location: ETLC E1-013 (Engineering Teaching & Learning Complex)
Sponsor: Committee on Educational Technologies
Date: Monday, July 21
Time: 9–11 a.m.

Presider: S. Raj Chaudhury

AA01: 9–9:10 a.m. Technology Talks: Clickers and Grading Incentive in Physics 101

Shannon D. Willoughby, Montana State University–Bozeman, Bozeman, MT 59717-3840; willoughby@physics.montana.edu

Eric Gustafson

A one-year clicker study was done in Physics 101. Students in Section 1 were assigned clicker points only for a correct answer, whereas in Section 2 students were awarded points for simply participating. During the first semester of this study, learning groups were recorded four times during the semester while they discussed clicker questions. The recordings were transcribed and conversations binned according to the ideas put forth by each member of the group. The nature of the conversations differed between the two sections and students in section 1 chose the correct answer more often than students in Section 2. It is hypothesized that students in Section 1 block voted more often, choosing the answer the "smart student" thought was correct, whereas students in Section 2 were more likely to choose the answer they really thought was correct, since the points awarded did not hinge on choosing the correct answer.

AA02: 9:10–9:20 a.m. Clicker Pre/Post Testing and Evaluation in Introductory Labs

Michael R. Meyer, Michigan Technological University, Houghton, MI 49931; mrmeyer@mtu.edu

After using clickers for more than two years during conventional physics classes, I implemented clickers for both pre-post testing and evaluations in my second-semester engineering physics lab sections. Three semesters into this experiment, I will summarize the systems used and data gathered from the 15 to 19 lab sections each semester. A discussion of the benefits and challenges of using clickers in a lab/tutorial TA led environment will follow.

AA03: 9:20–9:30 a.m. The Effect of Clickers on Force and Motion Conceptual Understanding

Susan E. Ramlo, The University of Akron, Hudson, OH 44236-1913; sramlo@uakron.edu

Classroom response systems, also known as clickers, are becoming increasingly popular in classrooms. Fies and Marshall (2006) reviewed the literature on clickers and found that much of the existing literature is either largely anecdotal or includes comparison of clicker versus non-clicker environments that are unequal in other respects as well. In the study to be presented, the Force and Motion Conceptual Evaluation (FMCE) was used as a measure of Newtonian conceptual understanding at pre-test and post-test. Multiple linear regression analysis was used to evaluate the effect of classroom clicker use on the FMCE post-test scores, while controlling the FMCE pre-test scores, age, and prior physics classroom experience. The classrooms compared all had the same instructor using similar teaching techniques with the exception of the daily clicker use in the classes receiving the clicker treatment. The results of the analyses will be reported and discussed.

AA04: 9:30–9:40 a.m. Teaching Algebra-Based College Physics with Clickers

Irina A. Struganova, Barry University, Miami, FL 33161; istruganova@mail.barry.edu

I am going to share my five years experience of using clickers in algebra-based college physics course at Barry University. I tried to use the clickers for different tasks, such as taking quizzes, tests, etc. However, I found that the clickers were the most beneficial for getting an immediate respond on the student's understanding of concepts covered in the class by projecting a few multiple choice conceptual questions during the lecture. Careful selection of the questions available in standard test files as well as writing my own questions was an important part to the success. Though incorporation of clickers into a lecture course require a lot of time, it's worth it, and I would recommend it to anyone, even in relatively small classes.

AA05: 9:40–9:50 a.m. Clicker Use in Upper-Level Courses*

Michael Dubson, University of Colorado at Boulder, Boulder, CO 80305; michael.dubson@colorado.edu

Steven Pollock, Stephanie Chasteen, Noah D. Finkelstein, Katherine Perkins

At CU Boulder, clicker use with peer instruction is now the norm in all of the freshmen physics classes, and almost all of the sophomore physics classes. In the last few years, we have begun to introduce interactive engagement techniques, including clicker use, in junior and senior-level courses, including Math Methods, QM1, E&M1, and StatMech. We will give a history of ongoing transformation efforts, and we will list the attributes of successful and unsuccessful clicker questions, with examples from several upper-division courses.

*Partially supported by NSF DUE 0737118 and by the University of Colorado through the Science Education Initiative.

AA06: 9:50–10 a.m. Do Experts See What Students See in Clicker Sequences? Validation I

Albert H. Lee, The Ohio State University, Columbus, OH 43210; alee@mps.ohio-state.edu

Lin Ding, Neville W. Reay, Lei Bao

One indispensable step in designing assessment questions is to solicit expert opinions to establish validity. At the Ohio State University, we have been developing sequences of multiple-choice clicker questions for introductory physics lectures. Each sequence is designed to cover one concept in different contexts. To validate the sequences we first invited physics experts, including professors, post-docs and graduate students, to critique the questions. The feedback we received was positive and proposed only a few minor changes. Then, we tested these questions with undergraduate students who were taking introductory physics classes. Students raised legitimate issues that were not regarded as problematic in physics experts' eyes, resulting in many significant changes. In this talk, we will address the background and the design of our validation process, which eventually led us to rely on students as experts in validating clicker questions.

AA07: 10 –10:10 a.m. Content, Context and Representation in Clicker Sequences: Validation II

Lin Ding, The Ohio State University, Columbus, OH 43210; lding@mps.ohio-state.edu

Albert H. Lee, Neville W. Reay, Lei Bao

Based on the well-received notion that learning is context dependent, we have designed and validated a series of clicker sequences for introductory physics courses. As one step in the validation process, we conducted student clinical interviews, where students were called upon as "experts" to critique the content, context, and representation of clicker questions. Responses from student "experts" were unexpectedly fruitful. Students identified many issues that were not spotted by physics experts. These issues involved physics content, question contextual features, and pictorial and graphical representations. Detailed results and examples from student interviews will be presented.

Session AB: Learning to Think Like a Physics Education Researcher (a session to honor Alan Van Heuvelen)

Location: ETLC E1-001 (Engineering Teaching & Learning Complex)
Sponsors: Committee on Research in Physics Education, Committee on Physics in Two-Year Colleges
Date: Monday, July 21
Time: 9–11 a.m.

Presiders: Xueli Zou and Kathy Harper

AB01: 9:00–9:30 a.m. A Physics Education Researcher Motivating a Community

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

Curtis J. Hieggelke

Alan Van Heuvelen has worked with the Two-Year College Workshop Project since 1991. During this period he has stimulated a number of curricular and program changes based on physics education research for a large number of physics faculty, both two-year college and high school. He helped steer and develop the Conceptual Survey of Electricity and Magnetism and helped with both the ranking tasks and TIPERs projects. I attended Alan's OCS workshop in 1989 which changed my personal teaching approach and since have benefited from his friendship and mentoring. In this talk we will share some of the numerous ways in which Alan has impacted our work and lives.

AB02: 9:30–10 a.m. Alan Van Heuvelen at New Mexico State University

Invited - Stephen Kanim, New Mexico State University, Las Cruces, NM 88003; skanim@nmsu.edu

Alan Van Heuvelen was a faculty member of the physics department at New Mexico State University in Las Cruces from 1964 until 1993. During this time, his research interests included atomic and molecular physics and biomedical applications of physics. A strong commitment to improving physics instruction led to his development of new laboratories at NMSU, his authorship of a popular introductory physics textbook, and eventually into his transformation into a physics education researcher. I came to Las Cruces to teach high school physics at about the time that this transformation began, and since then have benefited greatly from Alan's friendship and mentoring. In this talk I'll tell some stories of my own and relate some from other NMSU faculty members.

AB03: 10:00–10:30 a.m. Multiple Representations of a Physics Education Research Mentor

Invited - Kathleen A. Harper, The Ohio State University, Columbus, OH 43210; harper.217@osu.edu

Leith D. Allen, David Van Domelen, Xueli Zou

Alan Van Heuvelen's interests in and contributions to the field of Physics Education Research are vast. They span a large set of content areas, scientific reasoning and learning abilities, research and curriculum development issues, and instructional innovations. As Alan's PhD students during his time at The Ohio State University, his dedicated, fruitful work ethic gave us a rich scientific apprenticeship. He gave us substantial freedom in choosing our dissertation topics; these included the effectiveness of representations such as work-energy bar charts, students' facility with problem decomposition, expert-novice comparisons in problem solving, and student understanding of magnetic induction and its representations. Although there were a number of common threads throughout our research, each had unique elements that gave us different views of Alan's physics education research and teaching expertise. We share a few of the numerous ways in which Alan has impacted our work and our lives.

Session AC: State of Physics Teaching in the U.S.: A High School Perspective

Location: ETLC E1-017 (Engineering Teaching & Learning Complex)
Sponsor: Committee on Physics in High School
Date: Monday, July 21
Time: 9–11 a.m.

Presider: Dale Freeland

AC01: 9–9:30 a.m. Physics Teacher Preparation: Problems, Perspectives and Solutions*

Invited - Theodore Hodapp, American Physical Society, College Park, MD; hodapp@aps.org

Currently, the production of certified high school physics teachers in the United States is about one-third of the need. States such as Texas and Minnesota have recently passed legislation mandating additional science requirements for high school students, but produce only a fraction of the teachers needed to fill the legislated demand. This talk will describe the current situation and explore solutions currently being implemented to address these issues. Programs like PhysTEC (the AAPT/AIP/APS joint society effort) and Uteach are providing workable programs and increased teacher production. Federal funding remains in doubt for programs aimed at teacher preparation, though, and a picture of the expectations for this in the 2009 budget will be described.

*Partial support for PhysTEC is provided by the National Science Foundation (PHY-0108787), and by the American Physical Society's Campaign for the 21st Century.

AC02: 9:30–10 a.m. Physics Teacher Preparation: High School to University Involvement, Perspectives to Think About

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

Robert Beck Clark

After 20 years of high school physics teaching, then moving to Physics Teacher Preparation at Brigham Young University* has been a road less traveled by many of my peers. Teacher Preparation is an option not selected by many students of physics. During this session, we will ponder the efforts that the Physical and Mathematical Science College at Brigham Young University has made in an attempt to better prepare physical science teaching majors, and to increase the number and quality of these students. Brigham Young University's physics teaching program housed in the College of Physical and Mathematical Sciences, in the physics department will be discussed. Gain and glean information from BYU's successes and efforts in the goal of better teacher preparation and increasing the number of secondary physics teachers.

*Brigham Young University is involved in the Physics Teacher Education Coalition (PTEC).

AC03: 10–10:10 a.m. Leaky Bucket or Revolving Door: Why Don't We Support Our Novice Teachers?

Paul Hickman, Science Education Consultant, 23 Rattlesnake Hill Road, Andover, MA 01810; hickmanp@comcast.net

Marcia Fetters

Reports going back to the Glenn Commission's more than eight years ago call for induction programs and mentoring to support novice teachers. Many of our states now require induction and mentoring but it is often an unfunded mandate. Education and Policy research strongly support that induction programs are critical to improve long-term retention of teachers in the profession and to reduce the high cost of turnover. Mentoring or coaching by trained master teachers, who have taught at the same level and have strong physics content knowledge, has been shown to accelerate teacher growth along the learning to teach continuum. Now that PhysTEC sites are significantly increasing the numbers of new physics teachers and we have a growing coalition of 100 institutions in PTEC. How can we keep track of where they are and what they are doing? What can we do to address the need to support our novice teachers as they perfect their craft?

AC04: 10:10–10:20 a.m. QuarkNet in the Classroom: A Lead Teacher's Perspective

Jon Anderson, Centennial Senior High School, Circle Pines, MN 55014; jpanderson@isd12.org

This session will discuss how QuarkNet has impacted teachers associated with the University of Minnesota site. The experiences and observations of a Lead Teacher for seven years will form the basis for the talk on topics ranging from 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.

Session AD: Tutorials in Intermediate Mechanics

Location: ETLC E2-001 (Engineering Teaching & Learning Complex)
Sponsors: Committee on Research in Physics Education, Committee on Physics in Undergraduate Education
Date: Monday, July 21
Time: 9–11 a.m.

Presider: Bradley S. Ambrose

Invited - Bradley S. Ambrose, Grand Valley State University, Allendale, MI 49401; ambroseb@gvsu.edu

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 [1]. This two-hour invited session will serve as a "mini-workshop" focusing on Intermediate Mechanics Tutorials (IMT), a suite of research-tested materials that provides an innovative instructional approach to supplement traditional lectures. These materials, modeled after *Tutorials in Introductory Physics* [2] and *Activity-Based Tutorials*[3], 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 research results and obtain firsthand experience with selected tutorials. Because intermediate mechanics courses vary in format and content from institution to institution, we will also discuss how IMT can be tailored appropriately. A copy of all IMT materials, which include student worksheets, pretests, homework, and instructor guides, will be given to each participant.

1. B.S. Ambrose, "Investigating student understanding in intermediate mechanics: Identifying the need for a tutorial approach to instruction," *Am. J. Phys.* **72**, 453-459 (2004).
2. *Tutorials in Introductory Physics*, L.C. McDermott, P.S. Shaffer, and the Physics Education Group at the University of Washington (Prentice Hall, 2002).
3. *Activity-Based Tutorials*, *Volume 1: Introductory Physics*, M.C. Wittmann, R.N. Steinberg, and E.F. Redish (Wiley, 2004).

Session AE: Use of Research-Based Physics Curricula in Teacher Preparation

Location: NRE 1-001 (Natural Resources Engineering Facility)
Sponsor: Committee on Teacher Preparation
Date: Monday, July 21
Time: 9–11 a.m

Presider: Ingrid Novodvorsky

AE01: 9–9:30 a.m. Teaching People How to Teach Children to Think Like Scientists

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

Lezlie S. DeWater, Hunter G. Close

If children are to think like scientists, their teachers must learn to think like scientists, but the teachers must also learn how to help others think like scientists. How can teacher preparation programs follow through to this last step? Furthermore, who counts as a physics teacher? The authors believe that all elementary teachers are physics teachers. This shift increases the complexity of teacher preparation, but also increases the variety of resources from which we can draw, which feeds back into high school physics teacher preparation. We will discuss a two-course sequence for pre-service elementary teachers in which we have integrated research-based curricula with PD strategies used by Seattle Public Schools. This strategy of cross-pollination (between higher education and school districts, content and methods, and high school and K-8 teacher preparation) provides future teachers with an authentic experience of professional preparation, allows iterative improvements to progress more quickly, and engenders collaboration.

AE02: 9:30–10 a.m. Lessons Learned at the Buffalo State Summer Physics Teachers' Academy

Invited - Dan L. MacIsaac, SUNY Buffalo State College; danmacisaac@mac.com

Dave Henry, Kathleen A. Falconer, Marie Plumb, Joe L. Zawicki

Since 2002, Buffalo State Physics has run a Physics Teachers' Summer Academy modeled upon the well-known ASU Summer Physics program, offering more than 2000 credit hours to over 300 individual teachers seeking NYSED secondary physics certification. From these summer academy participants we have (as of March 2008) recruited into two graduate programs—admitting 78 candidates and graduating 21 M.S.Ed. (Physics) degree holding master physics teachers. During this time we have learned several lessons about managing a summer physics teachers academy, and teaching modeling physics to pre-service and in-service teachers, which we will share in our presentation.

D. MacIsaac, D. Henry, J. Zawicki, D. Beery, and K. Falconer, "A new model alternative certification program for high school physics teachers: New pathways to physics teacher certification at SUNY-Buffalo State College," *Journal of Physics Teacher Education Online*, **2**(2), 10-16. (2004).

AE03: 10–10:30 a.m. Using Investigative Science Learning Environment to Prepare Physics Teachers

Invited - Eugenia Etkina, Rutgers University, New Brunswick, NJ 08901; etkina@rci.rutgers.edu

In this talk I will describe how Investigative Science Learning Environment (ISLE) serves as a framework for a physics teacher preparation program whose main goal is to help future teachers develop pedagogical content knowledge (PCK) in physics. Investigative Science Learning Environment is a guided inquiry comprehensive learning system that engages students in processes that mirror the practice of scientists constructing knowledge. It is based on the theory of cognitive apprenticeship and formative assessment and relies heavily on multiple representations. These theoretical pillars can not only guide the development of physics curriculum but also help develop cognitive skills. Pre-service teachers who learn PCK through ISLE learn how to engage their students in the construction of knowledge while simultaneously acquiring science process abilities. They learn to scaffold and coach their students through continuous feedback and then slowly remove the scaffolding. They also become acquainted with the wealth of knowledge developed in PER.

Session AF: Hot Topics in Geophysics

Location: NRE 1-003 (Natural Resources Engineering Facility)
Sponsors: Committee on Graduate Education in Physics, Committee on Women in Physics
Date: Monday, July 21
Time: 9–11 a.m.

Presider: Steve Turley

AF01: 9–9:30 a.m. Satellites of the Outer Solar System: Glimpses of Earth

Invited - Jani Radebaugh, Brigham Young University, Provo, UT; jani.radebaugh@byu.edu

Recent discoveries and observations of the satellites of Jupiter and Saturn reveal processes like those on our own home planet Earth. Active volcanoes erupt continuously on Jupiter's moon Io, as observed by the Voyager, Galileo, Cassini, and now the New Horizons spacecraft. Rafted ice plates on Europa reveal a young surface and liquid water layer below the ice. Water and organic-rich geysers erupt from Saturn's tiny moon Enceladus as observed by the Cassini spacecraft, now orbiting the Saturn system. Saturn's largest moon, Titan, has a nitrogen-rich atmosphere with a surface pressure similar to Earth, organic "snows" organized into vast dune fields, lakes full of methane and ethane, and recent cryovolcanic (water-ice based) flows. Although Titan's materials are vastly different than those on Earth, the landforms on this frigid body are strangely reminiscent of Earth.

AF02: 9:30–10 a.m Geophysics in Oil & Gas Exploration—Imaging Under the Earth's Surface

Invited - Alexa M. Tomlinson, Shell Canada Energy, PO Box 100, Station M, Calgary, AB T2P 2H5; alexa.tomlinson@shell.com

Exploration with seismic data relies on the physics of reflecting and refracting acoustic waves as they travel through the layers of the Earth. Seismic data can image ancient coral reefs, beaches or mountains buried kilometers underground. Resource exploration geophysicists look for where those features have potential to be new oil or gas reservoirs. Advances in seismic imaging have helped geophysicists find more challenging targets and accurately position their wells. Seismic interpretation can be like a huge 3D puzzle, with lots of possible solutions, where improved imaging techniques can make all the difference in drilling a successful well. In this talk I will briefly discuss the physics behind seismic data and present some examples of seismic interpretations in gas fields in Alberta.

AF03: 10–10:30 a.m. Geophysics of the Solid Earth: Current Understanding

Invited - Claire A. Currie, Department of Physics, University of Alberta; ccurrie@phys.ualberta.ca

Douglas R. Schmitt

Geophysics is a broad and multidisciplinary discipline that, unfortunately, few students are aware of when they enter undergraduate studies. Part of the reason for this may be that geophysics is rarely identified as a discipline within the North American secondary school curricula. Problems in geophysics, however, do have great potential in providing useful examples that can motivate secondary teaching of physics. In this talk, we will give a brief overview of some modern concepts in the geophysics of the solid Earth. This will be followed with current geophysical research with a focus on studies at the University of Alberta, including work on earthquakes, the structure of the Rocky Mountains, and the tectonics of western North America. These examples will be placed in a context to show how they may be used to illustrate physical principles at the high school level.

Douglas R. Schmitt, Dept. of Physics, University of Alberta, Edmonton, AB, Canada; 780-492-3985 ***(abstract pending for Session AF—in addendum)***

Session AH: PER Around the World

Location: NRE 2-003 (Natural Resources Engineering Facility)
Sponsors: Committee on International Physics Education, Committee on Research in Physics Education
Date: Monday, July 21
Time: 9–11 a.m.

Presider: Genaro Zavala

AH01: 9–9:30 a.m. Research and Practice of Bilingual Physics Teaching with Multimedia

Invited - Ying Yun, Southeast University, No. 2 , Si Pai Lou, Nanjing, 210096, China; yyun@seu.edu.cn*

Yong Zhang, Hui Zhong, Jing Fang

To help freshmen students join the research work and get acquainted with physics materials written in English as early as possible, an integrated method was used to edit the textbook—*Bilingual Physics with Multimedia*, and the course, "Introduction to Bilingual Physics," was introduced. During the past eight years, this course was taught 14 times. This paper presents the characteristics, adaptabilities, and teaching experiences of the course using the edited textbook. Effects of cultivating students' creative abilities are deserved.

*Sponsored by Lei Bao.

AH02: 9:30–10 a.m. Cross Culture Comparison of Student Content Knowledge and Reasoning Ability

Invited - Lei Bao, Physics Department, The Ohio State University; lbao@mps.ohio-state.edu

Tianfang Cai, Jing Wang, Jing Han, Kai Fang

Standardized concept surveys have been widely used in physics education for both research and teaching. This study is an effort to systematically collect carefully documented data of popular concept tests from entry-level college students in both China and the U.S. The results will provide a baseline for further analysis of characteristics of students in education settings across different countries. In this report, we will make detailed comparisons of college students' results in the U.S. and China on three tests: FCI, BEMA, and Lawson Test. The results suggest that although Chinese students are good at solving very complicated content problems through years of training; their general abilities in scientific reasoning is at the same level as that of the American students. Details on curriculum structures in the U.S. and China education systems are compared to provide a base for interpreting the assessment data.

AH03: 10–10:30 a.m. To Know Is to Measure

Invited - Saalih Allie, University of Cape Town, Rondebosch, 7701 South Africa; saalih.allie@uct.ac.za

Andy Buffler, Fred Lubben

Over the past decade, our group, from the University of Cape Town, South Africa, and the University of York, U.K., has investigated various aspects of student understanding of scientific measurement, in particular the notion of uncertainty. A number of studies have been carried out on several cohorts of physics students at the University of Cape Town in the context of the freshman laboratory. To date, the work has covered three broad areas: (a) student views about measurement, (b) the validity of declared measurement actions, and (c) the effect of using a more logical and consistent framework for carrying out data analysis and interpreting uncertainty (as advocated by the ISO in "The Guide to Expression of Uncertainty in Measurement"). An overview of these endeavours, together with more recent work regarding student views of measurement in the everyday context, and the effect of audience on the mode of reporting will be presented.

AH04: 10:30–11 a.m. Learning Physics in Informal Environments

Invited - Maria Helena Caldeira, Departamento de Física, Universidade de Coimbra, Portugal; helena@teor.fis.uc.pt

Science Museums and Interactive Science Centres are increasingly more aware of their important role in nonformal science education. Science education researchers have noted a tendency for an increase of research on learning in informal contexts in the last two decades, having highlighted that it needed further attention. Several pertinent questions still need an answer: How effective is the nonformal science education enterprise? Do people working on it have a theoretical basis for what they are doing and for evaluating it? Is there some training program for people in this field and for school teachers? Are teachers aware of the value of nonformal education? Are they prepared to enroll in it? How can teachers' attitudes be changed toward nonformal science education? In this presentation, we will think about these questions and present some data on Physics nonformal learning.

Session AI: Physics Demonstrations with a Biological Flavor

Location: ME 2-3 (Mechanical Engineering Building)
Sponsor: Committee on Apparatus
Date: Monday, July 21
Time: 9–11 a.m.

Presider: Steven K. Wonnell

AI01: 9–9:30 a.m. How Biological Cells Use Physics to Thrive

Invited - Warren M. Smith, University of Michigan; elendil@umich.edu

Membrane transport is a fundamental process in biological cells. The process is guided by the constituent parts of the membrane and can in part be described by the polar and non-polar properties of the lipid bilayer. We will present some simple demonstrations that show the physical properties of polar and non-polar liquids, and extrapolate how the membrane uses these properties to allow only desirable molecules in and out of the cell.

AI02: 9:30–10 a.m. Physics Demonstrations and Experiments with a Biological Flavor

Invited - Wolfgang Rueckner, Harvard University; rueckner@fas.harvard.edu

With major curriculum changes in the physical and life sciences, the boundaries between physics, chemistry, and biology have become fuzzy. Many new lecture demonstrations and laboratory experiments have been developed to compliment the new interdisciplinary approach. Examples will be presented.

AI03: 9–11 a.m Understanding the Diffraction of DNA: How Watson and Crick Knew

Poster - Emily A. Alden, University of Michigan; ealden@umich.edu

Tim McKay

Rosalind Franklin's famous X-ray diffraction image of DNA is among the icons of modern biology. The image is easily recognizable, but students rarely understand how it led Watson and Crick to infer the double helix structure of DNA. Introductory physics students regularly study the interference and diffraction of waves scattered from an array of slits, but it is important to highlight that these properties of waves have important applications in the life sciences. The Institute of Chemical Education at the University of Wisconsin has created optical transform slides which deconstruct Franklin's image into identifiable constituent parts. We describe use of this tool in a new Physics for the Life Science Course at the University of Michigan. It provides the opportunity to connect fundamental physics principles to a central achievement of the life sciences in a particularly memorable way.

AI04: 9–11 a.m. WYSIWYG? Not Always—Blurring the Boundaries Between Disciplines

Poster - David D. Lawrie, Faculty of Science, University of Alberta; dlawrie@ualberta.ca

The phenomenon of color vision offers a number of opportunities to integrate physics with biology, medicine, and even psychology/computing science. Newly developed high-intensity LEDs (Light Emitting Diodes) permit several dramatic demonstrations and experiments. This presentation describes a specially developed apparatus that can be used at a number of levels (simple demonstrations to quantitative experiments) to investigate several effects involved in color vision.

AI05: 9-11 a.m. Teaching About the Physics of Medical Imaging*

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

Bijaya Aryal, Spartak Kalita, Dyan McBride

To help students understand that contemporary physics and contemporary medical imaging are closely connected, we have developed a series of lessons that is based on research on student learning. For each unit we study how students transfer their knowledge from traditional physics to the medical applications. Then, we built instructional materials. Each of the learning units involves a combination of hands-on activities, which present analogies and interactive computer simulations. Units on CT scans, magnetic resonance imaging (MRI), positron emission tomography (PET) and wavefront aberrations are in progress. The project's website is http://web.phys.ksu.edu/mmmm/.

* Supported by the National Science Foundation under grant DUE 04-27645.

AI06: 9–11 a.m. What a Biological Charge!

Poster - Stephen R. Wallin, Colorado State University-Pueblo; stephen.wallin@colostate-pueblo.edu

The charge carriers are quite different in the biological organism and can be intricate. It can be demonstrated that the electrons can transfer fairly rapidly, when people shake hands. The RC technique offers a reasonable way of measuring body resistance so students can understand.

AI07: 9–11 a.m. Interactive Radiological Physics Simulations with Mathematica

Poster - Peter J. Riley, Riyadh Al Kharj Hospitals Programme, PO 7897, Box D201, Riyadh, Saudia Arabia; pjrhot@hotmail.com

Teaching physics for clinical interns requires diverse visualisation aids. Mathematica v.6 provides a consistent resource for rapidly implementing such physics explorations. A single code line can generate an equation plot with interactive sliders and other widgets. These allow the user to scan the equation parameter-space with real-time display updates. For example, a waveform's amplitude, frequency and phase variables can be adjusted in any order. Such interaction enhances physical comprehension. Examples are presented from the Radiological Physics syllabi for radiologists, radiographers and medical physicists. These include explorations of the Compton scattering and Klein-Nishina formulae. More advanced simulations show the changes in radiological images resulting from variation of exposure parameters in x-ray radiography, computed tomography and magnetic resonance imaging. Students may interact with these simulations with a freely available player.

AI08: 9–11 a.m. Building a Physics Support Structure for the Life Sciences

Poster - Carl R. Nave, Georgia State University; RodNave@gsu.edu

Polls of the students in our noncalculus introductory physics classes reveal that 60 to 70% of them are from biology or other life-science-related disciplines. Yet our courses are so packed with topics that there is little time to devote to direct life-science applications of physics. In an effort to provide relevant life-science applications, some specific structures have been created to link biology topics to the physics framework in the HyperPhysics site. An additional motivation is the provision of background material for the teaching of anatomy and physiology. Many aspects of those courses involve physics, but like most introductory courses, they have little time to devote to topics outside their specific discipline. Active concept maps provide an easily navigable exploration environment in the freely accessible web resource.

AI09: 9–11 a.m. Physics Education for Premedical Students

Poster - Hideo Fusaoka, Aichi Medical University, Aichi 480-1195 Japan; fusaoka@aichi-med-u.ac.jp

Masaya Sengoku

In the United States applicants to medical school are obliged to take MCAT, the Medical College Admissions Test. Therefore, the level of most premedical students concerning physics is thought to reach a certain extent. On the other hand, in Japan students who finish high school immediately go to six-year medical university. They learn physics according to respective curriculum during the first or second year of university. The educational environments are different from each other. We will discuss physics education at Aichi Medical University in Japan and examine physics education for premedical students.

CANCELED

AI10: 9–11 a.m. Animation-Enhanced ECG Electric Potential Laboratory Activity

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

Readily available animations and interactive software were used to enhance a student activity of the Workshop Physics with Health Science Applications. In this computer/lab activity students take their own ECG and correlate the changing electrical potential measurement on their skin due to the changing electric dipole of the heart.

Session AJ: Favorite Activities/Lessons in the TYC Physics Classroom

Location: ETLC, Solarium
Sponsor: Committee on Physics in Two-Year Colleges
Date: Monday, July 21
Time: 8–9 a.m.

Presider: Dwain M. Desbien

AJ01: 8–9 a.m. Using a Conveyor Belt to Examine Relative Velocities

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

We use a homemade conveyor belt and battery-operated toy cars to examine relative motion. The conveyor belt is large enough to allow exploration of two-dimensional motion. This poster will share the design of the conveyor belt system as well as a description of several typical scenarios students explore with the use of this equipment.

AJ02: 8–9 a.m. Bar Chart Usage in Physics Classes

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

I have been using bar charts in all my physics classes for many years with great success. I find them useful not only for work-energy (which was there original use), but also in impulse-momentum, SHM, electricity and magnetism, and others. I use them as multiple representation tools. For this poster, I will illustrate several examples of the use of bar charts and many examples.

AJ03: 8–9 a.m. New Faculty Training Conference for Two-Year Physics Faculty

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

Dwain M. Desbien, Scott F. Schultz, Todd R. Leif, Sherry L. Savrda, Michael C. Faleski

The New Faculty Training Conference (NFTC) for Two-Year College Physics Faculty was held March 6-8, 2008 at Delta College in University Center, MI. This first-time ever new faculty conference for TYC faculty brought together 30 faculty in their first five years of teaching at a TYC. These participants represented 30 different institutions in 20 states. This poster will illustrate the various aspects of the NFTC, its program, the schedule, and many photos of the activities done during the conference.

AJ04: 8–9 a.m. Lights! Action !! Camera!!!

Poster - David Weaver, Chandler-Gilbert Community College, Mesa, AZ 85212; david.weaver@cgcmail.maricopa.edu

I passionately believe that all learning takes place within context and none happens without. Teaching a second semester algebra college physics course that is supposed to address electricity, magnetism, and optics presents challenges in a project-based environment.This poster will describe how my students use the flash circuit from disposable cameras to create coil guns capable of shooting a metal BB long distances and the physics they teach themselves in the process.

AJ05: 8–9 a.m. A Set of Classroom Assessment Techniques for Introductory Physics Courses

Poster - Jennifer Kirkey, Douglas College, New Westminster, BC V3L 5B2, Canada; kirkeyj@douglas.bc.ca

There is a long and well-documented history of classroom assessment. This poster is not an introduction to the field of classroom assessment. Cross and Angelo, in *Classroom Assessment Techniques*, (Jossey-Bass, 1993) and Cross and Steadman, in *Classroom Research,* (Jossey-Bass, 1996) do a wonderful job of explaining these ideas. Some specific and concrete examples of classroom assessment techniques that have proven to be very useful in my first-year physics and astronomy courses will be shared. Ready-to-copy pages that teachers can immediately use will be presented. Examples of student responses whose in-depth responses will be presented to help illustrate the usefulness of the simple, easy and astonishing useful technique of classroom assessment.

AJ06: 8–9 a.m. Changing the Syllabus to Get Students to Do What I Want

Poster - William P. Hogan, Joliet Junior College, Joliet, IL 60431; whogan@jjc.edu

I have made many changes over the years to the syllabi for my courses as I've tried to get students to focus more on understanding the material and less on their grade. I currently have some unusual policies about how homework and lab work are counted in determining student grades that I believe have been effective in influencing students to change their behavior and learn more from the homework and labs. My poster will provide details of these unusual policies and some comments about the effect they have had on student behavior.

AJ07: 8–9 a.m. Adaptive Multi-Leveled Virtual Laboratories for Science and Technology Education

Poster - Doyle V. Davis, White Mountains Community College, Berlin, NH 03570; ddavis@ccsnh.edu

Yakov Cherner

A collection of web-enabled simulation-based virtual labs has been developed for classical mechanics, heat and thermodynamics, fluid physics, fiber optics, and wireless communications. The labs are designed to enhance the understanding of technical concepts and underlying fundamental principles and contain expandable sets of virtual experiments (VE), learning resources, and assessment activities. An easy-to-use Web-based authoring tool that enables instructors with no-programming experience to produce appealing and pedagogically sound interactive virtual activities is available as well. Each VE focuses on a particular task and comprises such components as main and auxiliary simulations, learning objectives, assignments, step-by-step instructions for students, embedded assessments, and prerequisites. The virtual labs can be linked to related hands-on labs to form hybrid laboratories. Details at http://www.atelearning.com/root/elearningtools.php. Test drive some sample lessons at http://atelearning.com/SimBeLT. Click the resources tab. Enter your email address and the case sensitive password: p_Guest2007.

*Partially supported by NSF DUE-0603277.

AJ08: 8–9 a.m. What Makes a Good Peer Instruction Question?

Poster - Tom Carter, College of DuPage, Glen Ellyn, IL 60137; carter@fnal.gov

Ding Lin, Albert H. Lee, Neville W. Reay

Over the past six years, I have been using Peer Instruction in my introductory physics class and I have accumulated a large set of "clicker" questions. I will display some of my favorite questions and give a brief explanation of the key concept probed by each. Some of the questions were written by me but many were provided from other sources. I will provide a thumb drive for use in up-loading and down-loading different sets. I will specifically make available the electricity and magnetism questions in serial format recently written by the Ohio State PER group[1]. I also would like this poster to form a central point for people to swap question sets, discuss what makes a good question, and show off their own favorites.

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

AJ09: 8–9 a.m. The DC-Driven RLC Circuit

Poster - Michael C. Faleski, Delta College, University Center, MI 48710; michaelfaleski@delta.edu

In introductory physics classes, the series RLC circuit ordinarily is discussed in one of two contexts: the discharging underdamped circuit or the AC-driven circuit. What happens when the underdamped RLC circuit is driven by a DC source? This circuit provides a powerful demonstration that voltages across circuit elements are not bound only to be less than or equal to that of the source. In addition, there is a simple mass-spring analogy that demonstrates simply the qualitative features of the voltage for the capacitor as a function of time. Further investigation into the transient physics of the circuit reveals a response that has interesting features that could provide computational, theoretical, and experimental projects to the more advanced student.

Session AK: Undergraduate Student Research

Location: NRE 2-001 (Natural Resources Engineering Facility)
Sponsor: Committee on Physics in Undergraduate Education
Date: Monday, July 21
Time: 9–11 a.m.

Presider: Gary White

AK01: 9–9:10 a.m. Inertial Filtration in Lunar Gravity

Emily Sorensen, Carthage College, Kenosha, WI 53140; esorensen@carthage.edu*

Erin Martin

We present results from our test of the relative efficiency of a cyclone filter in simulated microgravity, lunar gravity, and Martian gravity compared to Earth. NASA's "Vomit Comet," a C-9B aircraft, flies in parabolas simulating reduced gravity for periods up to 40 seconds. This research is sponsored by the NASA Microgravity University Systems Engineering Educational Discovery (SEED) Program based in Houston, TX.

* Sponsored by Kevin Crosby and Brian Schwartz.

AK02: 9:10–9:20 a.m. Structural Design for Experimentation of Inertial Filtration in Lunar Gravity

Isa C. Fritz, Carthage College, Kenosha, WI 53140; ifritz@carthage.edu*

Bradley Frye

We present our experiment's structural design and layout from our test of the efficiency of a cyclone filter in simulated microgravity, lunar gravity, and Martian gravity compared to Earth. NASA's "Vomit Comet," a C-9B aircraft, flies in parabolas simulating reduced gravity for periods up to 40 seconds. This research is sponsored by the NASA Microgravity University Systems Engineering Educational Discovery (SEED) Program based in Houston, TX.

* Sponsored by Kevin Crosby and Brian Schwartz.

AK03: 9:20–9:30 a.m. Fighting Wrong Beliefs

Kevin H. Thomas, University of Central Florida; Orlando, FL 32826; kthomas@physics.ucf.edu*

Pseudoscience is a growing threat to scientific research and public support of science. Physics In Films is a General Education course at UCF that promotes science literacy and debunks science misunderstandings and popular pseudoscientific 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 pseudoscientific 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.

*Sponsored by Costas Effthimiou.

Damian Pope

AL: Plenary: Teaching Dark Matter to High School Students

Location: Students' Union, Horowitz Theatre
Date: Monday, July 21
Time: 11:15 a.m.–12:15 p.m.

Presider: Lila M. Adair, Welcome and Introduction

Damian Pope, Perimeter Institute for Theoretical Physics, 31 Caroline St. N., Waterloo Ontario, Canada N2L 2Y5

One of the greatest discoveries in physics over last few decades has been the fact that about 90% of the mass of every galaxy is made of an unseen substance called dark matter. Currently, no one knows what dark matter is composed of and finding this out is one of the biggest unsolved problems in physics today.This presentation will introduce "The Mystery of Dark Matter," an educational resource for high school students on the topic of dark matter recently produced by Perimeter Institute for Theoretical Physics. It includes a 25-minute in-class video and a teacher's guide that contains supplementary information, worksheets and hands-on student activities related to dark matter. It fits in with high school curricula worldwide and allows teachers to bring the topic of dark matter to their students as an application of uniform circular motion and universal gravitation. Free copies of the resource will be available at the end of the presentation.

AK04: 9:30–9:40 a.m. Quantum Cryptography—Cultivating the Self-Learning Ability

Yu-Fei Yang, Southeast University, Nanjing, Jiangsu, 211189 China; yufee_young@yahoo.cn

*Meng Fan, Xin-Da Xu**

As freshmen of Chien-Shiung Wu College, Southeast University, we are recommended to take the course Introduction to Bilingual Physics. The course really sparked our curiosity to explore the unknown world and cultivate our self-learning ability. This paper is written under the concepts of "Self-Learning" and "Using English as early as possible." It comprises four sections by using the question and answer method: 1. Where does our inspiration come from? 2. How did the quantum cryptography come into being? (Giving a brief introduction of quantum cryptography and its features) 3. What is the significance behind the quantum cryptography? (Using Three-People-Model) 4. Will the quantum cryptography have a bright future? After fully understanding these questions, we could draw the conclusion that the quantum cryptography is operational.

*We are the students of Prof. Y. Yun.

AK05: 9:40–9:50 a.m. Quantitative Measurement of Fe(II) in Human Blood with Spectral Analysis

Fuli Zhao, Sun Yat-sen University, Guangzhou, China, 510275; stszfl@mail.sysu.edu.cn

Xiaofeng Xu, Shuang Wang

We obtained Fe(II) ions solutions with various concentrations chemically, using 1, 10-phenanthroline (phen) as chromogenic agent. Through spectral analysis method, the concentrations of Fe(II) in these solutions were figured out, by means of Gaussion and linear fitting. Based on the chemical measurement of Fe(III), we have established a direct measurement of active haemachrome in human blood. As an optimized method, this creative idea is more accurate and precise. It might contribute to development of new devices for measuring Fe(II) ions in human blood.

AK06: 9:50–10:00 a.m. An Undergraduate Approach to Lattice Physics: Lattice Quantum Mechanics

Scott W. Moerschbacher, Lycoming College, Williamsport, PA 17701; moerschb@lycoming.edu

The experience of the undergraduate student participating in research in lattice physics can be somewhat limited in the scope of his or her research to the field of lattice quantum chromodynamics (LQCD). This paper presents a way to introduce the undergraduate student to lattice methods using the techniques studied in undergraduate quantum mechanics and introductory computer science courses, with no mention of quantum field theory. The projects proposed here are small-scale and thus solvable in one- or two-semesters, which is typically the timescale for an undergraduate senior project. Some preliminary results from my own students' work will also be presented.

Session BA: Crackerbarrel: Professional Concerns of High School Teachers

Location: ETLC E1-017 (Engineering Teaching & Learning Complex)
Sponsors: Committee on High Schools, Committee on Professional Concerns
Date: Monday, July 21
Time: 12:15–1:45 p.m.

Presider: David Callahan, Delaware Regional High School; ptcallahan@aol.com

BB: Crackerbarrel: Professional Concerns of Instructional Resource Specialists

Location: ETLC E2-001 (Engineering Teaching & Learning Complex)
Sponsors: Committee on Apparatus, Committee on Professional Concerns
Date: Monday, July 21
Time: 2:15–1:45 p.m.

Presider: Dean Hudek, Brown University; dean_hudek@brown.edu

Session BC: Crackerbarrel: Web Resources for Teaching Astronomy

Location: NRE 2-001 (Natural Resources Engineering Facility)
Sponsors: Committee on Space Science and Astronomy, Committee on Educational Technologies
Date: Monday, July 21
Time: 12:15–1:45 p.m.

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

The growth of the Internet has placed an abundance of wonderful teaching resources at our fingertips. Simulations, data repositories, wikis, opencourseware, web-based assessment engines, and many other types of resources are transforming how we teach. This crackerbarrel will provide an opportunity for astronomy educators to share information about the web resources that have made the greatest impact in their courses. Please attend with a URL or two in mind. Attendees will be invited to take turns making two minute presentations demonstrating a web resource and describing why it has made an impact in their class. Computers connected to the web and projection equipment will be provided."

Session BD: Crackerbarrel: Physics and Society Education

Location: NRE 2-003 (Natural Resources Engineering Facility)
Sponsor: Committee on Science Education for the Public
Date: Monday, July 21
Time: 12:15–1:45 p.m.

Presider: Jane Flood

Are you trying to incorporate energy issues into physics courses? Have you developed an exercise on radiation physics and medicine? Do your students have questions about creationism and the big bang? Join your colleagues to share ideas in a discussion of incorporating societal issues into physics classes. Topics might include nuclear proliferation, alternative energy sources, resource use, pseudoscience, radiation and public health, as introduced by participants.

Session CA: Physics and the Performing Arts: The Art of Physics Demonstration

Location: ETLC E1-013 (Engineering Teaching & Learning Complex)
Sponsor: Committee on Apparatus
Date: Monday, July 21
Time: 1:45–3:45 p.m.

Presider: David E.G. Sturm

CA01: 1:45–2:15 p.m. Why Is the NY Times Tuesday Science Section Only 8 Pages?*

Invited - Brian Schwartz, The Graduate Center of City University of New York; bschwartz@gc.cuny.edu

Adrienne Klein, Linda Merman

Newspapers across the United States give relatively little attention to science reporting whereas the performing arts usually have separate daily sections. Why? This is in spite of the government science budgets from NIH, NSF, DOE and others of about $60 billion whereas the total for the National Endowment for the Arts and the National Endowment for the Humanities is less than $300 million. For the past decade we have been involved in bringing science to the general public through the medium of the arts—theater, dance, music, fine art. (See http://web.gc.cuny.edu/sciart). In this presentation we discuss some of our collaborations such as: symposia organized in conjunction with the play Copenhagen; Street Fair Science; Science & the Arts Festivals; an evening of science and entertainment titled "String Theory for Dummies"; and, plans for public symposia associated with John Adams's opera "Doctor Atomic," scheduled for the Metropolitan Opera in October 2008.

*Supported in part by the National Science Foundation, NSF PHY-0431660.

CA02: 2:15–2:45 p.m. Enhancing Physics Education Through the Performing Arts

Invited - Colin Funk, The Banff Centre, Banff, Alberta, T1L 1H5, Canada; colin_funk@banffcentre.ca

Brian Woodward

At its heart, the study of physics is about exploring and learning—in the case of physics it is about how the universe is constructed and how it works. The role of physics education is to provide the mathematical and conceptual skills required to experiment with the forces that shape the cosmos. Historically, the science of physics has been taught primarily by a "lecture-and-lab" method. This traditional approach provides the student with a structured body of knowledge essential for the work. But does this approach provide familiarity with the creative tools—the imaginative capacity—necessary to the exploration and discovery process? This paper presents an aesthetic-based approach to exploration and learning—an approach that artists have long drawn from and one that more and more business leaders are embracing. The model outlined in this paper draws its philosophical underpinnings from the science of hermeneutics and consequently views physicists (similar to leaders and artists) as meaning-seekers and meaning-makers. The design parameters for aesthetic-based learning experiences developed at the Banff Centre Leadership Lab are briefly discussed.

CA03: 2:45–3:15 p.m. Visualise — The Beauty of Science Without Words

Invited - Wendy Sadler, Science Made Simple, 98 Fairwater Grove West, Cardiff, CF5 2JR, U.K.; wendy@sciencemadesimple.co.uk*

What happens if you take away the language barrier to learning science? No, not just the jargon and technical terms, but every single word. "visualise – the beauty of science," is a theater show that does just that. It came about following some research and some frustrating experiences the presenter had when working through translators. The show has since become a fully fledged theater piece that has been short-listed for awards at the Edinburgh Fringe Festival and has toured all across Europe. It's been described as "the Blue Man Group meets the Christmas Lectures." But can it teach audiences anything about physics?

*Sponsored by Stanley Micklavzina.

CA04: 3:15–3:45 p.m. Physics as a Performing Art

Invited - Brian Jones, Colorado State University; bjones@lamar.colostate.edu

When you teach a large lecture you are a performer, like it or not. You simply can't have the same type of interaction with your students as you can in a small class—but you can gain a great deal from the energy and the excitement that a large lecture can provide. In this talk, I'll share some practical suggestions for more effective student engagement in the large lecture class using tips from the performing arts, including suggestions for effective use of classroom demonstrations. The goal isn't to make you look like a performer, but to help you provide a more effective performance.

Session CB: Disseminating Results and Resources in Physics Education

Location: ETLC E1-001 (Engineering Teaching & Learning Complex)
Sponsors: Committee on Research in Physics Education, Committee on Physics in Undergraduate Education
Date: Monday, July 21
Time: 1:45–3:45 p.m.

Presider: Leon Hsu

Panel - Jan Tobochnik, Kalamazoo College; jant@kzoo.edu
Karl C. Mamola, Appalachian State University, Boone, NC; mamolakc@appstate.edu
Vince Kuo, Colorado School of Mines; hkuo@mines.edu
Bruce Mason, University of Oklahoma; bmason@ou.edu

Numerous venues exist for disseminating results and resources of interest to physics educators, but which one is right for you and your project? In this panel session, representatives from *The Physics Teacher,* the *American Journal of Physics*, comPADRE, and PERCENTRAL will briefly describe their respective venues, then answer questions from attendees regarding what kinds of articles or resources are appropriate for each, in addition to the editorial and publishing process. The discussion should be of interest not only to those seeking to disseminate their work, but also to physics educators looking for information and resources they can use.

Session CC: Curriculum Design, Improvement and Implementation: Reports by CASTLE Teachers

Location: ETLC E1-017 (Engineering Teaching & Learning Complex)
Sponsor: Committee on Physics in High Schools
Date: Monday, July 21
Time: 1:45–3:45 p.m.

Presider: Melvin Steinberg

CC01: 1:45–2:45 p.m. CASTLE Impact on Student Involvement

Panel - Pat Callahan, Delaware Valley Regional HS, Frenchtown, NJ 08825-3721; ptcallahan@aol.com

Al Gibson, Larry Cook, Tommi Holsenbeck, Trina Cannon

CC02: 2:45–3:15 p.m. Probing for Student Understanding of Electrical Resistance

Invited - Michael Cunha, 20 Byron Dr., Granby, CT 06035; mikecu@cox.net

An explanation of extensive action research using CASTLE activities directed at helping students generate the resistance concept will be presented. Video clips showing student-student and student-teacher interactions in a 9th grade physical science class will be shown and discussed. The presentation will also focus on how Section 2 of the CASTLE curriculum was revised in response to the extensive probing for student understanding that is evident in the video. Students' articulation of their thinking revealed the need for a new hands-on experiment that demonstrates the superiority of a partial blocking model vs. the strongly intuited "using up" idea.

CC03: 3:15–3:34 p.m. Extending CASTLE to Include Electromagnetic Fields

Invited - Richard B. Feren, 421 Webster St., Manchester, NH 03104; rbferen@comcast.net

I will demonstrate CASTLE experiments designed to promote image-based electromagnetic field concepts that are usually developed mathematically. A portable radio detects electric field radiated by accelerating charge when current in a distant circuit is turned on or off. Variable radiation from shaped-wire circuits shows magnetic fields of turned-on current contain energy that radiation carries to the radio. Current detected in a coil through which a magnet is moving suggests charge-pushing in the coil by curly electric field moving with the magnetic field—an imagistic relationship that is formalized as Faraday's law. A transformer with alternating input voltage produces brighter bulb lighting by output voltage when the iron core is inserted, suggesting charge-pushing in the secondary coil by stronger curly electric field around the primary coil—predicted by Faraday's law because iron increases rate of change of magnetic field by alternating current.

Session CD: Physics of Our Hobbies

Location: ETLC E2-001 (Engineering Teaching & Learning Complex)
Sponsor: Commitee on Physics in Two-Year Colleges
Date: Monday, July 21
Time: 1:45–3:45 p.m.

Presider: Scott F. Schultz

CD01: 1:45–2:15 p.m. Physics and High Power Rocketry

Invited - Dwain M. Desbien, Estrella Mountain CC, Avondale, AZ 85323-1000; dwain.desbien@estrellamountain.edu

As a child I enjoyed playing with Estes Rockets. A couple of years ago I got involved with rocketry again. However, this time I began to build high-power rockets (ones with motors that have a total impulse greater than 180 Ns). This talk will discuss the physics of high-power rockets and design issues related to the physics. Actual flight data from launches will be shown and I will discuss how I use this data in physics and other instructor use in calculus classes.

CD02: 2:15–2:45 p.m. Physics of Photography

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

Before becoming a community college physics instructor, I worked as an award-winning professional photojournalist. Photography has long been a hobby of mine and I occasionally still teach an introduction to photography course. In this talk I will show some photographs that I have taken and will talk about some of the "physics" decisions that I made while shooting the various images that I will show. Topics like shutter speed, light ratios, effects of aperture opening size, lens length, high speed photography will be explored.

Session CE: How Do Master Teachers Help Prepare Teachers of Physics?

Location: NRE 1-001 (Natural Resources Engineering Facility)
Sponsor: Committee on Teacher Preparation
Date: Monday, July 21
Time: 1:45–3:45 p.m.

Presider: Paul Hickman

CE01: 1:45–2:15 p.m. Teachers Teaching Teachers: The Obvious Solution

Invited - Lila M. Adair, Piedmont College, Monroe, GA 30656; adairtlj@mindspring.com*

I entered teaching by an alternative path, so it is only fitting that after retiring from 35 years of public school teaching and 13 years of teaching science-staff development courses, I should now be teaching college science methods courses to nontraditional teacher candidates. Almost all methods professors at Piedmont College, on our Athens, GA, campus, are real classroom teachers, who are either retired or near retirement, which explains why our student teaching success rate is almost 100%. I will discuss our techniques for teaching high school, middle school, and elementary school pre-service and graduate school teachers and why it is so important to have teachers trained by experienced classroom teachers.

*Piedmont College has campuses in Demorest, GA and Athens, GA.

CE02: 2:15–2:25 p.m. Non-Physics Teachers Are Teaching Physics—We Must Help Them!

Martin Alderman, Cornell University, Ithaca, NY 14853; mda35@cornell.edu

Reality check: In spite of our best efforts, there will probably never be formally trained physics teachers instructing all the physics classes in the United States. This will be particularly true in small schools, and in wide-spread rural areas. Such districts will undoubtedly continue to ask one science teacher to teach at least three different sciences, even if we do manage to prepare many more physics teachers. Such science teachers will be teaching out of their certification areas some of the time. This talk will consider some teacher preparation and placement options to deal with this unfortunate, yet undeniable reality.

CE03: 2:25–2:35 p.m. Development of Undergraduate Teacher Education at UNC-CH: UNC-BEST

David L. Green, University of North Carolina at Chapel Hill; greendl@physics.unc.edu

The University System in North Carolina, and in particular the Chapel Hill campus, has allowed undergraduate teacher preparation to drop by the wayside in favor of MAT and lateral entry programs. In 2007, UNC-CH through the President of the System and the chairs of the School of Education, the Biology Department and the Department of Physics and Astronomy began work to create what began as a Fast Track program to prepare academic majors in biology and physics for high school teaching. This program has grown from nothing into a fully state-accredited program and is now beginning operation under the name UNC-BEST (UNC Baccalaureate Education in Science and Teaching).

CE04: 2:35–2:45 p.m. The TIR Program at Towson University—Four Years and Growing!

Ann Craig, Towson University, Towson, MD 21252; janzann@aol.com

Denise Pafaff

Through the efforts of Dr. Cody Sandifer and Dr. Laura Lising, the PhysTEC TIR program was initiated four years ago at Towson University. The program is intended to support pre-service teachers in the elementary educators physics program. The first two TIRs identified the work that needed to be done. Two adjunct faculty members, who have extensive classroom experience working in the elementary school environment, now conduct the TIR program. They have attended weekly project meetings, made informal observations of science education courses, designed assessments and analyzed the data, implemented instructor and mentor teacher workshops and mentored the replacement teachers at the TIR's home elementary schools. Towson's TIRs work collaboratively on projects and divide other job responsibilities between them. It has been determined that the TIR program at Towson University is a viable and valuable asset and therefore proposals have been made to keep the program, funding it internally at the University.

CE05: 2:45–2:55 p.m. Master Teachers in MAT Courses and Space Physics Educational Outreach

Mary L. Urquhart, The University of Texas at Dallas; urquhart@utdallas.edu

Bill Montana

The Masters of Arts in Teaching (MAT) program at the University of Texas at Dallas (UT Dallas) has a long tradition of employing master teachers to assist with graduate content course work, including physics courses. As part of the joint NASA/US Air Force Coupled Ion Neutral Dynamics Investigation education program we have employed a master high school physics teacher as a "Teacher in Residence" in the William B. Hanson Center for Space Sciences (CSS) to assist with the development of the educational outreach materials for use in high school physics classes. We will describe the development of this partnership through the UT Dallas MAT program and how it has impacted the teachers seeking an MAT in Science Education, the master teacher and his students, the scientists in CSS, and the educational outreach program intended for a national audience for an ionospheric explorer scheduled to launch by summer 2008.

CE06: 2:55–3:05 p.m. Three Truths and a Lie—The First Year with PhysTec

Nancy K. Bresnahan, University of Minnesota, School of Physics & Astronomy; bresnahan@physics.umn.edu

Jon Anderson

This talk will describe the implementation of the PhysTEC program at a large university. The strategies for success and the problems of implementation are unique to every site and this one is no exception. At our site, the integration of Learning Assistants into an already updated and highly respected existing curriculum-posed particular challenges. The talk will discuss what worked, what didn't work, and where the program is headed in future years.

Session CF: Gordon Research Conference Session: Computation in the Physics Curriculum

Location: NRE 1-003 (Natural Resources Engineering Facility)
Sponsor: Commiteee on Physics in Undergraduate Education
Date: Monday, July 21
Time: 1:45–3:45 p.m.

Presiders: Chandralekha Singh, Wolfgang Christian

CF01: 1:45–2:15 p.m. Enriching Physics Education with Computational Physics Research

Invited - Rubin H. Landau, Oregon State University; rubin@science.oregonstate.edu

The inclusion of research into a student's education—even at the undergraduate level—is one of the hallmarks of a high-quality education. Computational physics encompasses a variety of topics, tools, and modes of thinking that may well enliven, enrich, and expand a physics curriculum that the author views as becoming narrower and more self-absorbed. This talk will survey some current research topics in computational physics in which important progress has been made (recipients of prizes or highlighted by learned organizations), as well as topics, such as fluid dynamics and molecular dynamics, that are of current importance yet seem to have fallen out of the standard physics curriculum. In addition to the research topics proper, examples will be given of the research tools and background subjects required for this research, as well as some modern views on computational thinking.

CF02: 2:15–2:45 p.m. Bringing Computational Physics into the Classroom

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

Many instructors recognize the need to better integrate computational physics into the undergraduate curriculum, but it is difficult to know what resources are available and how to sort through them. This talk will give some concrete examples of using computational physics in the classroom. It will demonstrate how to find resources that are part of a developing collection for computational physics on ComPADRE (www.compadre.org), the digital library for the physics community. It will then describe effective uses of these materials ranging from ready-to-run simulations to code that students can modify themselves. The resources are an outgrowth of the Open Source Physics Project (www.opensourcephysics.org), generously supported by NSF DUE-0442581.

CF03: 2:45–3:15 p.m. Symbolic Calculators Affect Epistemic Framing*

Invited - Thomas J. Bing, University of Maryland, College Park; tbing@physics.umd.edu

Edward F. Redish

Powerful symbolic calculators are not passive tools for physics students. These calculators couple strongly to students' epistemic framing of their physics tasks. Epistemic framing refers to students' (usually subconscious) selection of a subset of all their available resources for thinking, in this case, about mathematics in physics. A student's current framing leads them to search for a certain type of justification for the math they are using. This talk presents a detailed example of Mathematica keeping physics students' search for mathematical justification in the calculational realm as opposed to graphical analysis or mapping their math to the physical situation at hand. Their work is not naïve. Mathematica does not shut down their math sense. However, it tends to project their math sense along a certain axis.

*This work is supported by NSF grants DUE 05-24987 and REC 04-40113 and a Graduate Research Fellowship.

CF04: 3:15–3:45 p.m. Study of Computer Simulations—Interface Design for Engagement, Learning and Assessment

Invited - Wendy K. Adams, University of Colorado, Boulder; wendy.adams@colorado.edu

Sarah McKagan, Kathy K. Perkins, Sam Reid, Carl E. Wieman

Interactive computer simulations with complex representations and sophisticated graphics are a relatively new addition to the classroom, and research in this area is limited. We have conducted more than 230 individual student interviews during which the students described what they were thinking as they interacted with simulations as part of the research and design of simulations for the Physics Education Technology (PhET) project. PhET is an ongoing project that has developed over 65 simulations for use in teaching physics, chemistry, and physical science. These interviews are a rich source of information about how students interact with simulations and what makes an educationally effective simulation. We have observed that simulations can be highly engaging and educationally effective, but only if the student's interaction with the simulation is directed by the student's own questioning. We will describe what features are effective for engaging students in educationally productive interactions and the underlying principles which support our empirically developed guidelines.

1. See http://phet.colorado.edu

2. Supported in part by funding from National Science Foundation, The William and Flora Hewlett Foundation, The Kavli Foundation and the University of Colorado at Boulder.

Session CG: Innovations in Teaching Astronomy

Location: NRE 2-001 (Natural Resources Engineering Facility)
Sponsor: Committee on Space Science and Astronomy
Date: Monday, July 21
Time: 1:45–3:45 p.m.

Presider: Doug Lombardi

CG01: 1:45–1:55 p.m. Let's Get Rid of Gravity!

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

Terminology is an important part of the Learning Critical Thinking Through Astronomy textbook project. In this talk, I will present the results of an informal survey of students at two community colleges regarding use of the term "gravity." The survey results show two important things. The first is that "gravity" makes students think of a material substance. The second is that students do not or cannot apply the same physical reasoning to two places in our Solar System. The results hopefully reinforce the hypothesis that the word "gravity" should be avoided, especially in introductory courses and should instead be replaced with something more physically descriptive. I suggest "gravitational attraction" or "gravitational interaction."

CG02: 1:55–2:05 p.m. Teaching Dark Matter to Undergraduates

Gintaras K. Duda, Creighton University, Omaha, NE 68178; gkduda@creighton.edu

Katherine Garrett

Dark matter is one of the greatest unsolved mysteries of physics at the present time. About 80% of the universe's gravitating matter is nonluminous and its composition is completely unknown. This presentation will outline the history, astrophysical evidence, candidates, and detection methods of dark matter, with the goal of making dark matter accessible to upper-level undergraduates. Since the study of dark matter involves numerous sub-fields in physics and astronomy (such as particle physics, thermodynamics, galactic astronomy, among others), we will present ideas on how dark matter can be worked into undergraduate courses, putting students in touch with an exciting and cutting-edge area of modern research.

CG03: 2:05–2:15 p.m. Easy and Challenging Daytime Projects that Involve Observing the Sun

A. James Mallmann, Milwaukee School of Engineering;, mallmann@msoe.edu

Steven P. Mayer

For those who would enjoy getting experimental data outdoors in the summer, and maybe in the winter, we describe several projects that involve where the Sun is in the sky and where the Sun will be in the sky. Some of the projects can be easily achieved even by middle school or elementary school students. One of the projects, however, will challenge even experienced, competent experimenters. The mathematics for the projects range from simple arithmetic to spherical trigonometry, and for one of the projects the experimenter must be able to see something that more than 99 percent of people have never seen.

CG04: 2:15–2:25 p.m. Traveling Through Time with "Starry Night" —Laboratory Exercises in Astronomy

Brian P. Schwartz, Carthage College, Kenosha, WI 53144; bschwartz@carthage.edu

"Starry Night" can re-create a host of celestial events such as lunar eclipses, planetary transits of the Sun, and even the precession of the equinoxes. The historical observation of these phenomena played a critical role in the development of astronomy as a science. As we all know, astronomy hands us a number of problems regarding the measurement of distances as well as the relative geometry of our solar system. In this presentation I will describe a series of exercises ranging from the general-education to advanced undergraduate level to demonstrate how Ptolemy, Galileo, Kepler, and others moved from asking scientific questions to building scientific models. Thanks to "Starry Night" and their written records, we can do this by looking at the same events they observed. Special attention will be paid to descriptions of the orbits of the Moon and planets, as well as schemes for "universal time."

CG05: 2:25–2:35 p.m. 3-D Animations for Conceptual Astronomy

Michael R. Gallis, Penn State Schuylkill, Schuylkill Haven, PA 17972; mrg3@psu.edu

Instructors who teach conceptual astronomy often face the challenge of conveying concepts and ideas that have significant geometric content to students who are not inclined toward technical subjects. Visual aids such as computer animations facilitate the presentation of technical materials in a manner that is accessible to students without a strong mathematical background. This talk will cover example animations from the astronomy component of the Animations for Introductory Physics and Astronomy project at Penn State Schuylkill. The use of the animations in and out of the class will be discussed as well as student perceptions of the animations. The process by which the animations are created will also be briefly described.

* http://phys23p.sl.psu.edu/phys_anim/astro/indexer_astro.html

CG06: 2:35–2:45 p.m. Integrated Research in the BYU Undergraduate Astronomy Major

Eric G. Hintz, Brigham Young University; doctor@tardis.byu.edu

Michael D. Joner, J. W. Moody, Denise C. Stephens

We have designed an undergraduate astronomy major at BYU which makes astronomical research the focus of the program. The major requires a research focused class (Phscs 329) which teaches students how to take data at the telescope and reduce the data. The students then present their results in the format used to submit manuscripts to journals and as a meeting poster. Finally the class works together to prepare a real telescope proposal that is actually submitted. Majors must then take part in faculty mentored research leading to a senior thesis. Finally, the advanced seniors can take a second research focused class (Phscs 529) to give them exposure to non-optical astronomy. At all levels the data produced is of such quality as to generate referred publications in major astronomy journals. In this talk we will give a quick overview of our program.

CG07: 2:45–2:55 p.m. "Focusing on Learning:" One Astronomy Professor's Adoption of Learner-Centered Strategies

Janelle M. Bailey, University of Nevada, Las Vegas; janelle.bailey@unlv.edu

Kentaro Nagamine

Recent research in science education suggests that learner-centered instructional strategies can promote more learning than traditional teacher-based strategies such as lecture. However, the adoption of such strategies by instructors can elicit many concerns, including, for example, concerns of increased time requirements for preparation and grading, reduced content coverage, reactions of students and colleagues, and, of course, student achievement. Ethan, an astronomy instructor early in his career, recently adopted learner-centered strategies into his introductory course for nonscience majors on stars and galaxies. He shared the concerns listed above, but after receiving training in learner-centered strategies from the Center for Astronomy Education and support from an experienced colleague while implementing the changes for the first time, Ethan's overall reaction was a positive one. He felt that many students learned more than those in previous lecture-based course offerings, and that their increased active participation during the class was a constructive change.

CG08: 2:55–3:05 p.m. A National Study Using the Light and Spectra Concept Inventory

Edward Prather, University of Arizona - Center for Astronomy Education, Tucson, AZ 85721; eprather@as.arizona.edu*

Alex Rudolph, Gina Brissenden

Members of the Center for Astronomy Education (CAE) at the University of Arizona have been conducting a large-scale research project (involving thousands of students from more than 50 classes) using the Light and Spectroscopy Concept Inventory (LSCI) in an effort to document the learning that is occurring in Astro 101 classrooms across the nation. Similar to the Force Concept Inventory (FCI), the Light and Spectroscopy Concept Inventory was developed to measure student conceptual gains on a central topic to Astro 101 which students are known to struggle to understand. In addition to measuring student learning gains, we have developed an instructor survey to measure the perceived level of interactive-engagement instructors believe occurs in their courses. Our findings suggest that the amount of (professor-reported) interactive-engagement provided in learner-centered classrooms has a significant affect on student gains. A discussion of the LSCI results and correlation to instructor interactive-engagement data will be presented.

*Kevin Lee - Univ. of Nebraska

Session CH: Teaching Physics Around the World

Location: NRE 2-003 (Natural Resources Engineering Facility)
Sponsor: Committee on International Physics Education
Date: Monday, July 21
Time: 1:45–3:45 p.m.

Presider: Don Franklin

CH01: 1:45–2:15 p.m. Perimeter Institute's International Outreach—Why and How Do We Outreach?

Invited - John Matlock, Perimeter Institute, 31 Caroline St., N, Waterloo, ON 2L 2Y5 Canada; jmatlock@perimeterinstitute.ca

Damian Pope

Canada's Perimeter Institute for Theoretical Physics (PI) is an independent, nonprofit, scientific research and educational outreach

CJ: Ceremonial Session: Klopsteg Memorial Award

Michio Kaku, Klopsteg Award winner

Location: Students' Union, Horowitz Theatre
Date: Monday, July 21
Time: 4–5 p.m.

Presider: Harvey Leff

Michio Kaku, City College of New York, Physics Department, New York, NY 10031; kaku@sci.ccn.cuny.edu

Physics of the Impossible

Invisibility. Teleportation. Mind reading. Psychokinesis. Time travel. Star ships. Parallel universes. Normally, these would be dismissed by scientists as being impossible. One hundred years ago, the same was thought about lasers, televisions and visiting outer space. I pondered these types of questions as a child. As so often in the past, what was once considered impossible eventually has become commonplace. Might recently considered impossible phenomena also become possible in a few decades, centuries, or even millennia? I will explore the fascinating physics behind these fantastic phenomena, taking you on an exciting scientific tour beyond science fiction, fantasy, and magic. Using our best science, I shall argue that we can estimate when they might become possible, or can determine which are truly impossible.

organization. The Institute plays an active role in highlighting the wonders and importance of scientific research, discovery and innovation by providing a number of educational outreach programs specifically tailored for students, teachers and members of the general public. You will learn about the EinsteinPlus Workshops for educators. These popular one-week residential camps feature interactive presentations on hot topics in modern physics, including teaching strategies, as presented by the top scientists and outreach staff at the Institute. The workshops also feature a quantum computing lab tour and social events. The International Summer School for Young Physicists (ISSYP) will also be explained. These camps are designed for students, ages 16 and 17, and include special mentorship sessions with the international researchers. Other outreach initiatives will also be examined—including a history behind the Institute's new in-class teacher resources and a new program, now in development, designed to maintain ongoing and long-lasting links with interested educators.

CH02: 2:15–2:45 p.m. Developing Computer Instrumentation Capabilities in Latin America, a Recent Fulbright Fellowship in Ecuador

Invited - Perry A. Tompkins, Samford University, Birmingham, AL 35216; patompki@samford.edu

One of the professional opportunities afforded an academic in the United States is offered through the U.S. Fulbright Scholar program. This presentation concerns this author's four-month fellowship for teaching and infrastructure development at the University of Cuenca in Cuenca, Ecuador, as a Fulbright Scholar. Additionally, an unexpected, yet welcomed, opportunity for teaching at the premium technological university in Ecuador, ESPOL, will be outlined. This talk will discuss the specifics of the time spent in country, the opportunities and frustrations of the courses taught, and some more generic traveling around Ecuador. Additionally, there will be some general suggestions to assist one in applying for the Fulbright Program. The International Committee of the AAPT has expressed interest in expanding AAPT's international interactions and influence. The Fulbright program is an outstanding opportunity to support these aims. For more information on the U.S. Fulbright Scholars Program, please visit: http://www.cies.org/.

CH03: 2:45–3:15 p.m. Successful Implementation of UW Tutorials in an Engineering School in Chile

Invited - Olivier Espinosa, Universidad Técnica Federico Santa María, Valparaiso, Chile; olivier.espinosa@usm.cl

We report on the learning results obtained through the implementation of a series of University of Washington tutorials in introductory physics to a group of about 200 first-year engineering students taking a standard introductory calculus-based mechanics course. The learning gain was measured through the FCI, taken as pre- and post-test by 550 students, 168 of who had taken tutorials. The normalized gains were measured to be 0.55 for the tutorial group versus 0.46 for the nontutorial group. Additionally, the passing rates of both groups were basically the same, even though the exams included a very small fraction of tutorial-like questions, and despite the fact that the group taking tutorials was originally slightly weaker (based on the FCI pretest scores and previous grades).

CH04: 3:15–3:25 p.m. In-service Training on Use of Improvised Physics Apparatus in Philippines

Lamberto A. Jeresano, Bicol Physics Society, Inc. (Philippines); lajeresano@yahoo.com

Ivan B. Culaba

To introduce and implement innovation in physics education in secondary public/private schools in the Philippines is a daunting job. There are a host of problems such as underqualified teachers, large classes, dearth of learning materials (books and lab apparatus), inept supervisory/administrative support personnel, financial constraints, etc. In the midst of this dismal education environment, the authors and colleagues in a few education institutions have been engaged in innovative education projects to bring about some change in the way physics teaching is conducted in one region of the country. This paper describes the series of in-service projects focusing on the use/construction of improvised physics apparatus, inquiry learning, active learning, etc.These small projects have received grants from the AAPT Bauder fund.

*Ivan B. Culaba is a faculty member, Dept. of Physics, Ateneo de Manila University, Quezon City, Philippines.

CH05: 3:25–3:35 p.m. Learning Gains of an Electricity and Magnetism Course in an International Context

Genaro Zavala, Tecnologico de Monterrey, Monterrey, 64849 Mexico; genaro.zavala@itesm.mx

Our department in a large private university in Mexico has more than 600 students taking electricity and magnetism each semester. Our sections have a maximum of 36 students so there are a large number of sections each semester. Instructors are either faculty members or part-time instructors. We started implementing *Tutorials in Introductory Physics* from the University of Washington on a large scale in the fall of 2004. It has been four years after our initial implementation and still our learning gains measured by the Conceptual Survey of Electricity and Magnetism are low and the variability of the average gains for each section is very large. In this talk I present preliminary results of an analysis of factors affecting the learning gain.

CH06: 3:35–3:45 p.m. Art and Physics—A Symbiosis and Its Beneficial Use in Physics Teaching

Igal Galili, The Hebrew University of Jerusalem; igal@vms.huji.ac.il

There many examples when physics is used to facilitate art. There are, however, cases when physics illustrates the meaning of art pieces (Galili & Zinn 2007). Such cases may serve a powerful attractive force of physics class, introducing another dimension of physics as intellectually rich subject in eyes of interdisciplinary oriented curiosity that especially characterizes people of young age. I will bring three examples illustrating this claim. The first is the interpretation of depicting of Stigmatization of St. Francis by Giotto (13th century), the second is the interpretation of depicting Annunciation in the Western Europe painting (15th century) and the third is the interpretation of the architectural design in Byzantine Constantinople involving depicting of Gorgona Meduza (5th century).

Galili, I. & Zinn, B. (2007). "Physics and Art—A Cultural Symbiosis in Physics Education", *Science & Education* **16** (3-5), 441-460. http://www.springerlink.com/content/m10587131r251231/

Session CI: Energy and Environment

Location: ME 2-3 (Mechanical Engineering Building)
Sponsor: Committee on Science Education for the Public
Date: Monday, July 21
Time: 1:45–3:45 p.m.

Presider: Steve Shropshire

CI01: 1:45–2:15 p.m. How Can the World Respond to the Twilight of the Era of Cheap Energy?

Invited - Gordon J. Aubrecht, II, Ohio State University at Marion, Marion, OH 43302-5817; aubrecht@mps.ohio-state.edu

The cost of oil (in constant dollars), and the gasoline made from it, was higher in early 2008 than at any time in history. In response, for the first time in decades, Americans drove less. For the first time, a majority of Americans polled understand that global warming will lead to significant change in climate. How will these changes affect future actions of citizens of North America and the world? What can be done to protect the future of our children and grandchildren?

Session DA: PER: Issues in Instructional Reform

Location: ETLC E1-013 (Engineering Teaching & Learing Complex)
Sponsor: Committee on Research in Physics Education
Date: Monday, July 21
Time: 7–9 p.m.

Presider: Paula Engelhardt

DA01: 7–7:10 p.m. Facilitating Change in Undergraduate STEM: Preliminary Results from an Interdisciplinary Literature Review

Charles Henderson, Western Michigan University; Charles.Henderson@wmich.edu

Andrea Beach, Noah D. Finkelstein, R. Sam Larson

Although decades of research have identified effective instructional practices for improving Science, Technology, Engineering and Mathematics (STEM) education, these practices are not widely implemented. Scholars in three fields are interested in promoting these practices and have engaged in research on pedagogical change. Disciplinary-based STEM Education Researchers (SER) focus on changing curricula and pedagogical materials. Faculty Development Researchers (FDR) focus on changing faculty. Higher Education Researchers (HER) focus on policies and structures. There is little interaction between the fields and efforts in all areas have met with only modest success. We have systematically analyzed journal articles since 1995 related to instructional change to describe and critique the change efforts of these three fields. Results suggest that approaches to change differ by fields in important ways that have implications for their success. We hope this literature review and related efforts will result in improved interdisciplinary work toward the facilitation of lasting change.

DA02: 7:10–7:20 p.m. Survey of Instructors' Tendency to Adopt Innovation in Teaching

David Pundak, ORT Braude College, Ashdot Yaacov Ichud, Jordan Valley, 15155, Israel; dpundak@braude.ac.il

Fiana Yacobzon, Dvora Toledano Kitay, Shmaryahu Rozner

Although many innovations were developed in teaching in the past 20 years, only a limited fraction of faculty tends to adopt these new methods. Changing the way teaching is viewed within the physics departments may be the appropriate lever to bring about substantive change in the teaching practices of physics faculty. With the aim to recognize and measure the adoption level of innovation in teaching methods, we developed a survey with 37 items in six categories. The survey measures the faculty's beliefs regarding the following points: tutoring students during class time, the importance of students' collaborative learning, students' ability to develop and present new ideas, importance of conceptual understanding, responsibility of students for learning, and development of teaching methods. The survey was administered in the departments of physics, chemistry, mathematics and biology in colleges and in a university. At the meeting we will present the survey and some results we collected.

DA03: 7:20–7:30 p.m. Effects of Variation of Faculty Practice on Student Perceptions

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

Noah D. Finkelstein

We document and describe variations in faculty classroom practices during Peer Instruction activities in six different introductory physics classes. We identify 13 dimensions of practice along which we observe variation. We will discuss a subset of these including the role of clicker questions within the structure of the course, emphasis on sense-making and the importance of reasoning, use of student voice, and response to and management of disagreement among students. We hypothesize that collections of these practices, over time, give rise to what the activity, Peer Instruction, means to the students and professor. We present the results of a survey on students' perceptions of Peer Instruction in these courses, to identify what students perceive as important and valuable about this activity. Finally, we present preliminary results as to collections of classroom practices that appear to be particularly effective in communicating different pedagogical goals (or meanings) of Peer Instruction to students.

DA04: 7:30–7:40 p.m. Instructional Innovations in Physics and their Effects on Student Learning

Heidi L. Iverson, University of Colorado at Boulder; Heidi.Iverson@Colorado.edu

Maria A. Ruiz-Primo, Derek C. Briggs, Marie A. Huchton, Lorrie A. Shepard

This paper presents preliminary results of an NSF project in which the goal is to provide a synthesis of research on instructional innovations that have been implemented in undergraduate courses in physics. The research questions guiding the project are: What constitutes the range of principal course innovations that are being implemented in undergraduate science courses? To what extent are different course innovation approaches associated with differences in student learning? What issues are critical to the effective implementation of course innovations? The paper will describe: 1) the procedures followed to analyze the studies described in more than 400 journals articles, 2) the literature search procedures, 3) the characteristics of the studies reported, and 4) the results from synthesizing the quantitative results of those studies that met our criteria for inclusion. The paper concludes with recommendations for strengthening programs of research that focus on evaluating the effectiveness of instructional innovations in physics.

DA05: 7:40–7:50 p.m. Analysis of Learning Assistants' Views of Teaching and Learning

Kara E. Gray, University of Colorado; kara.gray@colorado.edu

Valerie K. Otero

In some research traditions, learning is viewed in terms of shifts in the identities of people as they take on increasing responsibilities in a community of practice. Undergraduate Learning Assistants (LAs) are talented mathematics and science majors hired to help transform large-enrollment undergraduate science courses to be more student-centered and interactive. We analyzed LA weekly online reflection data to identify how LAs view their roles and what this tells us about their views of themselves and their students as learners, their views of themselves as teachers, and their views of the purpose and practice of the LA program. This analysis will help us to begin to understand how students' identities as learners evolve as a result of taking on increasing responsibilities as LAs.

DA06: 7:50–8 p.m. How Physics Graduate Student TAs Frame Tutorial Teaching

Renee Michelle Goertzen, University of Maryland, College Park; goertzen@umd.edu

Rachel E. Scherr, Andrew Elby

The University of Maryland is investigating the specific nature of TAs' experience with reform instruction. The study uses reflective interviews and video of classroom interactions to investigate how TAs frame their role in tutorials, how they listen to students, what questions they ask, and what their goals seem to be in particular interactions in the classroom. We will discuss some of our preliminary findings about how the TAs that we observe view the nature of physics, their interpretations of instructional advice, and the utility of case studies to better understand how tutorial TAs behave in the classroom, as well as how we can better characterize productive TA actions.

DA07: 8–8:10 p.m. PER-Based Curriculum in Other Educational Systems: Tutorials in Argentinean High Schools

Julio Benegas, Universidad Nacional de San Luis, San Luis, 5700, Argentina; jbenegas@unsl.edu.ar

Julio Sirur Flores

We report on the implementation of the two Tutorials for Introductory Physics on simple resistive circuits in high schools of San Luis, Argentina. Our aim has been to determine to what extent this PER-based methodology can be successfully applied in our high school system. Two state-run, high schools classes with a similar gender population and a confessional school only for girls were selected. Our concern was on the long-lasting conceptual knowledge and the human, material, and institutional conditions necessary for a successful implementation of Tutorials. Conceptual knowledge was measured with the PER-derived multiple-choice test DIRECT, applied at three different times: before, immediately after, and one year after instruction. One year after instruction, conceptual knowledge of the two experimental classes was very satisfactory, comparable with that reported by Engelhardt and Beichner, and distributed among the whole student population, with similar gender performance, while the control class returned to the preinstruction level.

1. L.C. McDermott, P.S. Shaffer, & PER, *Tutorials in Introductory Physics,* (Prentice Hall), 1998, translated as Tutoriales en Física Introductoria (2001) Prentice Hall, Buenos Aires.

DA08: 8:10–8:20 p.m. Peer Instruction: From Harvard to the Two-year College

Nathaniel Lasry, Harvard University/John Abbott College; lasry@seas.harvard.edu

Eric Mazur, Jessica Watkins

We compare the effectiveness of a first implementation of Peer Instruction (PI) in a two-year college with the first PI implementation at a top-tier four-year research institution. We show how effective PI is for students with less background knowledge and what the impact of PI methodology is on student attrition in the course. Results concerning the effectiveness of PI in the college setting replicate earlier findings: PI-taught students demonstrate better conceptual learning and similar problem-solving abilities than traditionally taught students. However, not previously reported are the following two findings: First, although students with more background knowledge benefit most from either type of instruction, PI students with less background knowledge gain as much as students with more background knowledge in traditional instruction. Second, PI methodology is found to decrease student attrition in introductory physics courses at both four-year and two-year institutions.

DA09: 8:20–8:30 p.m. Transforming Upper-Division Undergraduate Electricity & Magnetism

Stephanie V. Chasteen, University of Colorado at Boulder; stephanie.chasteen@colorado.edu

Stephen J. Pollock, Darren Tarshis, Ward Handley, Paul Beale

How can we use research-based methods to better train our physics majors? With the goal of improving student mastery of material in upper-division courses, we have transformed an upper-division Electricity & Magnetism course using the principles of active engagement and learning theory to guide teaching practices and the results of observations, interviews, and analysis of student work to identify common student difficulties with the content. In this talk, I will describe the nature of our reforms as an example of a what a transformed upper-division course might look like. The course included consensus learning goals, "clicker" questions, study groups, interactive lecture, and tutorials. We will also highlight some key results regarding the effectiveness of these reforms relative to a traditional course as well as student feedback. Comparisons are based upon course grade, exams, homeworks, attitudinal surveys, interviews, a conceptual survey (the BEMA), and performance on a post-course assessment tool.

*All reform materials are available through http://www.colorado.edu/sei. This work was funded by the University of Colorado's Science Education Initiative.

DA10: 8:30–8:40 p.m. The Persistence of the Gender Gap in Introductory Physics

Lauren E. Kost, University of Colorado at Boulder; Lauren.Kost@colorado.edu*

Steven J. Pollock, Noah D. Finkelstein

Counter to previously published results,[1] we find a persistent gender gap in pre- and post-surveys of conceptual learning[2] despite the use of interactive engagement techniques in our introductory courses. To investigate where this gender gap comes from we've collected data on student demographics (gender, ethnicity, etc.), high school background (courses taken and standardized math test scores), student attitudes and beliefs about physics and about learning physics, and previous college math and science courses. There are significant differences ($p<0.05$) between males and females on several of these premeasures. We also explore differences between males and females in different subgroups of the student population, for instance among the physics majors. We find that several of these pre-measures are correlated with students' post-test scores, and could therefore contribute to the observed gender gap in our courses.

1. Lorenzo, et al, *Am. J. Phys.* **74**, 118.
2. Pollock, et al, *Phys Rev: ST: PER 3*, 010107.

*Sponsored by Noah D. Finkelstein.

DA11: 8:40–8:50 p.m. Mind the Gap Please

Vashti Sawtelle, Florida International University, Miami, FL 33179; davisvas@gmail.com

Eric Brewe, Jeffery M. Saul

In a 2005 American Institute of Physics report, Ivie and Ray showed that 46% of the students taking physics at the high school level are women. Yet, only 22% of the bachelor's degrees in physics are awarded to women.[2] Often referred to as the leaky pipeline, it is evident that a large hole exists between high school and college. This investigation will examine how the gender learning gap, the difference in learning gains experienced by men and women, effects participation of women in high school physics. I will present an overview of the investigation study design including the interview protocol, focusing on the persistence of high school women in physics, epistemological surveys, and pre/post diagnostics to be used in evaluating the actual and perceived learning gap. The presentation will include a discussion of the issues that were considered in creating the study design.

1. Supported by NSF Award #0312038.
2. R. Ivie, N.R., Kim, "Women in Physics and Astronomy 2005," *AIP Pub.*, R-430.02, (2005).

DA12: 8:50–9 p.m. Gender Difference in Difficulties with Physics for Engineering Lab Projects

Leong B. Lan, Monash University, Jalan Lagoon Selatan, Sunway, Selango 46150, Malaysia; lan.boon.leong@eng.monash.edu.my

Lim Jen Nee Jones

In our first-year Physics for Engineering labs, students work collaboratively on design projects where they design and build simple devices, or design and conduct simple experiments. Student evaluations indicate that these student-centered projects are much more effective physics lab exercises than traditional "cookbook" experiments. Written comments in the evaluations reveal that students had difficulties applying the physics they had learned and working collaboratively, and they needed more time to work on projects. However, a significantly higher percentage of women, compared to men, had difficulties applying physics and working collaboratively. Implication of this finding on attracting women to study physics/engineering is discussed.

Session DB: Getting Started in Physics Education Research

Location: ETLC E1-001 (Engineering Teaching & Learning Complex)
Sponsor: Committee on Research in Physics Education
Date: Monday, July 21
Time: 7–9 p.m.

Presiders: Kathleen A. Harper, Charles Henderson

DB01: 7–7:30 p.m. An Introduction to PER

Invited - Robert J. Beichner, NCSU, Raleigh, NC 27695-8202; beichner@ncsu.edu

The purpose of this talk is to describe the book chapter that seeks to introduce readers to the field of PER. Topics in the chapter include:

—the difference between PER and Physics Education/curriculum development.
—a brief history of PER.
—research traditions within PER (current types of PER, questions asked, methods used, etc.).
—topics that are typical of those studied in PER.
—applications of PER in the classroom.

DB02: 7:30–8 p.m. Quantitative Research in Physics Education

Invited - Xueli Zou, California State University, Chico; xzou@csuchico.edu

Simply speaking, quantitative research refers to an investigation that applies numerical methods to describe a phenomenon or observation. While conducting scientific research in education is advocated and moved nationwide, it becomes critical to better understand how to apply quantitative studies in PER. Designing a quantitative study does not guarantee the study scientific. While detailed discussions and examples are described in a chapter of the volume of *Getting Started in Physics Education Research (PER)*, this talk will briefly report on some empirical issues related to quantitative data analysis techniques, as well as related fundamental theoretical perspectives of quantitative inquiry and suggestions on how to report research results to encourage debate in the PER community.

DB03: 8–8:30 p.m. Qualitative Studies in Physics Education Research: Data, Analysis, and Relevance

Invited - Valerie K. Otero, University of Colorado Boulder; valerie.otero@colorado.edu

Danielle B. Harlow

What claims about student learning can one make on the basis of videotaped student discussions or interviews with students? What counts as evidence in a physics education research study that uses qualitative data? What do claims tell us when the sample size is six? How can you "graph" students' conceptions? These and other questions are addressed in a chapter on Qualitative Research in the new publication, *Getting Started in Physics Education Research*. This presentation will focus on conceptual framing, research questions, data collection and analysis, inferences, validity and reliability in qualitative research, and how to represent qualitative data. We will also describe our approach to the chapter, the intended audience, the chapter's contents, the limitations and benefits of using a qualitative or mixed-methods, approach. The audience will have opportunities to engage in aspects of qualitative research.

DB04: 8:30–9 p.m. Testing Student Understanding—What Makes an Instrument Good?

Invited - Paula V. Engelhardt, Tennessee Technological University, Cookeville, TN 38506; engelhar@tntech.edu

So you have decided to use one of the many instruments available to examine some aspect of your students' understanding of physics. But which one? Are all instruments created equal? Since the Force Concept Inventory(FCI) was first introduced, there is now a veritable alphabet soup of instruments that are available. How do you know which of these instruments are good and which are not? What makes an instrument a good instrument? What does it mean for an instrument to be reliable? What does it mean for an instrument to be valid? Why should you care? These questions will be the focus of this presentation.

Session DC: Alternative and Formative Assessment in High School Physics

Location: ETLC E1-017 (Engineering Teaching & Learning Complex)
Sponsor: Committee on Physics in High Schools
Date: Monday, July 21
Time: 7–9 p.m.

Presiders: Wayne Fisher, Laura Nickelson

DC01: 7–7:30 p.m. How Does Alberta's Graduating Examination in Physics Assess the Students' Conceptual Understanding?

Invited - Laura Pankratz, Alberta Education, Edmonton, AB T5J 5E6, Canada; laura.pankratz@gov.ab.ca*

In Alberta, to complete the high school physics program, students must write the Physics 30 Diploma Examination. Questions on this examination explore both computational ability and conceptual understanding. One of the written-response questions focuses on the students' conceptual understanding. How are these questions developed? How are the student responses scored? How do these questions assess students' conceptual understanding of the content mandated by the Physics 30 Program of Studies?

*Invited by Terry Singleton. Sponsored by Cliff Sosnowski and Vlad Pasek.

DC02: 7:30-7:40 p.m. Teachers of All Levels Work Together to Make New Curriculum*

Jim Flakker, Rutgers University, New Brunswick, NJ 08901; Jflakker@eden.rutgers.edu

Hector Lopez, Jeff Goett, Suzanne Brahmia, Eva Thanheiser, Alan Van Heuvelen, Eugenia Etkina

Rutgers faculty, graduate students and local teachers are working on the development and implementation of new physical science/physics curriculum that spans from middle school to high school. The curriculum is based on the existing learning system (ISLE, materials published as The Physics Active Learning Guide) that has been successfully implemented at the college level. However, adapting activities for the middle school and high school level is a challenge that cannot be met without a true collaboration with middle school and high school teachers. They participate in the revision of activities, design assessments, and then pilot curriculum modules in their classrooms. How do teachers see their role in the process of curriculum development? Does their practice change due to the experiences? In this talk we will provide an overview of the project and results of teacher observations, Internet discussions, and interviews.

*Sponsored by NSF DRL-0733140

DC03: 7:40–7:50 p.m. Bridging the Gap Between Middle/High School Physics and Mathematics*

Hector Lopez, Rutgers University, News Brunswick, NJ 08901; hlopez1@rutgers.edu

Jim Flakker, Jeff Goett, Suzanne Brahmia, Eva Thanheiser, Alan Van Heuvelen, Eugenia Etkina

Physics Union Mathematics is a new curriculum that spans through middle school and high school and attempts to bridge the gap between physics and mathematics. It is based on the Investigative Science Learning Environment system (ISLE) that was found to help students learn physics and develop scientific abilities at the college level. The main feature of ISLE is that students learn physics by mirroring the processes physicists use to construct knowledge. Now a group of Rutgers faculty, graduate students, and local teachers are working on adapting and revising the existing activities to bring the ISLE spirit into middle school and high school. The goal is not only to help students learn physics in an ISLE environment but also enhance their mathematical reasoning and strengthen connections between physics and mathematics. In the talk we will describe the process of curriculum development and first results in the schools.

*Sponsored by NSF grant # DRL-0733140 .

DC04: 7:50–8 p.m. Mathematical Reasoning in Physics in Middle School and High School*

Suzanne White Brahmia, Rutgers University, New Brunswick, NJ 08901; brahmia@physics.rutgers.edu

Jim Flakker, Jeff Goett, Hector Lopez, Eugenia Etkina

Physics Union Mathematics (PUM) is a new physics curriculum in its pilot phase that develops mathematical literacy and spans the middle and high school continuum. It has at its underpinnings the development of mathematical reasoning as a mechanism for better learning both mathematics and physics. We focus on areas in mathematics that relate directly to well-known areas of weaknesses in physics students, specifically: 1) proportional reasoning, 2) the appropriate use of integers, 3) generating and interpreting graphical information, 4) symbolic representation of physical quantities, and 5) measurement and units. In this talk we will focus on these reasoning skills and how we develop them along the middle and high school continuum with examples from material properties, energy and dynamics.

*Partially supported by the NSF grant # DRL-0733140.

DC05: 8-8:10 p.m. Improving Student Learning Through Continuous Formative Assessment

Stamatis Vokos, Seattle Pacific University, Seattle, WA 98119-1957; vokos@spu.edu*

Pamela Kraus, Eleanor Close, Hunter Close, Lane Seeley

The Physics Department at Seattle Pacific University and FACET Innovations, LLC, have been developing web-delivered formative assessment tools for use in the precollege classroom, in special courses for pre-service teachers, and in professional development courses for in-service teachers. This NSF-funded project targets foundational topical areas in physics and physical science: Properties of Matter, Heat and Temperature, and the Particulate Nature of Matter. In this talk, we will present recent data from secondary students and illustrate how a focus on continuous assessment of student ideas has helped students in a partner school district deepen their conceptual understanding. Challenges in developing a classroom environment in which formative assessment is at the center of instructional decisions will also be discussed.

*Supported in part by NSF grant ESI-0455796, the Boeing Co., the PhysTEC project, and the SPU Science Initiative.

DC06: 8:10–8:20 p.m. Analysis of High School Students' Math-Science Course Completion in Texas

Gregory H. Poelzer, The University of Texas-Pan American, Edinburgh, TX 78539; hpoelzer@utpa.edu*

Liang Zeng

This study analyzes the Texas Education Agency database concerning high school students' completion of math and science courses over a 10-year period (1997-2006). Exploratory analysis conducted on a variety of required math and science courses including algebra I, algebra II, biology, chemistry, physics, along with Advanced Placement and International Baccalaureate courses in math and science looks at student completion of these courses from the perspectives of ethnicity, gender, and gifted and nongifted status. It also looks at the gaps in student completion of courses for gifted and nongifted students across ethnicity and gender categories. Further, it looks at trends in student completion of courses over the 10-year period in question, and compares state trends with national trends.

*Sponsored by Liang Zeng.

DC07: 8:20–8:30 p.m. Adaptation of Research-Based Curricular Materials for Middle-School Use

David E. Meltzer, University of Washington, Seattle, WA 98195; dmeltzer@u.washington.edu

After several decades of experience teaching undergraduate and graduate students as well as adult learners, I spent much of this past year as the 8th-grade physical-science teacher at a local middle school. I will present some of my observations regarding using and adapting research-based curricular materials for this important audience.

DC08: 8:30–8:40 p.m. Students' Performance on Diagnostic Activities in DC Circuits

Corina Polingher, HEMDA - Science Education Centre – Tel Aviv-Jaffa, Tel Aviv 64245, Israel; polingher@hemda.org.il

Edit M. Yerushalmi, Ester Bagno

It has been shown that in the context of problem solving the activity of self-explanation leads to significant learning gains and can be enhanced through interventions that require students to present their explanations. We describe a classroom activity designed to obligate students to explain what is wrong in an erroneous statement and why it is wrong. The students were assigned as homework an "Incorrect Answers" page of mistaken statements that reflect well-documented difficulties of students with DC circuits and were required a) to highlight the incorrect assertion in each statement b) to explain why it was wrong, and c) to provide a corrected assertion. We will present results of a classroom study, in particular, how well were students able to identify the incorrect assertion, to explain the mistake and to correct it.

Session DD: Hollywood and Science Literacy

Location: NRE 1-001 (Natural Resources Engineering Facility)
Sponsor: Committee on Science Education for the Public
Date: Monday, July 21
Time: 7–9 p.m.

Presider: Jeff Saul

DD01: 7–7:30 pm. Using Hollywood Movies to Teach Physics

Invited - Adam Weiner, The Bishops School, 7607 La Jolla Blvd., La Jolla, CA 92037; weinera@bishops.com

Hollywood action and science fiction movies can provide a unique opportunity for teaching and learning physics in the classroom. I have found in my classes that students are instantly more engaged when confronted with "movie physics" problems, labs, or projects compared with "traditional" problems and exercises. They really want to know the answers—Could the car successfully make that jump? Would it be possible to survive the impact? Could interstellar space travel ever be feasible? Another benefit of analyzing the physics in a movie scene is that (ironically) the analysis models real-world problem solving in so far as the students need to make reasoned estimations to arrive at valid but nonexact solutions. Finally, critically evaluating the physics and science as portrayed by Hollywood allows us to debunk the myriad scientific inaccuracies and misrepresentations perpetrated in films and so develop more scientifically literate students.

DD02: 7:30–8 p.m. Quantum Flapdoodle

Invited - Costas Efthimiou, University of Central Florida, Orlando, FL 32816; costas@physics.ucf.edu

During the last two decades Hollywood has become even more antiscientific and has produced products that promote mindless sensationalism and dangerously undermine the science literacy of the public. By exploiting the gullibility of the public, higher gross income of the products is guaranteed. In this talk, we shall discuss some of these products and the seriousness of the threat they pose to our society.

Session DE: The Future of Upper Division Lab Experience

Location: NRE 1-003 (Natural Resources Engineering Facility)
Sponsor: Committee on Laboratories
Date: Monday, July 21
Time: 7–9 p.m.

Presider: David Abbott

DE01: 7–7:30 p.m. Advanced Undergraduate Physics Laboratory: Goals, Challenges, Options, Implementation, Feedback*

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

Intermediate and Advanced Undergraduate Physics laboratory courses with a strong enquiry component that serve as a bridge between the introductory physics laboratory and genuine undergraduate research activities have become an integral part of the modern physics curriculum. Drawing from my own experience, I will discuss various aspects of designing, teaching and coordinating advanced undergraduate laboratories, beginning from the development of the laboratory course concept, the experiments selection, to the implementation and feedback. Pros and cons of different advanced laboratory models as well as the pedagogical and the logistics implications will be discussed. The criteria of the evaluation of the effectiveness of the advanced laboratory courses as well as the challenges of standardizing such evaluations will be discussed.

*The work is supported by FEAS, Ryerson University.

DE02: 7:30–8 p.m. Connecting Research in Physics Education with Physics Laboratory Work

Invited - Homeyra R. Sadaghiani, California Polytechnic University Pomona; hrsadaghiani@csupomona.edu

Physics laboratories are intended to provide students an opportunity to investigate physical phenomena by making observations, collecting and analyzing data, and presenting their findings clearly. However, most students lack an adequate preparation and conceptual understanding to achieve these objectives. Based on findings of Physics Education Research (PER) a series of online pre-lab tutorials using multimedia animations and simulations were designed to better prepare engineering students for introductory calculus-based mechanics laboratory. With this example, I will discuss ways in which incorporating methods of PER in laboratory activities can improve student performance and attitude in lab without a large investment in time or equipment, and that follow-up work can lead to more meaningful learning.

DE03: 8–8:10 p.m. Atomic Force Microscopy in Undergraduate Physics Labs

Kelvin Chu, University of Vermont, Burlington, VT 05405; kelvin.chu@uvm.edu

Keith Zengel, Joshua Mannheimer

We describe several atomic force microscopy labs used in an upper-division physics and biological physics courses. Labs involve a hands-on simulation with a macroscopic model of an AFM, basic AFM theory and the use of biological and semiconductor samples, along with case-studies and student-driven inquiry to familiarize students with sub-micron scale phenomena and understanding of modern nanotechnology techniques.

DE04: 8:10–8:20 p.m. Discussion on Magnetic Levitation Produced by the Interaction Between Magnet and Moving Conductor*

Zhijian Gou, The Physics Teaching Lab of Hunan University, Changsah, Hunan 410082; China; xiezhong@hnu.cn

Mingxi Wang, Xiao Xie, Zhong Xie, Zhuying Wang

In the magnetic levitation experiment (the apparatus is produced by PASCO Inc.) the user is asked to orient the lever to the direction coherent with the radius of aluminum disc. No reason was given in the apparatus manual to explain this requirement. In this way, a magnetic levitation can be observed. If the lever direction is departure from the radius direction we found that the levitation is dependent on the moving direction of the aluminum disc and the moving speed. When the disc moves in clock, the lever with a magnet moves up and shows a perfect magnetic levitation. But when the disc moves in counter-rotation, the lever goes down at low speed and than gradually goes up with the speed increases to higher. What is the matter? In this presentation we will give a detailed discussion to the interaction between the magnet and moving non-ferromagnetic conductor (including several interesting videos) to explain this phenomenon.

*Supported by National Undergraduate Innovation Project. Xiao Xie is a member of AAPT.

DE05: 8:20–8:30 p.m. Inexpensive Precision Capacitance Measurement and its Applications in Undergraduate Laboratories

Jeffrey A. Clayhold, Miami University, Oxford, OH 45056; clayhoja@muohio.edu

Joseph R. Priest

We will describe an inexpensive system for precision capacitance measurement that is appropriate for undergraduate laboratories and electronic instrumentation courses. The system based on a newly available capacitance-to-digital integrated circuit that can measure picofarad capacitances to six significant figures. Circuitry and software for controlling the integrated circuit with a personal computer via an I2C interface bus and LabView software are described. Examples of physics experiments that make use of the circuitry are discussed, including a novel hydrostatic magnetometer that uses precision capacitance measurement to determine the magnetization of a small sample.

DE06: 8:30–8:40 p.m. The Harmonic Oscillator in Quantum Mechanics: The Third Way

Frank Marsiglio, University of Alberta; fmars@phys.ualberta.ca

We give some illustrative examples of one-dimensional problems in quantum mechanics that can be handled with comparative ease through matrix mechanics and a computer. The traditional undergraduate training leaves this step for graduate studies (if then, even). We also illustrate how this minimal training opens an easy path toward undergraduate research projects.

Session DF: Teacher Preparation

Location: NRE 2-001 (Natural Resources Engineering Facility)
Sponsors: Committee on Teacher Preparation
Date: Monday, July 21
Time: 7–9 p.m.

Presider: Monica Plisch

DF01: 7–7:10 p.m. Using Content-Specific Best Practices in a Science Course for Teachers

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

Mary Kay Kelly, Beth Basista

Within teacher education programs, different courses generally are designed to give pre-service teachers multiple opportunities to develop as teachers. Science content courses, general methods courses, and field experiences help the pre-service teacher to begin to develop pedagogical content knowledge (PCK). However, research has established that one of the difficulties for pre-service science teachers is the disconnect between how they have learned science content and how they are expected to teach science content to K-12 students. The value of science content courses for helping pre-service teachers develop PCK can be enhanced when content-specific best practices are incorporated, modeled, and made explicit. We have studied the effect of modeling content-specific best practices in a physics content course at The University of Dayton by assessing the students' content knowledge and attitudes toward teaching both before and after the course. The results of our study will be presented in this talk.

DF02: 7:10–7:20 p.m. The Relationship Between Conceptual Learning and Teacher Self-Reflection

Kathleen A. Falconer, Buffalo State University; falconka@buffalostate.edu

Joe L. Zawicki, Dan L. MacIsaac

While both constructivism and self-reflection are essential elements of contemporary science teacher preparation programs, the precise nature of the relationship between these two conceptual frameworks has not been well defined. This study explored the question: How do the levels of conceptual understanding and the attitudes of a teacher relate to their ability to reflect upon instructional efficacy? Twenty-nine graduate students participated in an intensive, summer graduate physics course on electricity and magnetism. Pre- and post-instruction surveys and assessments included conceptual instruments (CSEM, DIRECT), attitude and efficacy instruments (STEBI, Attitudes and Beliefs About the Nature of and the Teaching of Mathematics and Science), and a total of 14 (daily) reflective journal entries (content and pedagogy), six journal reading reflections, three learning commentaries and a course final exam. Journal entries and learning commentaries were rated (blindly) on the relative level of reflection. The results indicate some relationship between self-reflection and conceptual understanding.

DF03: 7:20–7:30 p.m. Subtle Factors to Successfully Recruiting Majors and Teachers*

Gay B. Stewart, University of Arkansas; gstewart@uark.edu

Tracy Bond

At the University of Arkansas, Fayetteville, the strongest venue for recruiting majors and teachers has been the calculus-based introductory physics sequence. These classes were reformed with NSF support first in a CCD project, and then as part of PhysTEC. Many classes nationally have been reformed without the factor of 10 gain in physics graduates. The learning gains are good in the classes, regardless of instructor. However, a preliminary study showed that recruitment did depend on instructor. The other factor that depended on instructor: student attitudes about the nature of science teaching.

*Supported by grants from the National Science Foundation.

DF04: 7:30–7:40 p.m. Learning to Teach Physics for Non-Majors at the University of Calgary

Saiqa Azam, University of Calgary, Calgary AB T2N 1N4, Canada; sazam@ucalgary.ca*

HsingChi von Bergmann, David Fry

Secondary science teachers in Alberta are expected to teach all science areas: biology, chemistry, earth science, and physics. Lack of interest among students in learning physics results in few physics majors among future science teachers in Alberta. This paper describes a program to prepare future science teachers who are majoring in chemistry or biological science, not physics, to teach physics at junior and senior high level. The program comprises an inquiry-based physics methods course, and a secondary science curriculum seminar. The methods course addresses physics content mainly by giving the students physics inquiry experiences designed according to methods presented in the seminar. After each physics topic experience, the students design inquiry lessons in that physics topic. They then use the methods to design lessons in their own disciplinary areas. In the curriculum seminar, the future science teachers discuss issues and research in science curriculum, teaching, learning, and assessment in sciences.

*Sponsored by HsingChi von Bergmann and David Fry.

DF05: 7:40–7:50 p.m. A View of Teacher Education from Multiple Perspectives*

Richard N. Steinberg, City College of New York; steinberg@ccny.cuny.edu

After many years of working with prospective and in-service science teachers in New York City, I wanted to improve my perspective by living what these teachers experience. I therefore became a participant in the New York City Teaching Fellows alternative certification program and then spent a year-long sabbatical as a full-time science teacher in an inner city public high school. In this presentation I correlate my experiences training to become a science teacher, teaching high school science, teaching undergraduate freshman physics, teaching science content in teacher courses, and teaching science education courses. I also share data on student performance and approaches to science.

*Supported in part by the National Science Foundation.

Session DG: Alternative Energy

Location: NRE 2-003 (Natural Resources Engineering Facility)
Sponsor: Committee on Science Education for the Public
Date: Monday, July 21
Time: 7–9 p.m.

Presider: Richard Flarend

DG01: 7:30–8 p.m. Borehole Heat Storage Field in the Drake Landing Solar Community

Invited - Gordon Howell, Howell-Mayhew Engineering, 15006 103 Ave., Edmonton, T5P 0N8 AB

The Drake Landing Solar Community (www.dlsc.ca) is a new 52-home subdivision south of Calgary. Its solar-source district heating system with seasonal heat storage will provide 90% of the homes' space heating from solar energy. Heat from 800 solar collectors is pumped in the summer into 250 m^3 short-term storage tanks and then into a field of 144 ground-loop boreholes for storage until winter. How does the borehole field work? How much energy is stored in it? What is its efficiency? How long does it take to charge the field? How do the short-term tanks and borehole field relate to each other and to energy efficiency in the homes?

DG02: 8–8:30 p.m. Physics in the Oil Sands of Alberta

Invited - Murray Gray, University of Alberta, Department of Chemical and Materials Engineering, Edmonton, AB T6G 26G, Canada; murray.gray@ualberta.ca

Tony Yeung

The oil sands mines of Northern Alberta are the largest mines in the world, feeding extraction plants that separate thousands of tons of sand and clay from the bitumen product every day. Every step of the oil sands operation involves the application of physics, from controlling the wear on mining equipment due to abrasive sand to the purification of the bitumen product. This presentation will comment on three examples: transportation of oil sand by pipeline as a slurry in water, stability of emulsified water droplets in diluted bitumen, and settling of clays in the tailings ponds.

DH: High Energy Physics Projects for High School and Two-Year College Students

Location: ME 2-3 (Mechanical Engineering Building)
Sponsor: Committee on Physics in Two-Year Colleges
Date: Monday, July 21
Time: 7–9 p.m.

Presider: William Waggoner

DH01: 7–9 p.m. Student-Initiated Research on Cosmic Rays (ALTA Project)

Invited Poster - Vladimir L. Pasek, Archbishop O'Leary High School, Edmonton, AB T5E 0X8, Canada; pasekv@mac.com

Richard Soluk, Brent McDonough

This cosmic ray research is a collaboration among high schools in the Edmonton area, the Czech Republic, and the University of Alberta's ALTA project (Alberta Large Area Time Coincidence Array). Cosmic ray detectors located at each school site collect the data used, and information is shared via the Internet. This presentation will focus on the research initiated by high school students and the subsequent analysis of the results. At first, the original experiments will be discussed, followed by the most recent ones. The future of this project and its benefits will be discussed in the conclusion.

DH02: 7–9 p.m. QuarkNet: Bringing HEP to the High School Classroom*

Invited Poster - Beth Marchant, Notre Dame University; marchant.2@nd.edu

QuarkNet has many resources for teachers to use in teaching high energy physics. Our "toolkit" includes on-line resources, such as research projects using real data from cosmic ray detectors and shorter exercises for you to use to integrate the idea of particle physics into your classroom while still sticking to the standards. QuarkNet also offers Masterclasses through students and teachers analyze LEP data and then share their data via videoconference connecting classrooms to other classrooms. Come to find out where all of these free resources are and how they can help you to be the most effective teacher you can be.

*QuarkNet is funded by the NSF and DOE.

DH03: 7–9 p.m. Scientific Collaboration—Cosmic Rays, Gravitational Waves, Particle Physics, Grid Computing

Poster - Thomas A. Jordan, University of Florida; jordant@fnal.gov

Students use their web-browsers and our e-Lab environment to search for and analyze data from professsional experiments (ATLAS, CMS and LIGO) as well as data from classroom cosmic ray detectors across the globe. These students can investigate real scientific data, build histograms and realize ways that professional science is similar to what they do in school. The e-Lab provides a road-map with conceptual milestones that allow individuals to learn as they go. Students can start analysis jobs and pick them up later in the day. Analyses run locally using grid computing techniques or can be "farmed out" to grid resources outside of the e-Lab environment. Students can save results, and re-run them tweaking analysis parameters. They can publish their results in an online poster, collaborate with students in other schools, and track their learning using an interactive logbook. Teachers can see and comment in logbooks owned by their students.

PST-II: Post-Deadline Posters and Papers

Location: TBA
Date: Monday, July 21
Time: 5:15–6:45 p.m.

(abstracts to appear in addendum)

TUESDAY, July 22

Registration *ETLC, Solarium*	7:30 a.m.–5 p.m.
Poster Sessions *ETLC, Solarium*	8–9 a.m. and 5–6 p.m.
Millikan Award – Eric Mazur *Students' Union, Horowitz Theatre*	4–5 p.m.
Exhibit Show *Students' Union, Dinwoodie*	8 a.m.–11 p.m. and 2–5:30 p.m.
Summer Picnic and Demo Show *Univ. of Alberta Business Quad, Horowitz Theatre*	5:45–8:15 p.m.

Session PST3: Poster Session III: Educational Technology/Astonomy/ Teaching Physics Around the World

Location: ETLC, Solarium (Engineering Teaching & Learning Complex)
Date: Tuesday, July 22
Time: 8–9 a.m.

PST3-01: 8–9 a.m. Supplementary Web-based Laboratory Exercise for High School/Introductory Undergraduate Physics Courses

Isaac-Yakoub Isaac, University of Alberta; iisaac@ualberta.ca

Chunyan Zhang, Raj Boora

The experimental component of a typical high school physics course is usually lacking due to either limited resources or curriculum allocation issues. This has a negative impact on student performance in first-year laboratory sessions. We designed a collection of virtual labs based on actual experiments at the University of Alberta that are suitable for use in class at the high school level as well as an introduction to the formal labs in first-year courses. The Virtual Physics Lab Experiments (VPLE) have been in use at the Physics Department for two years and are usually complemented by an online quiz that precedes the scheduled lab. The University of Alberta also offers this project to high school physics teachers to augment their teaching strategies and to draw their students' attention toward the important role of experiment in the field of physics. A sample "lesson plan" will be available along with an online demo during this poster session.

PST3-02: 8–9 a.m. An Online Lab Experience for Physics Students

Melissa A. Vigil, Marquette University, Milwaukee, WI 53201-1881; melissa.vigil@mu.edu

David Lloyd, Marlin Simon, Paul Baro, Jeane Finstein

Polyhedron Learning Media has created an online lab experience for college or AP level introductory physics. Each online lab contains everything needed to conduct the experiment: background information, theory, objectives, procedures, a video overview of the experiment, and post-lab assessments. Data collection, analysis, graphing, and reporting tools allow students to perform all phases of the experiment online using simulated equipment that is more realistic than currently available java applets. Students in algebra- and calculus-based courses at Auburn University took part in a study of the prototype labs. Post-test scores of students using the virtual labs (either alone or with TA assistance) were not significantly different than those who completed the hands-on version in a traditional lab setting. An unanticipated advantage of the virtual labs was the time savings of ~33%. Used alone or to supplement hands-on experiences, these simulations promise cost and time savings without loss of educational benefit.

PST3-03: 8–9 a.m. Captivate Your Students 24/7 with Adobe Captivate

Cheryl P. Schaefer, Missouri State University, Springfield, MO 65897; CherylSchaefer@MissouriState.edu

Adobe Captivate has an easy-to-use format that allows you to record a presentation and its keystrokes while sitting at your desk. All you need is a computer and a microphone and you are in business. Your presentation can be recorded and placed on the web for your students to access on their own time. Use this for online courses. Use it for student enrichment. At Missouri State we are using it to record presentations on subjects that interest our major students. As each is presented, the file with the presentation goes on the departmental website to be viewed again. If you are cameraphobic, no worries. The students see the computer screen, not you!

PST3-04: 8–9 a.m. Andes: An Intelligent Tutor Homework Helper

Brett van de Sande, University of Pittsburgh; bvds@pitt.edu

Sophia Gershman

Andes* is an intelligent tutor homework system designed for use as the homework portion of an introductory physics course. It encourages students to use good problem-solving techniques and provides immediate feedback on each step of a problem solution along with hints on request. We will discuss how Andes works, from a student perspective, and present research demonstrating its effectiveness as a pedagogical tool. Although, Andes was initially developed for use at the college level, teachers at the high school level have started to use Andes in their classes also. We will discuss the effectiveness of Andes in this new environment.

*See www.andes.pitt.edu

PST3-05: 8–9 a.m. Demonstrations and Interactive Assignments in Introductory Physics with Visual Python

Adam S. Thompson, Arizona State University; adam.thompson@asu.edu

Kevin L. Gibson, Robert J. Culbertson

VPython (or Visual Python) is a free open-source programming language that is relatively easy to learn. It can be used as a backdrop for interactive homework assignments that allow students to program functional relationships between physical variables and then visualize those relationships dynamically. Further, VPython can be used to create interesting and fruitful visual demonstrations in the classroom, demonstrations that might be too complex for an introductory physics student to program. This presentation will display several examples of such assignments and demonstrations that have already been used in the introductory physics classroom, as well as a few additional innovations that have yet to be employed but are intended for future use.

PST3-06: 8–9 a.m. Conceptual Electricity and Magnetism Problem Database

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

Richard Campbell

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 1000 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. There is no cost associated with using any of the facilities of the site.

PST3-07: 8–9 a.m. Interactive Tutorials to Develop Expertise in Introductory Students

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

Daniel Haileselassie

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 discuss the development and assessment of the tutorials.

*Supported by NSF-DUE 0442087.

PST3-08: 8–9 a.m. New Research on Effective Features of Interactive Simulations

Archie M. Paulson, University of Colorado; archie.paulson@colorado.edu

Wendy Adams, Kathy Perkins

The Physics Education Technology (PhET) project develops interactive, research-based simulations of physical phenomena (http://phet.colorado.edu). Our recent research seeks a better understanding of how students learn from simulations (sims) in order to inform both simulation design and use. By careful study of students' interaction with a few select sims, we find that student learning can depend strongly on particular sim features and how students interact with these features, such as the capability of receiving continuous and immediate feedback. Data were collected by recording and coding interviews involving student exploration of sims covering physics topics unfamiliar to the student. Results of this study 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.

PST3-09: 8–9 a.m. New Developments in PhET's Interactive Simulations Project

Archie M. Paulson, University of Colorado; archie.paulson@colorado.edu

Kathy Perkins, Wendy Adams, Carl E. Wieman, and the rest of the PhET team

The Physics Education Technology (PhET) project develops interactive, research-based simulations of physical phenomena that emphasize interactivity, animation, and context. All simulations (sims) are open-source and freely available at the PhET website (http://phet.colorado.edu). We will report on new developments over the last year. These developments include new sims in physics, geoscience, and chemistry, as well as a large number of new teaching activities. Many existing sims have been updated with improvements in usability. The research base of the PhET project has expanded with publications on sim implementation and their effectiveness, focusing on sim use in modern physics courses. The PhET website has undergone significant improvements in speed and functionality, and now offers a powerful translation utility to extend PhET to other languages. These features and the rising profile of the PhET project has recently led to a rapid growth in its user base.

*Funding provided by Hewlett Foundation, NSF, Kavli Institute, and the Univ. of Colorado.

PST3-10: 8–9 a.m. Using Splines to Explore Graphical Representations of Physical Phenomena

Michael R. Gallis, Penn State Schuylkill; mrg3@psu.edu

This poster describes two computer activities in which students explore the graphical representation of a physical phenomenon by manipulating the control points of a cubic spline displayed in a Java applet. In the kinematics activity, students create a graphical description of 1-D motion by modifying position, velocity or acceleration (a change in any one of these quantities is immediately reflected in the graphs of the other two) and then "playing" the corresponding motion. In the potential energy activity, students create a potential energy function, set the kinetic energy and watch the resulting motion. For both activities, students are provided basic directions and principles as well as a list of questions to be answered based upon their observations using the applet.

PST3-11: 8–9 a.m. Developing and Researching PhET Simulations for Teaching Quantum Mechanics

S.B. McKagan, University of Colorado; mckagan@colorado.edu

Kathy Perkins, Wendy Adams, M. Dubson, C. Malley, S. Reid, R. LeMaster, Carl E. Wieman

Quantum mechanics is difficult to learn because it is counterintuitive, hard to visualize, mathematically challenging, and abstract. The Physics Education Technology (PhET) Project, known for its interactive computer simulations for teaching and learning physics, now includes 18 simulations on quantum mechanics. Our simulations include several key features to help students build mental models and intuitions about quantum mechanics: visual representations of abstract concepts and microscopic processes that cannot be directly observed, interactive environments that directly couple students' actions to animations, connections to everyday life, and efficient calculations so students can focus on concepts rather than math. Like all PhET simulations, these are developed using the results of education research and feedback from educators, and are tested in student interviews and classroom studies. We describe the development of the quantum simulations, research demonstrating their effectiveness, and some insights about student thinking that we have gained from this research.

PST3-12: 8–9 a.m. Students' Perceptions and Interpretations of Clicker Questions

Lin Ding, The Ohio State University; lding@mps.ohio-state.edu

Albert H. Lee, Neville W. Reay, Lei Bao

Studies have shown that students differ from experts in many aspects of learning and practicing physics, including conceptual understanding, knowledge organization and problem solving. However, there is limited research devoted to how differently students, when encountering physics questions, perceive and interpret given information. Results from this research can be useful for course materials design, such as clicker questions. We developed a series of multiple-choice clicker sequences and conducted student interviews to observe how students view and construe the given conditions in clicker questions. One primary purpose is to validate clicker questions with the audience—students—who may provide a different perspective of question design. We find that students often have a different level of ability in distinguishing relevant and irrelevant information; consequently students are easily distracted by irrelevant features. Our observations from student interviews have resulted in a significant number of major modifications in clicker questions.

PST3-13: 8–9 a.m. Online Tutoring Using Tablet PCs and DyKnow

Duane L. Deardorff, The University of North Carolina at Chapel Hill; duane.deardorff@unc.edu

Robert Henshaw, Paul Carr, Brenda Shryock, April Hoffmeister

A pilot program has been implemented at UNC-Chapel Hill to provide online tutoring to supplement existing out-of-class instructional services. This effort is coordinated by the university's information technology services and includes participants from the physics and astronomy department, math department, and Learning Center. The pilot model uses a mix of technologies, including an interactive whiteboard program (DyKnow), tablet PCs used by the tutors, text chat, and phone conferencing. The tablets greatly facilitate the ability to draw figures and write equations in a digital environment, and this is a significant advantage over using only text. Lessons learned from this project will be presented, along with a demonstration of a tutoring session.

PST3-14: 8–9 a.m. "Math Animated," a Courseware of Calculus for Undergraduate Physics Students

Samuel Dagan, Tel-Aviv University; dagan@post.tau.ac.il

A courseware, called "Math Animated," to be hosted on the web, based on a course called "Mathematical Introduction for Physicists," for undergraduate students at the Tel-Aviv University, has been developed. In addition to the text, examples and exercises, the courseware takes advantage of the modern technology of interactive and animated graphics, which makes complicated concepts easy to understand. The graphics can be projected by the teacher in class, and accessed afterward at any time by the students. Interactivity and animation help the students to more effectively learn the material at their leisure. The courseware covers single and multi-variable calculus, containing more than 110 interactive and animated graphics. Math Animated is technically based on non-proprietary open standards, developed at the Web Consortium (http://www.w3.org/), including the XML applications SVG (for graphics) and MathML (for mathematical expressions). This makes Math Animated accessible via the web without the need of any particular software.

PST3-15: 8–9 a.m. Educational Technology*

Douglas A. Brown, Cabrillo College, Aptos, CA 95003; dobrown@cabrillo.edu

The Tracker video analysis program allows users to overlay simple dynamic particle models on a video clip. In a typical video modeling experiment, students capture and open a digital video file, calibrate the scale, and define appropriate coordinate axes just as for traditional video analysis. But instead of tracking objects with the mouse, students define theoretical force expressions and initial conditions for a dynamic model simulation that synchronizes with and draws itself on the video. The behavior of the model is thus compared directly with that of the real-world motion. Tracker uses the Open Source Physics code library so sophisticated models are possible. Video modeling offers advantages over both traditional video analysis and simulation-only modeling. This electronic poster will showcase video modeling experiments produced by students in my fall 2007 Introductory Mechanics course. The Tracker video analysis program is available at: http://www.cabrillo.edu/~dbrown/tracker/.

*Partial funding was provided by NSF grant DUE-0442581.

PST3-16: 8–9 a.m. Baby Steps to Big Things in the Classroom

Raj Boora, Faculty of Science DigiTLE, University of Alberta; raj.boora@ualberta.ca*

Blogs, wikis, clickers, 'casts, sims, games, and web2.0 are all tools that likely a great number of science teachers never had a clue about when they were starting to teach and now, many years on may not have time to understand. For those teachers just starting out, there is barely enough time to get a handle on teaching and keep up with the curriculum to try to integrate something new, especially when it's never been done in the department before. Some teachers have, however, made this jump and are starting to see how these new tools really can help them connect with students as well as connecting students with the content. This presentation will cover some adoption basics as well as a look at several technologies that could be used effectively with little preparation in just about any physics classroom.

*Sponsored by David Lawrie.

PST3-17: 8–9 a.m. Video-Based Motion Analysis Assignments for Engineering Students*

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

I will present a set of video-based motion analysis assignments created for the Mechanics course for engineering students. This calculus-based course is offered to the students enrolled in various engineering programs (mechanical, aerospace, industrial and chemical engineering) at Ryerson University, and includes some topics that are not typically covered by the introductory physics courses. Many of the assignments are based on the videos recorded by the students themselves. The author would like to thank the staff of the Activity Based Physics Faculty Institute (Summer 2006) for introducing her to Video Based Motion Analysis.

*The work is supported by the Faculty of Engineering, Architecture and Science, Ryerson University.

PST3-18: 8–9 a.m. A Peer Instruction Module for Teaching Stellar Evolution

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

Christopher M. Siedell, Todd S. Young

This poster will describe a new module of the ClassAction project focusing on stellar evolution. The concepts covered include main sequence lifetime, evolutionary tracks and stages for different mass ranges, cluster evolution, and end states. Much of this is accomplished by asking students to interpret tables of data and HR diagrams which encourages critical thinking. ClassAction is a collection of materials designed to enhance the metacognitive skills of college and high school introductory astronomy students by promoting interactive engagement and providing rapid feedback. The main focus is dynamic peer instruction questions that can be projected in the classroom. Instructors have the capability to recast these questions into alternate permutations based on their own preferences and formative feedback from the class. The questions can be easily selected from a FLASH computer database and are accompanied by outlines, graphics, and simulations which the instructor can utilize to provide feedback. These materials are publicly available at http://astro.unl.edu and are funded by NSF grant #0404988.

PST3-19: 8–9 a.m. Beauty and Power of Mathematics—Changing Attitudes in Astronomy Courses

Jennifer Kirkey, Douglas College, New Westminster, BC V6V 2H3, Canada; kirkeyj@douglas.bc.ca

Sarah Stephens

How do students' attitudes toward the beauty, power, usefulness and fun of mathematics in the course and the world around them change throughout a semester? Two instructors from a community college in British Columbia set out on a cross-disciplinary quest to answer this question in a first-year astronomy course for liberal arts students and an introduction to computers classroom. Using a five-point attitude scale, we gathered students' responses to statements such as: "math is beautiful," "math is powerful," "math is useful in this course," "math is useful in the rest of the life outside of the college" and "math is fun." Students were asked what was the most important classroom experience that fostered a positive attitude toward the beauty, power and usefulness of mathematics (if any). The results of the research, including methods to enhance our classroom activities to increase a positive change toward mathematics will be shared.

PST3-20: 8–9 a.m. A Hands-on Activity Involving Scale for Liberal Arts Majors

Jennifer Kirkey, Douglas College, New Westminster, BC V6V 2H3, Canada; kirkeyj@douglas.bc.ca

Astronomy courses for liberal arts majors are common and popular. The students' abilities, and most importantly, attitudes toward mathematics make laboratory activities challenging. We found this activity a surprising success. Near the end of the semester, students were given a bag with a set of Styrofoam spheres. The bag held about twice as many spheres as were needed. The largest sphere was about 6 inches or 150 millimetres in diameter. There was a tape measure on the floor. The students were told to assume the spheres were the eight planets and three dwarf planets. To scale, they put the planets in order and to the correct distance. The students completed the lab successfully. It was the one and only time they did not complain about the having to do math. They enjoyed spending extra time decorating the planets. The students rated it as their favorite activity of the semester.

PST3-21: 8–9 a.m. Giving All Astronomy Students a Taste of Research

Eric G. Hintz, Brigham Young University; doctor@tardis.byu.edu

Michael D. Joner, J.W. Moody, Denise C. Stephens

Often a descriptive astronomy class is turned into just memorizing a lot of facts about the universe. The students are not given a chance to see how astronomers actually learn about the nature of the universe. Using our campus research telescope, we have designed a number of hands-on projects to allow descriptive astronomy students a chance to take and analyze data. The projects range from taking data to create a three-color image to working with astronomy majors to acquire research quality data. We also show the historical importance of astronomy as a navigation tool by having students measure their location with a sextant and then comparing to a GPS measurement. We will present some of our hands-on projects and plans for the future, which include using our remote telescope, to let students get a little taste of being a "real" astronomer.

PST3-22: 8–9 a.m. The Astronomy Workshop: Tools

Melissa N. Hayes-Gehrke, University of Maryland; mhayesge@umd.edu

Douglas P. Hamilton, Grace Deming

The Astronomy Workshop (http://janus.astro.umd.edu) is a collection of interactive World Wide Web tools that were developed under the direction of Doug Hamilton for use in undergraduate classes and by the general public. The philosophy of the site is to foster student interest in astronomy by using their fascination with computers and the internet. We are upgrading the "Scientific Notation" tool; its initial function was to enable the practice of changing decimal numbers into scientific notation numbers. This tool is very popular, with 10,000 hits per day typically. The upgrades include multiplication and division and the implementation of automatically-graded quizzes, as well as instructional materials for teachers. We have also added a new tool, the "Solar System Visualizer," which animates orbits of the solar system's planets, moons, and rings to the correct scale (including retrograde motions), as well as displaying the orbits of a number of extrasolar systems to scale.

PST3-23: 8–9 a.m. Using IRAF and DS9 for Variable Star Research

Michiel N. Ford, Brigham Young University/Holton High School, Holton, KS 66436; mford@holtonks.net*

This poster will explain how Advanced Space Science students at Holton High School are learning to research data of variable stars using CCD images from Brigham Young University Department of Astronomy and Elk Creek Observatory, located at Holton High School. Students used LINUX, IRAF and DS9 to work on their data. They also take their own images using ECO's 20-inch RCOS telescope. This was research learned during an Research Experience for Teachers (RET) during the summers of 2007 and 2008 at Brigham Young University.

* Sponsored by Steven Turley.

PST3-24: 8–9 a.m. A Remotely Operated Observatory for Minor Planet Photometry

Richard Ditteon, Rose-Hulman Institute of Technology, Terre Haute, In 47803; ditteon@rose-hulman.edu

Oakley Southern Sky Observatory (E09) located near Siding Spring Observatory in New South Wales, Australia, houses a 0.5-m, f/8.4 Ritchey-Chretien telescope mounted on a German equatorial mount. Attached to the telescope is a CCD camera with 1024 X 1024, 24 µm pixels, a two-stage thermoelectric cooler, and built in color filter wheel with BVRI and clear filters. The hardware is controlled by a custom program. When conditions are favorable, power is turned on, the roof opens, calibration and data frames are recorded. Images are transferred to Rose-Hulman by a background program. The observatory closes itself before dawn or if it gets cloudy. Currently we are using the observatory for photometry of minor planets. Students are responsible for selecting targets, processing the returned images, determining the period and light curve of each minor planet and writing a paper for publication. Recent results will be presented.

PST3-25: 8–9 a.m. The 2007 Outburst of Comet 17P/Holmes

Stephen Luzader, 59 Centennial St., Frostburg, MD 21532;sluzader@frostburg.edu

On Oct. 24, 2007, normally obscure Comet 17P/Holmes suddenly exploded into naked eye visibility. The ease with which it could be observed and photographed made it an ideal subject for an astronomical research project. Applying simple optical concepts to CCD and film images, we could estimate the size and rate of growth of the comet's coma. Measurements from our backyard images showed an early expansion rate of about 1900 km/s, in agreement with estimates given by professional astronomers. By the end of November 2007 the coma had become the largest object in the solar system, with a diameter of about 1.6 million km. Photographs of the comet will be shown along with a summary of the analytical techniques used to determine the size. Speculations about the cause of the outburst will be presented as well.

PST3-26: 8–9 a.m. Astronomy for the Liberal Arts: Teaching the Science Core Requirement

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

Spelman College students wishing to satisfy the science core requirement may take Introduction to Astronomy. These students come from the Humanities and Fine Arts divisions and are often uncomfortable with math and science. Strategies for this course include discussion of current astrophysics research, the use of animations and movie clips to help students visualize abstract physical concepts. All students complete a semester-long project. They may either carry out observational work or develop a thesis topic where they are encouraged to present connections between their field of interest and astronomy. The course does not have a required observing component. However, laboratory activities have been developed for the course. Other lab exercises use computer simulations of astronomical techniques and the night sky.

PST3-27: 8–9 a.m. Stellar Evolution—Cosmic Cycles of Formation and Destruction

Doug Lombardi, Southern Nevada Regional Professional Development Program, North Las Vegas, NV 89030; dalombardi@interact.ccsd.net

Donna L. Young

The Chandra X-ray Observatory is designed to collect X-rays from high-energy objects in the universe—such as stellar nurseries, the remnants of supernovae explosions, neutron stars, pulsars and black holes. The Chandra E/PO program has created a specially designed stellar evolution poster and tutorial on the Chandra X-Ray Observatory website to learn about stellar cycles. A classroom activity designed in a web quest format that utilizes multi-wavelength images of stellar nurseries, supernovae, neutron stars, pulsars, binary stars and black holes can be used to further investigate and learn about stellar life cycles. A separate activity, designed to show the relationship of different stages of stellar evolution and the Hertzsprung Russell diagram can be used both as a classroom activity and as an interactive Internet version. An assessment activity, written as a performance task with scoring rubric, uses a different set of multiwavelength images to determine gain in understanding. The sequence of activities, aligned to National Science Standards and Benchmarks, involves students in a series of activities designed to show how scientists view, study, and examine the process of stellar evolution.

PST3-28: 8–9 a.m. College Students' Lunar Phases Concept Domain

Rebecca S. Lindell, Southern Illinois University–Edwardsville; rlindel@siue.edu

Previous research (Lindell, 2001) showed that college students' lunar phases concept domain consisted of eight dimensions: Period of Moon's orbit, Period of Moon Phases, Direction of Moon's orbit around the Earth, Motion of the Moon in the sky, Phase and Sun-Earth-Moon relationship, Phases-Location in the Sky-Time of Observation relationship, Cause of Phases and Effect of Location on Earth on observed phase. Each dimension uncovered has a number of facets, each representing the scientific correct answer, as well as the different alternative models possible. In a follow-up study, interview data was collected from 25 pre-service elementary education majors. This additional study uncovered previously undiscovered difficulties students had with lunar phases. The discovery of these new difficulties resulted in the need to revise the original concept domain. The new revised concept domain will be presented.

PST3-29: 8–9 a.m. What Changes When Shifting to Learner-Centered Strategies in Introductory Astronomy?

Janelle M. Bailey, University of Nevada, Las Vegas; janelle.bailey@unlv.edu

Kentaro Nagamine

Instructors who are considering new strategies in their introductory astronomy course often ask, "How much will I have to cut in order to use these methods?" While there is no single answer to this question, many instructors may find it useful to know what someone else has done in this area. This presentation will demonstrate changes to the curriculum of an introductory-level course on stars and galaxies for nonscience majors. In particular, we will discuss changes to: topics included in the course; approximate course time per topic; number of presentation slides per topic; number of in-class activities per topic; number of in-class questions, a la *Peer Instruction* (Mazur, 1997; Green, 2003); and number of test questions per topic. While these changes are not to be taken as a dogmatic "how-to," they may serve as a representative example of the considerations an instructor embarking down the learner-centered path may take.

PST3-30: 8–9 a.m. Hemda: Unique Model of Science Education

Corina Polingher, Hemda – Science Education Centre – Tel Aviv-Jaffa; polingher@hemda.org.il*

Tehilla Ben-Gai

Hemda, the Center for Science Education in Tel Aviv-Yaffo, combines the advantages of 24 highly qualified teachers and high-quality equipment centralized in one location. As the scientific arm of 17 high schools, we provide both curricular (teaching toward matriculation examinations especially in physics, but also in chemistry and computational science) and extracurricular (individual tutoring, science workshops and elective courses) programs to 1200 students. Our students' curricular achievements are 13% higher than the national average and they successfully participate in national and international competitions. As a Teachers' Center, Hemda offers to science teachers training courses, the services of our extensive science education library, and the opportunity to attend the weekly seminar and journal club held by our team of teachers. Hemda also contributes to the community by holding series of popular scientific lectures given by leading scientists in their fields, which are attended by thousands of people of all ages.

* Sponsored by Edit Yerushalmi.

PST3-31: 8–9 a.m. Experimental Modules for Teaching Straight Propagation of Light

Jung Bog Kim, Korea National University of Education; jbkim@knue.ac.kr

Kyuwhan Kim

Many experiments to show straight propagation of light have used indirect ways, which focus on not beam path but just results appearing on a screen. Actually, experiments about straight propagation of light have been contained in elementary school curriculum in South Korea. Elementary school teachers in Korea had many misconceptions about straight propagation of light because of not so good experimental setup in the textbook. We have developed modules showing beam paths by using straws. Modules consist of six sets, which are i) aperture and straw, ii) vision through straws, iii) straws and shadow, iv) pin hole camera, v) reflection, and vi) refraction. Teacher's misconceptions have been changed into scientific conception.

PST3-32: 8–9 a.m. Opportunities and Challenges for Outreach with PhET Simulations in Uganda

Sam McKagan, University of Colorado; mckagan@colorado.edu

Laurel Mayhew

The Physics Education Technology (PhET) Project is a suite of interactive computer simulations for teaching and learning physics that are freely available online. These simulations appear to be ideally suited for use in physics classes in developing countries, where laboratory equipment is extremely scarce, but computers are becoming more widely available. We report on workshops introducing these simulations, along with inquiry-based teaching methods, to high school physics teachers in rural Uganda. Within a few hours, many teachers who had never before used computers were using the simulations as proficiently as American university students and learning a great deal of physics. Teachers viewed the simulations as being very valuable for their students and were excited to use them in their classes. However, many challenges to implementation remain, including a lack of technical resources, as well as professional development and support opportunities for teachers.

PST3-33: 8–9 a.m. Learning the Uncertainty Principle: A Study of its Difficulties

Carlos M. Hinojosa, Tec of Monterrey, Garza-Sada 2501, Monterrey NL 64849, Mexico; chinojos@itesm.mx*

Alejandro J. Mijangos

The difficulties when learning basic physics concepts have been widely documented in specialized literature. Generally this research is based in the measured achievement of heterogeneous groups of students that belong to different specialties. There is not enough research on learning difficulties for students at college level whose major is physics. This work investigates the assimilation of Heisenberg's Uncertainty Principle by Physical Engineering students at Tecnológico de Monterrey that have been previously exposed to this concept in traditional Modern Physics and Quantum Physics courses. The later ones are traditional in the sense that they have no elements of active learning. Interviews were made in order to establish common difficulties and conceptual mistakes when working with physical situations that involve the Uncertainty Principle. The reported results provide a base for the design of courses under the active learning philosophy.

*Sponsored by Genaro Zavala (Tec of Monterrey).

PST3-34: 8–9 a.m. Experiments for Teaching Physics by the First Korean Astronaut

Min Chae, Korea National University of Education; bachmin@gmail.com

Jinsoo Hwang, Myoung Soo Hong, Kyuhwan Kim, Jungsook Lee

In April, the first Korean astronaut went into space. The astronaut tried many experiments in ISS. We developed experimental setups for scientific education. The experiments consisted of the space pen, Newton's law, momentum, angular momentum, acceleration and gravity, and surface tension. We will present the purpose, the contents of the experiments, how to design, and important ideas for each item.

PST3-35: 8–9 a.m. Online Interactive Assessment: Short Free Text Questions with Tailored Feedback

Sally E. Jordan, The Open University, Milton Keynes MK7 6AA, U.K.; s.e.jordan@open.ac.uk

This poster will describe work in progress at the UK Open University in which the range of question types used for online interactive assessment is extended to include those requiring free-text responses of around a sentence in length. Answer matching is authored using a linguistically based tool supplied by Intelligent Assessment Technologies Ltd., which looks for understanding without unduly penalising errors of spelling or grammar. Responses such as "The Earth orbits the Sun" can be differentiated from "The Sun orbits the Earth" and "The forces are balanced" is marked as correct whereas "The forces are not balanced" is not. Targeted feedback is provided on incorrect and incomplete answers and students have three attempts at each question so they can use the feedback while it is fresh in their minds. Evaluation shows that students enjoy this type of assessment and that the computer's marking is typically indistinguishable from that of human markers.

Session EA: PER: Assessing Student Understanding

Location: ETLC E1-013 (Engineering Teaching & Learning Complex)
Sponsor: Committee on Research in Physics Education
Date: Tuesday, July 22
Time: 9–11 a.m.

Presider: Cathy Ezrailson

EA01: 9–9:10 a.m. Student Difficulties Concerning Derivative and Slope Concepts in Multivariable Calculus*

Warren M. Christensen, University of Maine; warren.christensen@umit.maine.edu

John R. Thompson, Donald B. Mountcastle

Previous work on students' understanding of graphical interpretation of slope, derivative, and area under curves in various physics contexts has shown substantial difficulties, most notably in kinematics.[1] Concurrently, several reports point toward students' lack of algebraic acumen as a likely cause for their low achievement in a physics classroom.[2] As part of ongoing research on mathematical challenges that may underlie documented physics difficulties, we developed and administered a brief survey on single- and multivariable calculus concepts to students near the end of a Calculus III course. Some of the questions are based on our earlier work in thermal physics that are essentially stripped of their physics content. Initial findings show that one in five students encounter some type of difficulty when asked to rank the slopes at five different points along a single path. Students asked to rank the derivatives of three different functions at a single point face more difficulties.

1. Beichner, *Am. J. Phys.* **62** 750 (1994).
2. Meltzer, *Am. J. Phys.* **70** 1259 (2002).

*Supported in part by NSF Grants PHY-0406764, REC-0633951, and the Maine Academic Prominence Initiative.

EA02: 9:10–9:20 a.m. Addressing Thermodynamics Students' Partial Differentiation Difficulties Through Research-Based Curriculum Development*

Brandon R. Bucy, University of Maine; brandon.bucy@umit.maine.edu

John R. Thompson, Donald B. Mountcastle

We have reported previously that students demonstrate an inability to correctly equate the mixed second-order partial derivatives of the state function of volume (nonzero quantities in general), arguing instead that these derivatives must identically equal zero.[1] We have developed and implemented a guided-inquiry instructional sequence for upper-level undergraduate thermodynamics students to address this and related student difficulties with partial derivatives encountered in our research. The sequence uses a graphical interpretation of partial derivatives in the context of an ideal gas P-V-T surface to bridge the abstract mathematical concepts with concrete physical properties. We present pre- and post-instruction data from two semesters of a classical thermodynamics course in which the sequence was administered, and compare those outcomes to results obtained after lecture-based instruction only. Preliminary results imply that the sequence not only addressed the difficulty discussed above but also positively impacted student performance on related topics.

* Research supported in part by NSF Grants #PHY-0406764 and #REC-0633951, and by the Maine Academic Prominence Initiative.

1. B.R. Bucy et al., 2006 *Phys. Educ. Res. Proc.* **883**, 157 (2007).

EA03: 9:20–9:30 a.m. Student Conceptions of Integration and Their Impact on Thermodynamic Work*

Evan B. Pollock, University of Maine; evan.pollock@umit.maine.edu

John R. Thompson, Brandon R. Bucy, Donald B. Mountcastle

As part of ongoing research on the teaching and learning of thermodynamics at the advanced undergraduate level, we explore student conceptions of thermodynamic work and the related mathematical concepts through an analysis of personal interviews. Students were given a P-V diagram and asked to answer qualitative questions pertaining to work (PdV) and internal energy of two processes shown on the diagram. The physics questions were paired with equivalent qualitative math questions asking about signs and comparisons of magnitudes of various integrals, including path integrals. Students exhibited considerable difficulties when asked to preform integrations over a predefined path. The interviews have uncovered evidence that some students rely on the length of the integration path, and/or symmetry of the paths when comparing the magnitude of two integrals, rather than area under the curve to answer questions requiring integration. These notions negatively impact student performance on questions pertaining to thermodynamic work.

* Work supported in part by NSF Grants #PHY-0406764 and #REC-0633951.

EA04: 9:30–9:40 a.m. Mulitple Interpretations of Student Reasoning About Static Friction

Andrew Boudreaux, Western Washington University, Bellingham, WA 98225-9164; boudrea@physics.wwu.edu

Over the past 30 years, many aspects of student reasoning about force and motion have been examined.These topics continue to provide a rich arena for investigation. This talk presents results from written questions administered to students in a liberal arts physics course. Students were asked to analyze the forces exerted on an object at rest in a variety of circumstances, all involving static friction. Responses allow a number of specific difficulties to be identified. For example, students tend to omit one member of a Newton's third law static friction force pair, even when they have been able to identify a normal force pair. Student thinking can be characterized in a somewhat different way as well.

EA05: 9:40–9:50 a.m. How Different Is "Not the Same"

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

John R. Thompson, Michael C. Wittmann

Short answer, ranking task, multiple choice; these are just a few of the different kinds of questions that are used in PER to find out what students know. Given the assumption that students with similar answers to the same question have the same idea, students are typically sorted into different groups based on their answers. As part of a project aimed at making the sorting process more systematic and quantitative, we look at the type of data each kind of question yields and how to numerically define the difference between any two sets of answers to the same set of questions.

EA06: 9:50–10 a.m. Are Introductory Physics Students Better Prepared for Kinematics and Dynamics?

Jeff Marx, McDaniel College, Westminster, MD 21157; jmarx@mcdaniel.edu

Since 2001, I have administered Interactive Lecture Demonstrations (ILDs) to our first semester, calculus-based General Physics class. As part of each ILD sequence, students are asked to make a "prediction" regarding the outcome of a demonstration. Students then share their predictions with their classmates who are sitting near them, and, possibly, update their predictions as a result of their discussion. I collect these Prediction Sheets (on which the students have signed their names) at the end of the class, or if they are part of a bound volume, at the end of the term. In this presentation, I will put forward results and analysis of shifts in students' predictions related to the Kinematics and Dynamics ILDs over the last several years.

EA07: 10–10:10 a.m. Evolution of Student Knowledge: Pre, Post and in Between*

Eleanor C. Sayre, The Ohio State University; le@zaposa.com

Andrew F. Heckler

In the physics education research community, a common format for evaluation is pre- and post-tests. At The Ohio State University, we take advantage of our large class sizes by collecting more frequent data points. The data cover the first two quarters (mechanics, E&M) of a calculus-based introductory sequence populated primarily by first- and second-year engineering majors. Different subpopulations of students are evaluated every week of the quarter using a variety of conceptual and procedural tasks. Unsurprisingly for a traditional introductory course, there is little change on many conceptual questions. However, preliminary data suggest that some student ideas peak and decay during a quarter, a pattern expected from memory research yet unpredicted by pre-/post-testing.

*This research is partially supported by a grant from the Institute of Education Sciences, U.S. Department of Education (#R305H050125).

EA08: 10:10–10:20 a.m. The Effects of Testing Conditions on Pre-Post Test Results

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

Lin Ding, Albert H. Lee, Lei Bao

Pre-/post-testing with conceptual surveys is frequently used to assess student learning gains. Though it is recognized that timing and incentives can impact test results, it is difficult to control them across different studies. Pre-tests usually are administered either at or near the beginning of a course, while post-tests are given at or near the end of a course. There also is no accepted norm for offering incentives. Because these variations may change test results, it is important to study their impact. We analyzed four years of data that were collected at The Ohio State University from more than 2100 students, who were pre-/post-tested with the Conceptual Survey of Electricity and Magnetism. The time frames for giving this test had marked effects on test results, and incentive-granting had a significant influence. These results suggest that testing conditions should be carefully controlled and documented.

EA09: 10:20–10:30 a.m. On the Measurement of Scientific Reasoning Ability: A Developmental Perspective

Lei Bao, The Ohio State University; lbao@mps.ohio-state.edu

Tianfang Cai, Jing Wang, Jing Han, Kathy Koenig

Research on student scientific reasoning ability has been gaining popularity in recent years. An important area is the assessment of the reasoning ability. The Lawson's Classroom Test of Scientific Reasoning is one of a few readily available tools for measurement and has been used in several recent studies. It is then important to find out the developmental baselines on this test for students from elementary school to college levels. Using Lawson's test, we have collected data from students in both the U.S. and China. In this talk, we will present our data and analysis which allow us to determine the developmental metric of student reasoning ability spanning from elementary school level to college level. We will also discuss culturally based differences observed in this study.

EA10: 10:30–10:40 a.m. Assessing Middle School, High School, and College Students' Reasoning Ability

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

Tianfang Cai, Jing Han, Jing Wang, Lei Bao

Student reasoning ability has recently been getting the attention of educational researchers. However, an area of study that is largely untapped is how scientific reasoning abilities develop in students throughout their middle school, high school, and college years. Using Lawson's Classroom Test of Scientific Reasoning we have gathered data from middle and high school students and college students in both the United States and China. In this talk we present data that portrays student development (by grade level) of different skill dimensions of scientific reasoning. We also discuss how this data fits into a broader research plan.

EA11: 10:40–10:50 a.m. Identifying Differences in Diagnostic Skills Between Physics Students: Students' Self-Diagnostic Performance Given Alternative Scaffolding*

Edit Yerushalmi, Weizmann Institute of Science, Israel; ntedit@wisemail.weizmann.ac.il

Elisheva Cohen, Andrew Mason, Chandralekha Singh

"Self-diagnosis tasks" aim at fostering diagnostic behavior by explicitly requiring students to present diagnosis as part of the activity of reviewing their problem solutions. We have been investigating the extent to which introductory physics students can diagnose their own mistakes when explicitly asked to do so with different levels of scaffolding support provided to them. In our study in an introductory physics class with more than 200 students, the recitation classes were split into three different experimental groups in which different levels of guidance was provided for performing the self-diagnosis activities. We will present our findings regarding how well students were able to self-diagnose their mistakes in the three experimental groups.

*Supported by ISF 1283/05 and NSF DUE-0442087.

EA12: 10:50–11 a.m. Improving Self Efficacy Amongst First-Year Students Using Map Meetings

Christine Lindstrom, University of Sydney; clind@physics.usyd.edu.au

Manjula D. Sharma

Self-efficacy is a measure of a person's belief in their abilities to perform a certain task. It has been shown to relate to performance but this result has received minimal attention in tertiary physics education. Self-efficacy is important in physics because of the subject's perceived difficulty, particulalry for service teaching. A new type of tutorials, called Map Meetings, were trialed in 2006 at the University of Sydney, Australia, with first-year students without prior experience with formal physics instruction. These tutorials focused on establishing a solid understanding of the fundamental concepts. Map Meetings were offered as one extra weekly contact hour. It was found that students who did not attend Map Meetings decreased statistically significantly in self-efficacy during the semester, whereas those who attended at least eight out of 10 Map Meetings showed no statistically significant change, indicating that Map Meetings had a positive effect on these novice physics students.

EA13: 11–11:10 a.m. Equivalence of the FMCE Administered by Web and Paper

Scott W. Bonham, Western Kentucky University, Bowling Green, KY 42101-1077; scott.bonham@wku.edu

Jason Musser

Even in a proctored environment, there can be advantages of administering conceptual assessments to students through a web-based system. These include immediate scoring and minimizing possible errors by student marking incorrectly. Web-based systems can also easily handle less common formats, for example the Force and Motion Conceptual Evaluation (FMCE) which offers up to 10 choices per question. However, it is imperative that when assessments are administered in a different mode from which they were originally developed and validated, that there be a check on the validity in the new format. The validity of a web-based version of the FMCE was verified in multiple introductory physics classes at the author's institution. In each laboratory section some of the students were assigned to take the assessment on the web and the remaining ones using a paper format. Results of the analysis will be presented.

EA14: 11:10–11:20 a.m. Mechanics Baseline Test Results and Analysis at West Point

Michael P. Schock, United States Military Academy; hm3544@usma.edu*

The United States Military Academy requires all of its sophomores to take two semesters of an introductory calculus-based physics course. West Point offers more than 90 choices for an academic major, which means that our physics classes are populated with students concentrating in math, science, engineering, as well as language, history, international relations, and more. The Mechanics Baseline Test (MBT) was administered in fall 2007 near the completion of the first semester of mechanics. The MBT results for this large (N = 962) and academically diverse student population are reported and compared by academic major. We will also conduct an assessment of the MBT as a benchmark for student performance on course evaluations. A summary of results will be discussed as well as a process for future curriculum refinement, student evaluation refinement, and teaching best practices.

* Sponsored by Bryndol Sones.

Session EB: The Art and Science of Teaching

Location: ETLC E1-001 (Engineering Teaching & Learning Complex)
Sponsors: Committee on Physics in Undergraduate Education, Committee on Research in Physics Education
Date: Tuesday, July 22
Time: 9–11 a.m.

Presider: Ray Burnstein

EB01: 9–9:30 a.m. Between the Idea & the Reality: Symbolic Forms in Art & Science

Invited - David Hestenes, Arizona State University; hestenes@asu.edu

Science education is keen to promote conceptual learning. But what is a concept and what distinguishes conceptual understanding from mere rote knowledge? How does scientific meaning relate to meaning in art and literature? We will address these questions within a comprehensive theory of SYMBOLIC FORMS [1,2] with examples from mathematics, physics, art and poetry.

1. D. Hestenes, "Modeling Theory for Math and Science Education," in D. Lesh (ed.) *Mathematical Modeling ICTMA-13: Education and Design Sciences* (Indiana 2008).
2. E. Cassirer, *The Philosophy of Symbolic Forms* (Yale U. Press: (1953), New Haven. Three volumes.

EB02: 9:30–10 a.m. A New Use for Multimedia Learning in Introductory Physics

Invited - Gary Gladding, University of Illinois; geg@uiuc.edu

We have recently created multimedia learning modules for use in an introductory calculus-based electricity and magnetism course. We have designed these modules in accordance with the literature from this field of psychology. Our intention is to reduce the cognitive load students experience during their first interaction with new physics material. In particular, we present the material as narrated animations under student control. The idea is to create visual representations that reinforce the words as they are spoken so that the student can use the information from both their auditory and visual short term memories to construct their understanding. The module is structured as a pre-lecture with embedded assessment that most students require about 15 minutes to complete. After completing the pre-lecture, students submit another short assessment which we use to create the "lecture" experience. We will present "in vitro" and "in vivo" studies of the effectiveness of this learning environment.

EB03: 10–10:30 a.m. How to Improve Physics Teaching by Making It More Like Physics Research

Invited - Carl Wieman, University of British Columbia and University of Colorado; carl.wieman@ubc.ca

Physics has been a leader among the sciences in taking a research-based approach to education. I will briefly review some insights for improving teaching provided by physics education research as well as relevant research from cognitive psychology. Then I will discuss community norms of physics research, such as routine collaboration, rapid dissemination, collective standards, and peer review, and how these practices have been critical to the success and efficiency of modern physics research. Finally, the bulk of my talk will address how these norms can by adapted to the teaching enterprise to make teaching physics easier, more fun, and more effective.

Session EC: AP Physics B Redesign Update

Location: ETLC E1-017 (Engineering Teaching & Learning Complex)
Sponsors: Committee on Teacher Preparation
Committee on Physics in High Schools
Date: Tuesday, July 22
Time: 9–11 a.m.

Presider: John Eggebrecht

EC01: 9–11 a.m. Motivations, Methods, and Results for the Design of New Courses and Exams

Panel - Laurence Cain, Davidson College, Davidson, NC 28035; lcain@davidson.edu

Connie Wells, John Eggebrecht

The AP algebra-based physics course and exam are undergoing significant improvements that will support the goal of deeper understanding of essential concepts in physics. These improvements include the release of two exams no earlier that May 2012. The separate exams will cover primarily mechanics, thermodynamics, wave properties, and the inquiry and reasoning skills that reflect the scientific investigation and rational structure of these concepts. The second exam will cover primarily electricity, magnetism, fields, optics, more advanced topics in mechanics, and atomic processes. The benefits of the redesign include detailed articulations of what is and what is not in each of the courses and of expectations for student inquiry and reasoning skills. Progress toward professional development opportunities to support these changes is described.

Session ED: Tutorial: Interactive Lecture Demonstrations

Location: ETLC E2-001 (Engineering Teaching & Learning Complex)
Sponsors: Committee on Research in Physics Education,
Committee on Educational Technologies
Date: Tuesday, July 22
Time: 9–11 a.m.

Presiders: David Sokoloff, Ronald Thornton

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

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. 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 session will demonstrate—through active audience participation; Suite materials designed to promote active learning in lecture; Interactive Lecture Demonstrations (ILDs). The demonstrations will be drawn from energy, heat and thermodynamics, oscillations and waves, electricity and magnetism, light and optics. Results of studies on the effectiveness of this approach will be presented. This session should be of special interest to teachers of large lecture classes as well as those who teach small classes where only one computer is available.

Session EE: NSF-Supported Projects in the Preparation of Physical Science Teachers

Location: NRE 1-001 (Natural Resources Engineering Facility)
Sponsor: Committee on Teacher Preparation
Date: Tuesday, July 22
Time: 9–11 a.m.

Presider: Ingrid Novodvorsky

EE01: 9–9:30 a.m. Support for the Preparation of STEM Teachers—Past, Present and Future

Invited - Duncan E. McBride, National Science Foundation; dmcbride@nsf.gov

Warren W. Hein

The National Science Foundation has a history of providing support for the preparation of K-12 STEM teachers. NSF funds the development of curriculum materials to be used in the preparation of K-12 pre-service teachers such as the "Physics for Everyday Thinking," "Physics by Inquiry," and "Powerful Ideas in Physical Science" curricula. Extensive support for teacher preparation was provided through the "Collaboratives for Excellence in Teacher Preparation," and the Noyce Scholarship Program currently provides scholarships for pre-service teachers. NSF also supports pre-service teacher preparation indirectly by providing funding for projects such as "Workshop Physics," "Activity-Based Physics," and the "Tutorials in Introductory Physics" that address the learning experience for all undergraduates. Although most of the NSF support for STEM teacher preparation is provided through the Education and Human Resources Directorate (EHR), the Mathematics and Physical Sciences Directorate (MPS) provides funding as well. A good example is funding provided for PhysTEC, a joint project of APS, AAPT, and AIP, which was funded by both MPS and EHR. This presentation will provide an overview of NSF funding for teacher preparation programs with an emphasis on current and future funding opportunities.

EE02: 9:30–10 a.m. Measuring the Effectiveness of Teacher Preparation: Content, Pedagogy, and Practice

Invited - Valerie K. Otero, University of Colorado Boulder; valerie.otero@colorado.edu

The NSF-funded Learning Assistant (LA) and Noyce Fellowship program at the University of Colorado, Boulder, uses the transformation of large-enrollment science courses as a mechanism for recruiting and preparing talented science majors for careers in teaching. Through recent funding from NSF, we have embarked on a large-scale, multi-disciplinary, longitudinal research project to study the effectiveness of our LA/Noyce Fellowship program in enhancing students' content knowledge, their pedagogical knowledge, and their K-12 teaching practices. I will describe this research project and the measurement instruments we use, and present qualitative and quantitative data to support claims about the program. The presentation will conclude with a description of how our newly funded UTeach replication project (CU Teach) and the NSF-Funded Physics and Everyday Thinking project dovetail with the LA/Noyce Fellowship program toward developing an infrastructure to support the recruitment, preparation, induction, professional development, and retention of science teachers in the state of Colorado.

EE03: 10–10:30 a.m. PET as a Model for Introductory Biology and Geology Courses

Invited - George D. Nelson, Western Washinton University, Bellingham, WA 98225-9155; george.nelson@wwu.edu

As part of an NSF-funded Math and Science Partnership grant, we have developed and implemented a year-long series of science content courses for future elementary teachers based on Physics and Everyday Thinking (PET). The geology and biology courses continue the theme of energy and interactions developed through PET, and the pedagogical model mimics PET. The courses are taught on five campuses, three community colleges that feed Western Washington University, and the Northwest Indian College. Student learning results for both inservice and preservice teachers are positive. We have documented positive changes in elementary classroom science instruction and student achievement as well as differences in pre-service students in science teaching methods courses.

EE04: 10:30–11 a.m. Evolution of a K-12 Teacher Preparation Program in Physics from 1970 to Today

Invited - Lillian C. McDermott, University of Washington; lcmcd@phys.washington.edu

The Physics Education Group at the University of Washington has been engaged in the preparation of K-12 teachers since the early 1970s. For almost as many years, the group has been investigating student understanding of physics at the university level and beyond. Findings from this research have guided the development, implementation, and assessment of Physics by Inquiry,[1] a laboratory-based curriculum that has been especially designed to prepare K-12 teachers to teach physics and physical science effectively. This work has taken place in special physics courses for pre-service teachers, in annual national NSF Summer Institutes for Inservice Teachers, and in academic-year Continuation Courses that help teachers apply what they have learned at the university in their own classrooms. The Institutes have gradually evolved into a national program and the Continuation Courses into a professional community in which local K-12 teachers mutually support one another. The teacher education program and closely related projects have been supported by NSF through several divisions in the Directorate for Education and Human Resources (e.g., DUE, ESIE, DRL-K12) and by Physics in the Directorate for Mathematical and Physical Sciences.

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

Session EF: Canadian Women in Science

Location: NRE 1-003 (Natural Resources Engineering Facility)
Sponsor: Committee on Women in Physics
Date: Tuesday, July 22
Time: 9–11 a.m.

Presider: Marina Milner-Bolotin

EF01: 9–9:30 a.m. Symmetries and Broken Symmetries

Invited - Janis A. McKenna, University of British Columbia; janis@physics.ubc.ca

Symmetry not only adds beauty to nature, but it plays an important role in the laws of nature. Symmetries in nature and symmetries in the laws of physics will be reviewed, including mathematician Emmy Noether's groundbreaking work that uncovered the connection between symmetries and conservation laws. Many of the fundamental symmetries in nature are not perfect, but are broken or imperfect symmetries. Several of these will be explored, including time-reversal symmetry, chiral symmetry (left/right-handedness), charge and parity symmetries, and matter-antimatter symmetry... all of which add to the richness of the physical laws of nature as well as the beautiful world of nature.

EF02: 9:30–10 a.m. Exploring Galactic Magnetism

Invited - Jo-Anne C. Brown, University of Calgary; jocat@ras.ucalgary.ca

Just as the Earth has its own magnetic field, so does our Galaxy. This field is believed to be important in star formation and Galactic dynamics in general. The idea that the Milky Way has a magnetic field has only been around for 58 years. This, coupled with the fact that direct measurements of the field are not possible (at least, not until we invent warp engines), means very little is known about the Galactic magnetic field (GMF). Currently, my research focus is on identifying the general topology of the GMF. In my talk I will describe how we observe the GMF and present a summary of the observations to date. I will discuss how these observations have impacted our understanding of the structure and evolution of the field.

EF03: 10–10:30 a.m. X-ray Pulsars and the Search for the Supra-nuclear Equation of State

Invited - Sharon Morsink, University of Alberta; morsink@phys.ualberta.ca

Neutron stars are tiny stars with ultra-strong magnetic and gravitational fields and densities larger than nuclear. Their small size and large average densities allow them to spin at very rapid rates, with surface velocities that are a large fraction of the speed of light. In the last 10 years a new class of rapidly-rotating accreting X-ray pulsars has been discovered. I will explain why observations of this type of pulsar have the potential to constrain the properties of supra-nuclear density matter and will give an overview of recent observations and theoretical work on this problem.

Session EG: Best Practices for Teaching with Technology

Location: NRE 2-001 (Natural Resources Engineering Facility)
Sponsor: Committee on Educational Technologies
Date: Tuesday, July 22
Time: 9–11 a.m.

Presider: Tim Erickson

EG01: 9–9:10 a.m. Tablet PCs as Digital Whiteboards in a Discussion-Based Introductory Physics Class

Charles De Leone, California State University San Marcos; cdeleone@csusm.edu

Edward Price

Many active learning-based physics courses use whiteboards as a space for groups to respond to prompts based on short lab activities, problem solving, or inquiry-oriented activities. Students may then present their whiteboards during whole class discussion. Tablet PCs and software such as Ubiquitous Presenter (http://up.ucsd.edu) can be used as digital whiteboards in such a course. In a controlled study, we introduced Tablet PCs as digital whiteboards in an active-learning based introductory physics course for biologists at California State University San Marcos. This talk will describe our use of digital whiteboards, as well as their features and limitations.[1]

1. Supported by the HP Technology for Teaching Grant Initiative.

EG02: 9:10–9:20 a.m. The Impact of Digital Whiteboards in an Active Learning Introductory Physics Class

Edward Price, California State University San Marcos; eprice@csusm.edu

John Saunders, Robin Marion, Charles De Leone

Tablet PCs and software such as Ubiquitous Presenter[1] can be used as digital whiteboards in active learning classes. Compared to regular whiteboards, digital whiteboards offer added features (such as projection and automatic archiving), but also differ in important ways such as size and ease of use. To better understand these differences, we studied the use of digital whiteboards in an active-learning introductory physics course at California State University, San Marcos. In this talk we will present the preliminary results of this study, including the impact of digital whiteboards on students working in small groups, on the overall classroom environment, and on the instructor.[1]

1. Supported by the HP Technology for Teaching Grant Initiative.

EG03: 9:20–9:30 a.m. The Ubiquitous Presenter Program with Clickers

William F. Junkin, Eckerd College, St. Petersburg, FL 33711; junkinwf@eckerd.edu

Brian Smith

The Ubiquitous Presenter program is a great program for promoting classroom interaction as material is presented through whiteboard and/or PowerPoint slides with ink annotations and drawings by instructor and student (http://up.ucsd.edu/). One of its strengths is student involvement by requiring student responses. If students have computers, a polling feature is already built into the Ubiquitous Presenter program. As this presentation will demonstrate, we have created a module that can be added to this open source program so that students can respond using clickers in classrooms with no or only a few student computers.

EG04: 9:30–9:40 a.m. Captivate Your Students 24/7 with Adobe Captivate

Cheryl P. Schaefer, Missouri State University; CherylSchaefer@MissouriState.edu

Adobe Captivate has an easy-to-use format that allows you to record a presentation and its keystrokes while sitting at your desk. All you need is a computer and a microphone and you are in business. Your presentation can be recorded and placed on the web for your students to access on their own time. Use this for online courses. Use it for student enrichment. At Missouri State we are using it to record presentations on subjects that interest our major students. As each is presented, the file with the presentation goes on the departmental website to be viewed again. If you are cameraphobic, no worries. The students see the computer screen, not you!

EG05: 9:40–9:50 a.m. The Role of Physics in Engineering Education*

Roman Ya Kezerashvili, New York City Technical College, CUNY, Brooklyn, NY 11201; rkezerashvili@citytech.cuny.edu

The aim of the talk is to review the problems of modern engineering education and to discuss how some of them could be resolved by using Computer-Based Education in general physics classes. Main requirements to outcome of engineering education and aspects of the learning process are discussed and the role of information technologies in engineers' education is analyzed. A number of teaching practices as a computer-based and traditional physics laboratory, visualization, simulation, lecture and demonstration and their educational advantages are presented and analyzed. The benefits of online engineers' education in Computer Systems Technology and in Electrical and Telecommunications Engineering Technology are presented.

*Supported by U.S. Department of Education grant P120A06005.

EG06: 9:50–10 a.m. Interactive Problem Solving through Visual Programming

Lucian M. Undreiu, UVA's College at Wise, Wise, VA 24293; lmu8y@uvawise.edu

Adriana Undreiu, David Schuster

We have used LabVIEW visual programming to build an interactive problem-solving tutorial to promote conceptual understanding in physics problem solving. This programming environment is able to offer a web-accessible problem-solving experience that enables students to work at their own pace and receive feedback. Intuitive graphical symbols, modular structures and the ability to create templates are just few of the advantages this software has to offer. The architecture of an application can be designed in a way that allows instructors with little knowledge of LabVIEW to easily change its variables or personalize it. Both the physics solution and the interactive pedagogy can be visually programmed in LabVIEW. We choose a "cognitive apprenticeship" pedagogy which guides students to develop conceptual understanding and physical insight into phenomena, rather than purely formula-based solutions.

EG07: 10–10:10 a.m. Three-Dimensional, Interactive Simulations of Fraunhofer Diffraction Phenomena

John T. Foley, Mississippi State University; jtf1@msstate.edu

Taha Mzoughi

WebTOP is a 3D interactive computer graphics system developed to help instructors teach and students learn about waves and optics. Recently, we have ported several WebTOP modules to X3D, which makes the modules platform independent and offers other improvements. In this talk the new X3D modules that simulate Fraunhofer diffraction from a rectangular aperture, the intensity patterns generated by light from various sources incident upon a diffraction grating, and the Rayleigh resolution criterion are showcased.

EG08: 10:10–10:20 a.m. Technology Use in Large Introductory Physics Lecture Classes

George A. Kuck, California State University (CSULB), Long Beach, CA 90840-3901; galbertk@aol.com

Technology can help increase student learning in large introductory physics classes (> 100 students.) There is a trend in many teaching universities requiring faculty to do research, causing class sizes to grow to maintain department budgets at levels acceptable to trustees and/or taxpayers. As is well known, students do not learn as well in large classes as they do in smaller classes, requiring teaching techniques that may be distinctly different from those that are successful in small classes. Using technology can help but does not make up for the increase in class size. This talk will present how the different technology implementations have influenced learning gain, {learning gain = [(post test — pretest) / (1 — pretest)]}, the implementation limitations and the lessons learned by the author in the CSULB algebra-based physics and physical science classes.

EG09: 10:20–10:30 a.m. Research on Effective Features of Simulations and Classroom Use Implications*

Archie M. Paulson, University of Colorado; archie.paulson@colorado.edu

Wendy Adams, Kathy Perkins

The Physics Education Technology (PhET) project develops interactive, research-based simulations of physical phenomena that emphasize interactivity, animation, and context. The research base seeks a better understanding of how students learn from simulations (sims) in order to inform both simulation design and use. We will report on our recent research, involving careful study of students' interaction with a few select sims. We find that student learning can depend strongly on particular sim features and how students interact with these features, such as the capability of receiving continuous and immediate feedback. Data were collected by recording and coding interviews involving student exploration of sims covering physics topics unfamiliar to the student.

*Funding provided by Hewlett Foundation, NSF, Kavli Institute, and the Univ. of Colorado.

EG10: 10:30–10:40 a.m. Investigating Web-Based Synthetic Physics Tutoring: Research on What Works*

Chris M. Nakamura, Kansas State University, Manhattan, KS 66506-2601; cnakamur@phys.ksu.edu

Dean A. Zollman, Brian Adrian, Mike Christel, Scott Stevens

One-on-one tutoring is an effective teaching method.[1] It is not, however feasible for general instruction. Interactive technology may offer an opportunity to reap benefits associated with human tutoring. Social interactions have also been shown to have value in these types of environments.[2] An interactive web-based system that includes a social component through Synthetic Interviews may be a useful resource to augment classroom instruction. We present progress toward the development of a system designed to provide interactive feedback to high school students using Synthetic Interview technology developed at Carnegie-Mellon University. Pedagogically, the system is based on the learning cycle and is designed to address conceptual understanding and problem solving in high school mechanics and provide research data on the most effective components of the system. Methods for testing the system's efficacy will be discussed.

*Supported in part by U.S. National Science Foundation under grant numbers REC-0632587 and REC-0632657.

1. B.S. Bloom, *Educational Researcher* **13**(6), (1984) 4-16.
2. Dan Schwartz, PERC Invited Talk (Unpublished) (2007).

EG11: 10:40–10:50 a.m. Efficacy of Multimedia Learning Modules in Introductory Electricity and Magnetism

Tim Stelzer, University of Illinois; tstelzer@uiuc.edu

David Brookes, Gary Gladding, Jose Mestre

Despite the use of Just-In-Time-Teaching, preflights and clickers, students in the calculus-based sequence at UIUC rarely if ever read the textbook before attending lecture. To address this problem, we have developed web-based multimedia learning modules (MLM) for students to complete before attending lecture. This talk will describe the multimedia learning modules as well as the research that guided their design. It will also include results from a clinical study we performed that showed students using the MLMs learned more and retained that knowledge better than students using a traditional text.

EG12: 10:50–11 a.m. I Survived 46 Years Teaching with Current NY Times Web Applications

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

To inhance the teaching of physics I have for 35 years cut articles from the *New York Times* that have physics applications. I would place these articles on a page and add questions. In recent years I have been placing recent articles on the web for students to use as extra credit projects, or quiz or test questions. I have turned these news articles on science and technology into one page questions. I now have five web pages with about 30 applications and questions per page. These applications are mostly in mechanics, heat and waves. Besides the students enjoying these current web applications, this author and professor of physics for 46 years enjoys reading the *New York Times* daily with a cup of coffee. Tuesday is the best day for physics-related applications since it is the science section day for the *Times.* All the web-based questions are in MS Word and can be printed with ease. The website home for these physics applications from the *New York Times* is: http://CisePhysics.homestead.com/files/NYT.htm.

EG13: 11–11:10 a.m. Podcasting/Vodcasting Project Simulates Interest in Technical Physics

Yvonne Glanville, Penn State–Worthington Scranton; yug100@psu.edu

Podcasting and Vodcasting have been used in a technical physics class on two fronts. Firstly, podcasting was used to convey information to students using this new medium to simulate learning. Students would listen to supplementary lectures at their leisure on their ipods/mp3 players. Podcasting was seen by the students as a nonintrusive way to bring physics into their lives outside of the classroom. On the second front technical physics students have used this new medium, vodcasting, to convey information about the physics of subjects they enjoy. Specifically, the students were given a project to create a physics newscast/talk show using vodcasting.

EG14: 11:10–11:20 a.m. Supporting Distance Learners with Interactive Screen Experiments

Sally E. Jordan, The Open University, OpenCETL, Walton Hall, Milton Keynes MK7 6AA, UK; s.e.jordan@open.ac.uk

Physics students at the UK Open University experience experimental work in laboratory-based residential schools and in home-based experiments embedded within the module being studied. However students who are lacking in confidence in experimental work may require extra practice and some, especially those with a disability, may be unable to complete the experiment without assistance. This paper will describe the use of interactive screen experiments, based on photographs of real experiments in progress, to support such students. Interactive screen experiments are currently being used to support students studying the physics components of an introductory interdisciplinary science module and an associated laboratory-based residential school. Evaluation, including the observation of students using the interactive screen experiments, will be described.

Session EH: Reports from the Conference "Graduate Education in Physics: Which Way Forward?"

Location: NRE 2-003 (Natural Resources Engineering Facility)
Sponsor: Committee on Graduate Education in Physics
Date: Tuesday, July 22
Time: 9–11 a.m.

Presider: Steve Turley

EH01: 9–9:30 a.m. Preparing for a Career with a Physics Degree

Invited - Michael Thoennessen, Michigan State University; thoennessen@nscl.msu.edu

At the beginning of the year, AAPT and APS organized a joint conference on Graduate Education in Physics: Which Way Forward? More than 100 participants including department chairs, directors of graduate studies, representatives from industry as well as graduate students, discussed many different aspects of preparing the next generation physicists. Topics included "Does the Undergraduate Curriculum prepare for Graduate School," "Preparing for Non-Academic Careers," "Communication Skills and Professional Development," and "Industrial Internships." A summary of the conference will be presented.

Session EI: Teaching and Learning Upper-Level Electricity and Magnetism

Location: ME 2-3 (Mechanical Engineering Facility)
Sponsor: Committee on Physics in Undergraduate Education
Date: Tuesday, July 22
Time: 9–11 a.m.

Presider: Ernest Behringer

EI01: 9–9:30 a.m. Easing the Transition to Upper-Division E & M*

Invited - Corinne A. Manogue, Oregon State University, Corvallis, OR 97331; corinne@physics.oregonstate.edu

Why do strong students who have done well in lower-division mathematics classes suddenly have trouble applying that knowledge in upper-division physics? How can we help students develop the complex three-dimensional visualization resources that they need to solve upper-division E & M problems? How can we encourage students to make genuine symmetry arguments when employing Ampere's law, rather than just parroting the words "by symmetry, this is obvious"? We will report on upper-division curricular materials and active-engagement strategies, developed for the Paradigms in Physics Project at Oregon State University, that can be used in upper-division E & M and/or mathematical methods courses.

*Supported in part by NSF grant DUE 0618877.

EI02: 9:30–10 a.m. Improving Teaching and Learning of Upper-Level Electricity and Magnetism

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

We are investigating the difficulties that students have in learning upper-level electricity and magnetism. Our investigation includes interviews with individual students and the development and administration of free-response and multiple-choice questions. To help improve student understanding of these concepts, we are developing and evaluating tutorials. These tutorials take into account the common difficulties related to a particular topic. We will discuss the effect of this research and development project on improving student understanding.

EI03: 9–11 a.m. Student Use of Geometric Reasoning in Electricity and Magnetism Problems*

Poster - Leonard T. Cerny, Oregon State University; cernyl@onid.orst.edu

Corinne A. Manogue

In Oregon State University's junior-level Paradigms in Physics courses, a sequence of electricity and magnetism problems were chosen to encourage students to use geometric reasoning in combination with manipulation of algebraic symbols (analytic reasoning). Multiple video cameras captured students working in groups of three to solve problems. There were multiple examples of students correctly applying, incorrectly applying, or failing to apply geometric resources. This poster focuses on situations in which students productively use geometric reasoning. Specific examples of student reasoning will be presented, along with an analysis of ways in which the staging of the problem, instructor interaction, and the group process contributed to student success in using geometric reasoning to solve problems.

*Supported in part by NSF grant DUE 0618877.

EI04: 9–11 a.m. Reforming Upper-Division Undergraduate Electricity & Magnetism*

Poster - Stephanie V. Chasteen, University of Colorado at Boulder & the Science Education Initiative; stephanie.chasteen@colorado.edu

Steven J. Pollock, Ward Handley, Darren Tarshis, Paul D. Beale

Techniques like "clicker" questions and student discussion have been used successfully in introductory physics courses, but less attention has been focused on how we train physics majors and future physicists. With the goal of improving student mastery of material in upper-division courses, we have reformed an upper-division Electricity & Magnetism course using principles of active engagement and learning theory. The reformed materials include 1) Consensus learning goals; 2) Concept ("clicker") questions; 3) Interactive lecture techniques such as kinesthetic activities and whiteboarding; 4) Homework 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 comparison across courses. The learning goals and post-test were created in close collaboration with faculty (both PER and non-PER). This collaborative process and the reforms will be described. All materials are available through http://www.colorado.edu/sei.

*This work was funded by University of Colorado through the Science Education Initiative.

EI05: 9–11 a.m. Assessment of Reforms in Upper Division Undergraduate Electricity & Magnetism*

Poster - Stephanie V. Chasteen, University of Colorado at Boulder & the Science Education Initiative; stephanie.chasteen@colorado.edu

Steven J. Pollock

We are well-informed about the techniques that improve student mastery of the material in introductory physics. Instructors teaching future physicists and physics majors at the upper-division, however, must guess at how these same techniques might apply, and rely upon their own informal observations of students in order to inform their pedagogy. In addition, little research exists on common student difficulties with the content at this level. We have reformed an upper-division Electricity & Magnetism course using the principles of active engagement and learning theory to guide teaching practices, and the results of observations, interviews, and analysis of student-written work to identify student difficulties with the content. In this poster, we present data on the effectiveness of these reforms relative to a more traditional course. Comparisons are based upon course grades (exams, homeworks), attitudinal surveys, interviews, observations, a conceptual survey (the BEMA), and performance on a post-course assessment tool.

*This work was funded by University of Colorado through the Science Education Initiative.

EJ: Plenary: The Ruse and the Reality of Nanotechnology

Robert Wolkow

Location: Students' Union, Horowitz Theatre
Date: Tuesday, July 22
Time: 11:15 a.m–12:15 p.m.

Presider: Steven Turley

Robert Wolkow, National Institute for Nanotechnology, Department of Physics, Edmonton, AB; rwolkow@ualberta.ca

Nanotechnology doesn't exist yet, not substantially, not compared to what is coming. What exists today is nano-science. It is the many, diverse and substantial developments in nano-science that have created the buzz about future nanotechnology. The ability to literally see, touch and even move at will individual atoms, and the knowledge that electricity works differently when run through the tinniest wires, and the prospect of astoundingly small consumption of power and materials during the making and using of nano-devices—those are the things creating the excitement. And the excitement is well founded—there are many reasons to believe a nano-based technological revolution is coming. I will give clear examples, using real atom-scale images of some of the new capabilities we have in hand today and that we foresee having. Unfortunately, as happens when a complex subject gets summarized, some rather gross misconceptions have been popularized. There is a common notion now that anything will be possible given the new eyes and the new hands of the nanotechnologist. That is not true. I will explain through analogies to everyday experience that nanoscience and future nanotechnology is constrained by the same natural laws that have always governed. In a sense, nanotechnology strives to select out naturally occurring structures, with desirable properties, that were present all along but were diluted by many and less desirable variants.

EI06: 9–11 a.m. Student Difficulty with Vector Field Notation in Upper Level E&M

Poster - Brant Hinrichs, Drury University, Springfield, MO 65802; bhinrichs@drury.edu

An upper-level E&M course (i.e. based on Griffiths) involves the extensive integration of vector calculus concepts and notation with abstract physics concepts like field and potential. We hope that students take what they have learned in their math classes and apply it to help represent and make sense of the physics. This poster looks at how students in an upper level E&M course interpret i) mathematical notation used to represent vectors and vector fields and ii) diagrams used to represent vector fields. I present preliminary data from student interviews and paper and pencil worksheets that suggest some difficulties with interpretation are related to ambiguities in notation that are context dependent.

EI07: 9–11 a.m. Teaching Electromagnetism from a Relativistic Viewpoint

Poster - Roberto B. Salgado, Syracuse University; salgado@physics.syr.edu

Jammer & Stachel (1980) suggested that a Galilean-invariant theory of Electomagnetism [formulated by Le Bellac & Levy-Leblond (1973)] can be used as a stepping stone in a new pedagogical approach to teaching Lorentz-invariant electromagnetism. We present a formulation of this idea in the context of Spacetime Trigonometry, a new geometric framework for teaching relativity.

M. Jammer, J. Stachel, "If Maxwell had worked between Ampere and Faraday: An historical fable with a pedagogical moral," *Am J Phys,* **48**(1), 5-7 (1980).
M. Le Bellac, J.M. Levy-Leblond, "Galilean electromagnetism," *Nuovo Cimento,* 14B, 217-233 (1973) (For Spacetime Trigonometry, refer to http://www.aapt-doorway.org/Posters/SalgadoPoster/SalgadoPoster.htm).

EI08: 9–11 a.m. Improving Students' Understanding of Magnetism

Poster - Chandralekha Singh, University of Pittsburgh; clsingh@pitt.edu

We investigate student difficulties related to magnetism by administering written free-response questions and by developing and administering a multiple-choice test. We also conducted individual interviews with a subset of students. Some of these interviews were lecture-demonstration based interviews in which students were asked to predict the outcomes of experiments, perform the experiments and reconcile the differences between their predictions and observations. Some of the common misconceptions found in magnetism are analogous to those found in electrostatics. Some additional difficulties are due to the nonintuitive three-dimensional nature of the relation between magnetic field, magnetic force and velocity of the charged particles or direction of current. Another finding is that students often used their gut feeling and had more difficulty reconciling with the idea that the magnetic force and field are perpendicular to each other when they were shown actual lecture-demonstration setups and asked to predict outcomes of experiments than when they were asked to explain relation between magnetic force and field theoretically solely based upon an equation.

EI09: 9–11 a.m. Four Simple Ways to Improve Upper-Level Undergraduate Electricity and Magnetism

Poster - Tony A. Stein, Southwestern Oklahoma State University; tony.stein@swosu.edu

What does the displacement field, D, mean physically and why is it called the displacement field? What about the H field? Where are the electric and magnetic energies stored? Most importantly, what do the vector potential A and gauge invariance mean physically? Undergraduate electricity and magnetism seems to cause more questions and confusion than it answers. Just as important are the questions that should be asked but are not. How does the force get from here to there? Why is A including gauge invariance the basis of almost all higher level theories? Here I will demonstrate small changes to the electricity and magnetism curriculum that simplifies the pedagogy and reduces confusion by better answering these questions and more.

Session FA: Crackerbarrel: Professional Concerns of PER Solo Faculty

Location: ETLC E1-013
Sponsors: Committee on Research in Physics Education, Committee on Professional Concerns
Date: Tuesday, July 22
Time: 12:15–1:45 p.m.

Presider: Paul Engelhardt

Session FB: Crackerbarrel: Recruiting and Retaining Underrepresented Minorities in Physics

Location: NRE 1-001
Sponsor: Committee on Minorities in Physics
Date: Tuesday, July 22
Time: 12:15–1:45 p.m.

Presider: Daryo S. Khatri

Session FC: Crackerbarrel: There Ought to Be... (Technologies I wish I had)

Location: NRE 2-001
Sponsor: Committee on Educational Technologies
Date: Tuesday, July 22
Time: 12:15–1:45 p.m.

Presider: Leon Hsu

Ever have an idea for an activity or wanted to do something in your class that you couldn't because the required technology didn't exist, wasn't implemented in a way that you could use, or just wasn't known to you? Come join this Crackerbarrel discussion. We'll discuss ideas, share resources, invent workarounds, and brainstorm possible ways to make the technology we want a reality.

Session GA: PER: Cognition and Problem Solving

Location: ETLC E1-013 (Engineering Teaching & Learning Complex)
Sponsor: Committee on Research in Physics Education
Date: Tuesday, July 22
Time: 1:45–3:45 p.m.

Presider: Scott Bonham

GA01: 1:45–1:55 p.m. Triangular Model of Concept Structure

Pavol Tarabek, Educational Publisher Didaktis, College of Applied Economic Studies, Bratislava, Sloakia, EU; didaktis@t-zones.sk

The triangular model of physical concept structure and its four developmental levels will be presented. The model is built upon Vygotsky's theory and derived from a semantic modeling. The basic components of the model are: core C, meaning M, meaning layers

M1, M2, M3, sense S and their relationships. This model also distinguishes the concept's meaning and sense like two disjunctive sets (by Frege's idea). Based on this model, a method of cognitive analysis and modeling of concepts has started to develop. The triangular model of concept "force" on Aristotelian (pre-Newtonian, misconception) or Newtonian cognitive level will be presented. Both developmental levels will be demonstrated by answers of pupils and students of grades 6 to 12. The Vygotian phases of concept formation—complex, pseudoconcept, and concept will be presented on the concepts electric current, conductor of electric current and demonstrated by answers of students of grades 8 to 12.

The website that will accompany the paper, is www.didaktis.sk. See e-publication: Educational and Didactic Communication 2007, Vol.2, the paper: "Cognitive Analysis and Triangular Modeling of Concepts in Curricular Process."

GA02: 1:55–2:05 p.m. Novice Ontologies in Physics

Ayush Gupta, University of Maryland, College Park; ayush@umd.edu

David Hammer, Edward F. Redish

One route to understanding student difficulties in many science topics is to attend to naïve "ontologies" of science concepts—for example whether students think of heat as a material or as a process (Chi, 1994).[1] We have shown that expert reasoning often straddles ontological categories; for example, experts think about heat in ways that involve both matter-like and process-like attributions (Gupta, Hammer, & Redish, in review).[2] We have also argued that novice reasoning is not constrained to ontological categories (Gupta, Hammer, & Redish, in review). In this talk, we present our analysis of student discussions in the physics classroom to characterize the form of ontological knowledge evident in their reasoning and find connections between our everyday ontological nowledge and ontologies in physics.

1. M. T. H. Chi, J.D. Slotta, & N. de Leeuw, *Learning and Instruction* **4**, 27-43 (1994).
2. A. Gupta, D. Hammer, & E.F. Redish, E. F. (in review), *Journal of the Learning Sciences.* Available online at http://arxiv.org/abs/0802.4278.

Supported by NSF grants REC 0440113, DUE 05-24987 and DUE 0524595.

GA03: 2:05–2:15 p.m. The Specificity Effect: Implications for Transfer in Physics Learning

David T. Brookes, University of Illinois at Urbana-Champaign; dbrookes@uiuc.edu

Brian H. Ross, José Mestre

In physics instruction we often present students with an abstract principle, and then illustrate the principle with one or more examples. We hope that students will use the examples to refine their understanding of the principle and be able to transfer the principle to new situations. However, research in cognitive science has shown that students' understanding of a new principle may become bound up with the example(s) used to illustrate it. We report on a study with physics students to see if this "specificity effect" was present in their reasoning. The data show that even students who understand and can implement a particular physics principle have a strong tendency to discard that principle when the transfer task appears superficially similar to their training example. The implications of this effect for transfer and expertise will be discussed.

GA04: 2:15–2:25 p.m. Towards an Operational Definition of Abstraction in Physics Education Research

Noah S. Podolefsky, University of Colorado at Boulder; noah.podolefsky@colorado.edu

Noah D. Finkelstein

What makes an electromagnetic (EM) wave abstract? And to whom is such a wave considered abstract in theory and/or in practice? We will present an operational definition of abstraction based on the analogical scaffolding model.[1] Mental spaces, e.g. concepts, are posited as a richly interconnected system consisting of three key components: representations of an object (sign), the object itself (referent), and metal models of that object (schema). Blending theory [2] is employed as a mechanism of complex meaning making—in a blend process—two or more mental spaces (e.g. atom and solar system) are blended to create a third space with enriched meaning (e.g. "Bohr" atom). We specify abstraction as the number of blending iterations that are required in order to infer particular relations between mental space components (e.g., sign-schema relations). We distinguish between the salient understandings of individuals and how these understandings are coupled to the historically rooted community notion of abstraction in physics.

1. N.S. Podolefsky, N.D. Finkelstein (2007) *Phys. Rev. ST Phys. Educ.* Res. 3, 010109.
2. G. Fauconnier, M. Turner, *The Way We Think*, Basic Books (2003).

GA05: 2:25–2:35 p.m. Identification of Specific Cognitive Processes Used for In-Depth Problem Solving*

Wendy K. Adams, University of Colorado at Boulder; wendy.adams@colorado.edu

Carl E. Wieman

The education and cognitive science literature contains a wide range of ideas about problem solving in math and science and the teaching of scientific problem solving. Neuroscience studies provide a rich source of information about how the brain works at the cellular level and the location of brain activity while using specific processes. We use the results of research in these fields to frame the 44 specific component processes that were identified while interviewing a wide range of people solving a wide range of in-depth problems during the development of the CAPS (Colorado Assessment of Problem Solving). Understanding the component processes used in problem solving provides insight for improved teaching. We will present ways that solvers can compensate for certain weaknesses, show stoppers (processes that are required to solve a problem) and provide a sampling of cognitive processes that are needed in the real world but are not taught in the classroom.

* Supported in part by funding from National Science Foundation.

GA06: 2:35–2:45 p.m. Group Learning Interviews to Facilitate Problem Solving Using Structure Maps*

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

Fran Mateycik, David Jonassen

Research has shown that students often tend to focus on means-ends analysis rather than conceptual relationships during problem solving. Our study explored a strategy that could potentially improve students' problem-solving skills by helping them focus on the conceptual underpinnings during problem solving. We conducted a series of group learning interviews with 11 student participants who were concurrently enrolled in an algebra-based physics class. During each interview session participants were asked use a structure map—a diagram that elucidates the conceptual structure—while solving a series of problems of increasing complexity. Participants were also asked to provide us feedback and suggest modifications to improve the usefulness of the structure maps. We will present results on how the interview participants responded to the structure maps and how the structure maps evolved over the course of the semester in response to participants' suggestions.

*This work is funded in part by the National Science Foundation under grant DUE 06185459.

GA07: 2:45–2:55 p.m. Text-Editing, Problem-Posing, and Jeopardy Tasks in Introductory Physics*

Fran Mateycik, Kansas State University, Manhattan, KS 66506-2601; mateyf@phys.ksu.edu

David Jonassen, N. Sanjay Rebello

In this study we explore students' performance on four tasks completed during a semi-structured clinical interview conducted at the end of the semester. A total of 21 participants were selected from students enrolled in introductory algebra-based physics. Eleven of these students also participated in a longer study during which they received training to use concept maps while solving problems sharing similar deep-structure elements. The other 10 students served as a comparison group in our study. All 21 participants were given four tasks to complete during the interview: one problem-posing task, one Jeopardy problem task, and two text-editing tasks. Each participant was asked to complete the tasks and then describe how they worked through the tasks. In this talk we will describe the tasks and their rationale as well as the general trends in performance.

*This work is funded in part by the National Science Foundation under grant DUE 06185459.

GA08: 2:55–3:05 p.m. Cognitive Development Through Physics Problem Solving: A Taxonomy of Introductory Physics Problems

Raluca Teodorescu, George Washington University, Washington, DC 20052; rteodore@gwu.edu

Cornelius Bennhold, Gerald Feldman

Research in the cognitive processes of learning has revealed the multi-faceted and intricate nature of solving problems in physics and has identified a number of individual mental abilities needed to organize and integrate the requisite knowledge. We have created a taxonomy of physics problems (based on Marzano's New Taxonomy of Educational Objectives) that organizes existing introductory physics problems according to the cognitive processes required to solve them. This hierarchical framework is intended to help physics instructors select appropriate curricular materials once they have identified their learning objectives related to the building of basic thinking skills. It also helps problem developers categorize their problems according to the cognitive processes being fostered. This taxonomy provides a scheme for creating physics-related assessments with a cognitive component. We will report on the design of the taxonomy as well as validity and reliability studies that have been carried out during the development of this classification tool.

GA09: 3:05–3:15 p.m. Student Cognitive Development in a Thinking-Skills Physics Curriculum (Part I – Methodology)

Cornelius Bennhold, George Washington University, Washington, DC 20052; bennhold@gwu.edu

Raluca Teodorescu, Gerald Feldman

Physics education research has demonstrated the inadequacy of many traditional introductory physics curricula for developing good problem-solving skills. Students who are exposed to a broad overview of physics without much depth leave these courses lacking a coherent conceptual framework of physics principles as well as advanced problem-solving and critical thinking abilities. We have designed a "thinking skills" curriculum that aims to enhance higher-order cognitive processes in students. Based on a new taxonomy of physics problems developed by Teodorescu et al., students experience the same physics concept with problems requiring increasingly complex cognitive processes across different curricular units (homeworks, recitations, labs and exams). The students are exposed to a much wider range of problems for a given physics concept with the aim of moving them closer to an expert-like status in problem solving. This methodology can easily be adapted to other curricular settings and can be continuously adjusted throughout the semester.

GA10: 3:15–3:25 p.m. Student Cognitive Development in a Thinking-Skills Physics Curriculum (Part II – Preliminary Results)

Gerald Feldman, George Washington University, Washington, DC 20052; feldman@gwu.edu

Cornelius Bennhold, Rebecca Stein, Raluca Teodorescu

Developing thinking competency in problem solving has long been recognized as one of the primary educational objectives in introductory science courses. In order to address these objectives, there has been significant effort to trade "breadth for depth" by focusing on fewer topics but emphasizing the enhancement of scientific competencies such as structured problem solving. The instructional approach we use in our introductory course explicitly links physics problems to the higher-order thinking processes we want the students to develop, while addressing the common student complaint that the various course elements (textbook readings, lecture materials, homework problems, lab exercises) appear disjointed and unrelated to each other. We present preliminary results on improving students' thinking competence, their understanding of physics concepts and their problem-solving proficiency based on rubrics that evaluate specific cognitive processes. We also discuss different patterns of student problem-solving behavior that have emerged from these rubrics.

GA11: 3:25–3:35 p.m. Robust Assessment Instrument for Student Problem Solving

Jennifer L. Docktor, University of Minnesota, Tate Laboratory of Physics, Minneapolis, MN 5455-0112; docktor@physics.umn.edu

Ken Heller

Problem solving is one of the primary teaching goals, teaching tools, and evaluation techniques of physics courses. Unfortunately, there is no standard way to evaluate problem solving that is valid, reliable, and easy to use. Such an assessment instrument is necessary if different curricular materials or pedagogies are to be compared. This tool might also be useful to diagnose student difficulty and direct instruction. The main challenges with constructing such an instrument include defining relevant categories and obtaining evidence for validity and reliability. We will report progress on instrument development, including results from our ongoing pilot study.

GA12: 3:35–3:45 p.m. Can Scientific Reasoning Ability and Epistemological Beliefs Limit Success in Introductory Physics?

Brian A. Pyper, BYU-Idaho, Rexburg, ID 83460-0520; pyperb@byui.edu

London Jenks, Michelle Klingler, Allison Shaffer

Research in physics education is shedding new light on the relationship between scientific reasoning ability, epistemological beliefs, and conceptual change in Introductory Physics. This project collected survey data from several courses at BYU-Idaho in an ongoing effort to improve conceptual understanding among introductory physics and physical science students.

Session GB: Transforming University Physics Departments

Location: ETLC E1-001 (Engineering Learning & Teaching Complex)
Sponsor: Committee on Research in Physics Education
Date: Tuesday, July 22
Time: 1:45–3:45 p.m.

Presiders: Charles Henderson, Melissa Dancy

GB01: 1:45–2:15 p.m. Introduction of TEAL (Technology Enabled Active Learning) at MIT

Invited - John W. Belcher, MIT, Cambridge, MA 02139; jbelcher@mit.edu

Prior to spring 2003, the mainline introductory physics courses at MIT were taught in lecture recitation format with a lecture size of 300 students or more. This format had low average attendance, no laboratory component, and a high failure rate (~12%). In spring 2003 the department began teaching the mainline electromagnetism course (and later in 2005 the mechanics course) in an interactive format. Individual class sizes are around 100 students, with all five class hours in two specially designed classrooms. A laboratory component was re-introduced into the courses, and classes are a mixture of lecture with "clicker" questions, experiments, and collaborative exercises. Current average attendance rates are over 80%, and failure rates 4%. We discuss the pitfalls and difficulties that ensued in the early years of this change, including student resistance. We also discuss the changes the department is considering after six years of experience teaching in this format.

GB02: 2:15–2:45 p.m. It Starts With One: Making Change Without a Crisis*

Invited - Laurie E. McNeil, University of North Carolina at Chapel Hill; mcneil@physics.unc.edu

Significant change in a physics department (or any institution) is often precipitated by a crisis such as a decline in enrollment or a threatened withdrawal of resources. But what about inducing change when no such problems are present, and the prevailing attitude is, "it ain't broke, so why fix it?" I will discuss approaches that a change agent may utilize under such circumstances.

* Supported by NSF DUE-0511128.

GB03: 2:45–3:15 p.m. Radical Model for Instructional Reform in a Large Research Department

Invited - Wendell H. Potter, University of California, Davis; whpotter@ucdavis.edu

Guiding principle: Large-scale reform of instructional practices occurs only when significant numbers of departmental faculty have an intense personal experience with reformed teaching that then begins to change their understanding of what it means to learn and to teach. Implications of this principle include (1) the necessity of creating such teaching opportunities in a course that will involve a large number of the faculty, (2) the need to create this course prior to there being significant departmental support for such reform, (3) ensuring that the experience of teaching in the reformed course is sufficiently different to move faculty away from their comfortable traditional ways, yet safe enough to allow them to give teaching this way an honest try. We have created this kind of reformed course, Physics 7, the one-year introductory physics course taken by more than 1700 bio-science majors each year. We describe our 12-year journey down this reform path.

GB04: 3:15–3:45 p.m. Introductory Physics Reform at the University of Illinois

Invited - Tim Stelzer, University of Illinois, Urbana, IL 61801; tstelzer@uiuc.edu

Gary Gladding

Ten years ago the physics department at the University of Illinois undertook a fundamental restructuring of its introductory physics courses. We borrowed ideas such as Peer Instruction and JiTT and collaborative problem solving when possible, and developing what we needed (e.g. Interactive Examples and iclickers) when necessary. The transformation is considered a great success, with nearly 60 faculty having taught the reformed courses and students unanimous in their preference for the new format. In this talk I will briefly discuss the changes we made, with a focus on what was necessary to make the transformation effective and sustainable.

Session GC: Voices from the Classroom: Past, Present, and Future

Location: ETLC E1-017 (Engineering Teaching & Learning Facility)
Sponsor: Committe on Physics in High Schools
Date: Tuesday, July 22
Time: 1:45–3:45 p.m.

Presider: Shannon Mandel

GC01: 1:45–3:45 p.m. Voices from the Classroom: Past

Panel - James Hicks, Barrington High School (retired), Crystal Lake, IL 60012: ujhicks@juno.com

Chris Chiaverina

When the two of us first joined forces at Barrington High School in 1971, we had no idea how our meeting would affect our professional and personal lives. Sharing a common phenomenological focus, we thrived on spending after-school hours and weekends coming up with new ways of letting nature do the teaching. Exchanging ideas, providing encouragement and counsel, and fueling a mutual love of physics, we served as each other's mentor. It's difficult to say who learned more or had more fun, our students or the two of us. Whether gliding down the hall on a human hovercraft or bobbing up and down on an anti-node at a water park, students and teachers alike enjoyed an incredible ride! We look forward to sharing some of the intangibles of physics teaching that make the profession so rewarding.

GC02: 1:45–3:45 p.m. Physics Teachers Voices from the Past Present and Future: Present

Panel - John P. Lewis, Glenbrook South High School, Glenview, IL 60024; jlewis@glenbrook.k12.il.us

Trying to put your fingers around what brings pleasure to the physics teacher has always been an incredibly hard thing to do. Does it sound vain to say that one takes pleasure when she sees a student do well on the AP Exam? What about those moments in class when everything just seems to be flowing so well?

GC03: 1:45–3:45 p.m. The Future of Physics Teaching

Panel - Jaime D. Stasiorowski, Deerfield High School, Deerfield, IL 60015; jstasiorowski@dist113.org

Teaching physics is not something I thought I would do…ever! As a non-physics major, I was asked to teach freshman physics, a new course at our high school. I represent the future of physics teaching—nonphysics majors asked to teach physics. I have come to really enjoy teaching physics and love learning more and more to share with my students. Since I am still learning, I am constantly looking for physics in action in the real world. My childlike wonder has inspired my students to be always looking for physics in their lives as well. We start with an exploration in class—many times with toys they may have seen before but never thought about how they worked.

Session GD: Incorporating Writing in the Laboratory

Location: ETLC E2-001 (Engineering Teaching & Learning Facility)
Sponsor: Committee on Laboratories
Date: Tuesday, July 22
Time: 1:45– 3:45PM

Presider: Marsha Hobbs

GD01: 1:45–2:15 p.m. Learning the "Write" Way in the Physics Classroom and Laboratory

Invited - Teresa L. Larkin, American University, Washington, DC 20016-8058; tlarkin@american.edu

The educational benefits of adapting a writing approach in the classroom and laboratory have been widely documented. Writing can serve as a tool to improve the quality of teaching as well as to promote deeper and more meaningful student learning. In this presentation various strategies will be shared to demonstrate how writing can be used to enhance student understanding in introductory physics classrooms and laboratories. These strategies have been designed to address the role of writing in terms of the assessment of student learning and have been employed within introductory physics courses for nonmajors at American University for several years. One strategy involves the use of writing as a means of helping students to uncover and then confront their conceptions (or misconceptions) regarding topics being covered in an introductory level physics course. A second strategy involves a writing technique developed to bring science and engineering topics to the forefront by having students write and present a scientific paper to an audience of their peers. Time permitting, the presentation will conclude with a brief overview of a number of Classroom Assessment Techniques (CATs). CATs are formative assessments, designed to uncover the knowledge students bring with them into the classroom and laboratory.

GD02: 2:15–2:45 p.m. Reflective Writing in the Laboratory

Invited - Calvin S. Kalman, Physics/Concordia University, Montreal, QC H4B 1R6, Canada; Calvin.Kalman@Concordia.ca

The purpose of writing is to make the laboratory experience meaningful for the student. The laboratory experience should not be a rote activity in which a student manipulates some equipment and produces some acceptable numbers. It is essential that students come to understand background material about an experiment before entering the laboratory. Understanding cannot be achieved by any form of reading the material. Reflective writing ("Students Perceptions of Reflective Writing as a Tool for Exploring an Introductory Textbook," Calvin S. Kalman, et. al., *Jrnl. Of Coll. Sci. Teach.* March/April 2008 37(3),74-81) as I have developed it involves a metacognitive examination of textual material. Students understood that engaging in reflective writing enables them to determine when they do not understand a concept as it is being read and that reflective writing promotes self-dialogue between the learner's prior knowledge and new concepts.

GD03: 2:45–2:55 p.m. Writing as a Tool for Coaching Students to Think Scientifically*

Mary V. Frohne, Holy Cross College, Notre Dame, IN 46556-0308; vfrohne@hcc-nd.edu

In teaching introductory physics labs, an often-desired outcome is the enhancement of students' skills in scientific reasoning. Lab reports are the primary means of communication by which the students verbalize their reasoning to their instructors and more importantly, to themselves. By providing a flexible "lab summary" reporting format in lieu of a formal report, and by coaching students to focus on their phenomena rather than themselves, the quality of students' scientific reasoning skills can be greatly improved in a short amount of time. The coaching involves releasing students from stereotypical thinking habits as well as encouraging scientifically competent thinking. These methods have been used successfully in liberal arts physics, algebra-based physics, and calculus-based physics courses.

* Sponsored in part by the University of Notre Dame, Notre Dame, IN.

GD04: 2:55–3:05 p.m. The "Essay" Lab

Michael C. Faleski, Delta College, University Center, MI 48710; michaelfaleski@delta.edu

Research in recent years has shown that student understanding of basic circuits (light bulb / battery) is deficient in many ways. Sometimes, the conceptual misunderstandings are masked because students can solve numerical problems at the end of the chapter. One way to address misunderstandings is to have students write sentences describing the physics of circuits which have undergone a simple change such as closing/opening a switch or removing a bulb. I will share an activity that I use in my classes, dubbed the "Essay Lab" by students, in which students perform a set of standard measurements with circuit elements but have a "nontraditional" write-up associated with it. Results from assessment tools such as the CSEM and DIRECT will be presented.

GD05: 3:05–3:15 p.m. Adapting a Rubric for Formal Laboratory Reports

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

Keith Rusnak

At Miami University we hope our students learn to think critically. We developed a critical thinking rubric to use for research papers written as part of capstone courses, where students do original research. I have adapted this rubric for use with formal laboratory reports in a 100-level course, with mixed success.

GD06: 3:15–3:25 p.m. How Can Scientists Best Communicate Science to the Public?

Gordon J. Aubrecht, II, Ohio State University at Marion, Marion, OH 43302-5695; aubrecht@mps.ohio-state.edu

Communication is hard. Clear communication is harder still. Hardest of all appears to be clear communication of science to the public. Part of the problem is the virus of anti-intellectualism, but another part of the problem is encapsulated in the Pogo maxim: "we have met the enemy, and he is us." Solutions include eschewing scientific code-words; including information on methods of science and limitations of science in teaching at all levels; insisting that students giving oral explanations speak clearly; and insisting that physics students write clear essays as problem solutions. This sounds easy, but in practice is much harder than it sounds, and it may not even be effective: Demaree[1] has found that the link between writing and learning content is not obvious, and showed that students may not even be learning to write through practice in the context of physics.

1. D. Demaree, *Toward understanding writing to learn in Physics: Investigating student writing,* Ph.D. thesis, Ohio State University, 2006.

Session GE: Culturally Responsive Physics Teaching

Location: NRE 1-001 (Natural Resources Engineering Facility)
Sponsor: Committee on Teacher Preparation
Date: Tuesday, July 22
Time: 1:45–3:45 p.m.

Presider: Ingrid Novodvorsky

GE01: 1:45–2:15 p.m. How Do We Increase the Participation of Under-represented Groups In Physics?

Invited - Juan R. Burciaga, Whitman College, Walla Walla, WA 99362; burciaj@whitman.edu

To the individual teacher or faculty member, the scope of the problems facing under-represented groups in physics seems so pervasive and far-reaching that there seems to be little that any one person can do. Yet, paradoxically, the individual instructor is almost certainly the most sure path to effective and long-term change. It is in the classroom and its associated activities that we have the greatest control, the most authority and freedom. But what can an instructor do to make learning physics more open, more inclusive? How can we establish programs that can make a permanent and sustained change to the way physics is practiced? How do we create inclusive learning environments? How do we become teachers that can challenge, engage, and support a diverse student body? Perhaps most importantly? What does the individual instructor need to know?

GE02: 2:15–2:45 p.m. Research Results and Recommendations Concerning Female Students in Physics Classrooms

Invited - Patsy Ann Johnson, Dept. of Secondary Education/Foundations of Education; Slippery Rock University of Pennsylvania; patsy.johnson@sru.edu

Research about pedagogy and assessment will be summarized with an emphasis on practices shown to have a positive effect on female students. Topics will include the following: gender stereotypes and gender bias; attributions regarding success and failure; self-concepts related to learning physics; teacher expectations of students; respectful and responsive classroom environments; wait time after oral questions and answers; gender-neutral and inclusive language, diagrams, and illustrations; historical and contemporary role models; curriculum relevant to everyday life; relationship of physics to societal issues; interdisciplinary approaches to learning; history, philosophy, and epistemology of physics; cooperative and collaborative learning; building on students' prior experiences, skills, and knowledge; presentation of evidence and inferences to classmates; multiple sources of information; computer and calculator use; career information; assessment item contexts and formats; and authentic assessment.

GE03: 2:45–3:15 p.m. The ISU Urban Studies Field Trip—Community-based Clinical Experiences

Invited - Carl J. Wenning, Illinois State University, Normal, IL 61790-4560; wenning@phy.ilstu.edu

Using a small start-up grant, during the autumn of 2007 the Illinois State University Physics Teacher Education program instituted an urban studies field trip that now takes place each autumn in a high-needs secondary school. All students enrolled in the sophomore level course " PHYSICS 209—Introduction to Teaching High School Physics" are required to participate in this project. Such contextualized teaching and learning is a powerful tool for acquainting teacher candidates with a target community's culture, needs, and resources. During the Urban Studies Field Trip, teacher candidates conduct a series of clinical observations and interactions. Data collection and analysis takes place before and after the field trip. These experiences help teacher candidates better understand the problems of and potential for student teaching and teaching careers within a high-needs urban setting.

Session GF: Seeing the Universe Without Our Eyes

Location: NRE 1-003 (Natural Resources Engineering Facility)
Sponsor: Committee on Space Science and Astronomy
Date: Tuesday, July 22
Time: 1:45–3:45PM

Presider: Louis Rubbo

GF01: 1:45–2:15 p.m. The Pierre Auger Observatory and High School Cosmic Ray Research

Invited - Gregory R. Snow, University of Nebraska, Dept. of Physics and Astronomy, Lincoln, NE 68588-0111; gsnow@unlhep.unl.edu

The Pierre Auger Observatory, the world's largest cosmic ray experiment in western Argentina, has now recorded a data sample of ultra-high energy cosmic rays that exceeds the data samples of all previous experiments combined. The status of the Southern and Northern Hemipshere sites of the Observatory will be described. A striking result, published in *Science* in November 2007, is the correlation of the arrival directions of cosmic rays with energies greater than 5.6 x 10^{18} eV with nearby galaxies that have an Active Galactic Nucleus. The University of Nebraska's Cosmic Ray Observatory Project, an innovative outreach experiment that enlists high school teams in the study of cosmic ray air showers, will also be described.

GF02: 2:15–2:45 p.m. Whispers from the Cosmos: Seeing the Universe in Gravitational Waves

Invited - Shane L. Larson, Utah State University, Logan, UT 84322-4415; s.larson@usu.edu

At the dawn of the 21st century, advanced technology is providing access to the Cosmos through detection of ripples in the fabric of spacetime itself. These ripples in spacetime, called gravitational waves, carry information in the form of gravity itself. Gravitational waves carry the stories of what happens when two black holes collide, of how the inner core of a star destroys itself during a supernova explosion, and of how the graveyard of the galaxy is filled with the quiet whisper of binary white dwarf stars that spiral together ever so slowly as they fade into oblivion. This talk will explore the modern description of gravity, what gravitational waves are and how we hope to measure them, and what we hope to learn from their detection. Gravity has a story to tell, and in this talk, we'll explore some of discoveries we hope to make by listening.

Session GG: Educational Technology

Location: NRE 2-001 (Natural Resources Engineering Facility)
Sponsors: Committee on Educational Technologies, Committee on Apparatus
Date: Tuesday, July 22
Time: 1:45–3:45 p.m.

Presider: Michelle Strand

GG01: 1:45–1:55 p.m. Math Animated, a Courseware of Calculus for Undergraduate Physics Students

Samuel Dagan, Tel-Aviv University, Tel-Aviv 69978, Israel; dagan@post.tau.ac.il

A courseware, called "Math Animated," to be hosted on the web, based on a course called "Mathematical Introduction for Physicists," for undergraduate students at the Tel-Aviv University, has been developed. In addition to the text, examples and exercises, the courseware takes advantage of the modern technology of interactive and animated graphics, which makes complicated concepts easy to understand. The graphics can be projected by the teacher in class, and accessed afterward at any time by the students. The courseware covers single and multi-variable calculus, containing more than 110 interactive and animated graphics. Math Animated is technically based on non-proprietary open standards, developed at the Web Consortium (http://www.w3.org/), including the XML applications SVG (for graphics) and MathML (for mathematical expressions). This makes Math Animated accessible via the web without the need of any particular software.

GG02: 1:55–2:05 p.m. Computer Simulation to Teach Compositions of Color and Sound

Junehee Yoo, Department of Physics Education, Seoul National Univer-

sity; yoo@snu.ac.kr

Jaebong Lee, Jeongwoo Park, Sungmuk Lee

Two web-based activities are developed to promote scientific concepts of compositions of light and sound. Concepts in superposition of waves and spectrum as well as perception are involved. Students expect the resultant colors and sounds, and then perceive the results, displayed by the simulation. The performances of the 7th grade students are investigated by questionnaire and video taping.

GG03: 2:05–2:15 p.m. WebTOP: Waves and Optics Learning Activities Using X3D

Taha Mzoughi, Kennesaw State University, Kennesaw, GA 30144; tmzoughi@kennesaw.edu

John T. Foley

WebTOP is a 3D interactive computer graphics system developed to help instructors teach and students learn about waves and optics. Topics addressed by WebTOP include waves, geometrical optics, reflection and refraction, polarization, interference, diffraction, lasers, scattering 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. In addition, WebTOP includes several highly interactive guided tutorials. To help ensure that WebTOP modules abide by current standards for 3D web visualization, we are porting the modules to X3D, the new standard for displaying 3D computer graphics. X3D replaces the Virtual Reality Modeling Language (VRML) and offers several new enhancements. Most noteworthy is the fact that X3D based applications do not require the use of a plug-in and they can run on all popular computer platforms (Windows, Mac and Linux). We will use the presentation to demonstrate several of the new X3D WebTOP modules and the other resources available through WebTOP. WebTOP is sponsored in part by the National Science Foundation (DUE 0231217).

GG04: 2:15–2:25 p.m. Videos of Physics Demonstrations

Farhang Amiri, Weber State University, Ogden, UT 84408-2508; famiri@weber.edu

Ronald Galli

We have produced a comprehensive library of physics demonstrations. These computer videos of approximately 200 physics concepts, average about five minutes each and encompass almost all topics that are covered in the standard lower division physics courses. This presentation will involve a discussion of how the demonstration videos were conceived, developed, and produced. We will describe how the movies can be accessed and viewed by faculty and students. Also, we will discuss various ways in which the videos can be put to use. Samples of the demonstration videos will be shown.

GG05: 2:25–2:35 p.m. A Case Study in Video Analysis: A Frontal Crash Test and Impulse

David J. Palazzo, U.S. Military Academy; david.palazzo@usma.edu

Bryndol Sones

The United States Military Academy Department of Physics has explored various uses of the video analysis program LoggerPro. Our motive is to export the analysis of mechanical phenomena to the students domain, their dorm room. We attempt to connect the classroom to our student's world. This has encouraged our students to analyze everyday phenomena that might otherwise go unexplored. We present a video analysis case study from the fall 2007 introductory calculus-based mechanics course where students analyzed a frontal crash test of a military vehicle. Using the principle of impulse, students directly measure the National Highway Transportation Safety Administration's metric the "Head Injury Criteria." We summarize our lessons-learned from this case study as well as present preliminary data that suggest that "context-rich" video analysis projects help students make the link between classroom physics and playground physics.

GG06: 2:35–2:45 p.m. Using Video Analysis in an Interdisciplinary Calculus-Physics Course

James J. Carroll III, Eastern Michigan University, Ypsilanti, MI 48197; jcarroll@emich.edu

Kim Rescorla

Eastern Michigan University (EMU) students enrolled in Calculus II and/or Physics I participated in an interdisciplinary course as part of a project titled "Creative Scientific Inquiry Experience: Developing an Integrated Science Curriculum." [1] The team-taught, one-hour seminar course was designed to link concepts and principles in calculus to applications in physics. Each week students used video analysis software to investigate the mathematics and physics underlying motion. Video analysis provides a visual tool for linking graphical analysis with observed motion. The course concluded with students presenting their own video-based research projects. An overview of the course and the weekly projects will be presented.

1. National Science Foundation Grant #0525514.

GG07: 2:45–2:55 p.m. Real Life Data Using 3-D Simulations in the Laboratory

Adam S. Thompson, Arizona State University, Tempe; adam.thompson@asu.edu

Kevin L. Gibson, Robert J. Culbertson

Digital videos and Vernier's Logger Pro® with an assortment of hardware can be used alongside Vpython, the Python programming language with a 3-D interface module called "visual," to create interesting and fruitful learning experiences in the laboratory. Students perform somewhat standard experiments using Vernier's equipment and import their collected data from Logger Pro into Vpython. Then they conceive of mental models of the apparatus and interactions present in the experiments and program those models into Vpython. The student models (theory) seemingly come alive alongside an animation based on the collected data (experiment). Students can then adjust and improve their models on the spot. Models can be created that are increasingly complex, allowing for phenomenon ranging from multi-body gravitational orbits, atomic bonding, and wave transmission through a medium, to circuits, optics, and diffraction through gratings.

GG08: 2:55–3:05 p.m. Web-Based Computer Simulations for Physics Laboratory

Raj Boora, University of Alberta; raj.boora@ualberta.ca*

Chunyan Zhang, Isaac Isaac

The classic lab environment is integral to many physics programs. However, due to the high enrollments, limited time in the lab, unfavorable instructor-student ratios, access to lab resources can often be difficult. Virtual Physics Lab Experiments are a computer-based solution to some parts of this problem. Created in Flash and accessed over the web, these fully interactive labs allow students to explore a lab environment that provides real-time results just as they would experience in a real lab. Intended to improve undergraduate physics lab effectiveness by building critical thinking skills and improve comprehension of content presented in the existing lab manual, students and instructors have found these simulations to be a valuable tool.

* Sponsored by Isaac Isaac.

GG09: 3:05–3:15 p.m. An Online Lab Experience for Physics Students

Melissa A. Vigil, Marquette University, Milwaukee, WI 53201-1881; melissa.vigil@mu.edu

Marlin Simon, David Lloyd, Jeanne Finstein, John Baro

Polyhedron Learning Media, Inc. has created an online lab experience for college or AP level introductory physics. Each online lab contains everything needed to conduct the experiment: background information, theory, objectives, procedures, a video overview of the experiment, and post-lab assessments. Data collection, analysis, graphing, and reporting tools allow students to perform all phases of the experiment online using simulated equipment that is more realistic than currently available java applets. Students in algebra- and calculus-based courses at Auburn University took part in a study of the prototype labs. Post-test scores of students using the virtual labs (either alone or with TA assistance) were not significantly different than those who completed the hands-on version in a traditional lab setting. An unanticipated advantage of the virtual labs was the time savings of ~33%.

GG10: 3:15–3:25 p.m. Wikis as a Medium for Collaborative Lab Reports

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

Wiki technology allows many individuals to change the same document. Further, Wiki software keeps copies of each version so that one can look at the history of changes. Thus, in addition to providing a mechanism for collaborative resources, such as Wikipedia, the Wiki technology is useful for other types of collaborative work. Using a freely available Wiki (http://pbwiki.com/) we have experimented with using Wikis to help students prepare lab reports in a physics course. The instructor loads each lab write-up, in a tutorial format, to the Wiki. Students then modify the write-up and turn it into a report on their experiment. By starting with the instructor's writeup the students are not required to repeat information state elsewhere. This has both advantages and disadvantages. The history provides us with an indication of the contribution of each student. Our first semester of experience will be reported.

GG11: 3:25–3:35 p.m. Successes and Challenges of Introductory Physics Homework Discussion Boards

Craig C. Wiegert, University of Georgia, Athens, GA 30602-2451; wiegert@physast.uga.edu

Introductory physics courses lend themselves well to web-based homework submission and grading, through systems such as LON-CAPA, WebAssign, and Mastering Physics. These course environments usually offer discussion boards or interactive chat features; however, these abilities are as often as not disabled by the instructor due to fears of possible abuse, especially when constant monitoring is infeasible. I will describe the pitfalls and successes encountered in the first year of using a largely unmoderated homework discussion board for introductory physics courses, and will discuss the effects observed so far in student attitudes and learning.

GG12: 3:35–3:45 p.m. Can Students Receive Quality Tutoring From On-line Homework Forums?

Brett van de Sande, University of Pittsburgh; bvds@pitt.edu

Carla van de Sande

An increasingly popular method for students to obtain homework help is to post their questions on open, free homework forums. A number of questions come to mind: Do students get timely, accurate advice or are the replies filled with errors? Does the tutoring follow good pedagogical techniques or do students just receive worked solutions? We explore the quality of tutoring on English-speaking, open, free physics forums. We find that students receive a reply in approximately a half hour, that the tutoring contains few errors, and that tutors encourage students to engage in active learning. We find that the surprisingly high quality of the tutoring is due to explicit forum policies, along with the fact that the tutors form a community of practice: they monitor each others' work, correct errors, and learn from each other. We discuss implications for students, for teacher training, and for education research.

GJ: Ceremonial Session: Robert A. Millikan Award

Eric Mazur, Millikan Award Recipient

Location: Students' Union, Horowitz Theater
Date: Tuesday, July 22
TIme: 4–5 p.m.

Presider: Harvey Leff

Eric Mazur, Harvard University, Division of Engineering/Applied Science, Cambridge, MA 02138-2901; mazur@physics.harvard.edu

The Make-Believe World of Real-World Physics

That physics describes the real world is a given for physicists. In spite of tireless efforts by instructors to connect physics to the real world, students walk away from physics courses believing physicists live in a world of their own. Are students clueless about the real world? Or are we perhaps deluding ourselves and misleading our students about the real world?

Session GH: Rethinking the Upper-Level Curriculum

Location: NRE 2-003 (Natural Resources Engineering Facility)
Sponsors: Committee on Physics in Undergraduate Education, Committee on Laboratories
Date: Tuesday, July 22
Time: 1:45–3:45 p.m.

Presider: Ernie Behringer

GH01: 1:45–3:45 p.m. Missing Matter in the Undergraduate Physics Curriculum*

Panel - Bruce A. Sherwood, North Carolina State University, Raleigh, NC 27695; basherwo@unity.ncsu.edu

The undergraduate curriculum in most physics departments (over) emphasizes mathematical physics, with anonymous 3-kg masses and 5-microcoulomb charges. But aluminum is different from lead, and these differences are an important part of physics. Matter is considered in topic courses (elementary particles, nuclei, atoms, solids, stars), but typically not in the big core courses, which loom very large to students. There is an unhealthy compartmentalization among the core courses. For example, the intermediate mechanics course typically doesn't make connections to quantum mechanics or E&M. Opportunities are lost to emphasize the unity and reductionist nature of physics. One way to break down the barriers, and to provide better balance, is to introduce homework problems that deal with real matter, and that integrate different areas of physics. We'll look at several different genres of problems that involve the properties of real matter, and which are under-represented in the typical undergraduate curriculum.

*Supported in part by NSF grant DUE-0618504.

GH02: 1:45–3:45 p.m. Paradigms in Physics: Facilitating Cognitive Development in Upper Division Courses

Panel - Elizabeth Gire, Oregon State University, Corvallis, OR 97330; giree@physics.oregonstate.edu

One of the primary goals of upper-division physics courses is to facilitate the cognitive development students need to work as physicists. The Paradigms in Physics (junior-level courses developed at Oregon State University) address this goal by coaching students to coordinate different modes of reasoning, highlighting common techniques and concepts across physics topics, and setting course expectations to be more aligned with the professional culture of physicists. The Paradigms integrate several modes of instruction: active engagement, didactic lecture, lab activities and computer visualization. As a post-doc, I've co-taught the six core Paradigms and have been working on a project to disseminate Paradigms materials to other instructors/ institutions. In this talk, I'll discuss my experiences teaching in the Paradigms and what I' ve learned about meeting the needs of upper-division students.

GH03: 1:45–3:45 p.m. What's So "Advanced" About the Advanced Lab?

Panel - David A. Van Baak, Calvin College, Dept. of Physics and Astronomy; Grand Rapids, MI 49546; dvanbaak@calvin.edu

The upper-level undergraduate curriculum in physics has for many decades traditionally included a "modern physics laboratory" or "advanced lab" course, or courses. This presentation puts such laboratory courses in perspective, not only against the context of theoretical courses and research experiences, but also in relation to conceptual and personal development in the students they serve. The content and curriculum of advanced-lab courses will necessarily differ among institutions, in part because of particular resources that might be locally available, but there are still some general observations of the aims and methods of such courses, the character and organization of such courses, and even the student experiences in those courses, that are worthy of summary.

Session GI: 400 Years Since Galileo

Location: ME 2-3 (Mechanical Engineering Building)
Sponsors: Committee on Space Science and Astronomy, Committee on History and Philosophy of Physics
Date: Tuesday, July 22
Time: 1:45–3:45 p.m.

Presiders: Susana Deustua, Jordan Raddick

GI01: 1:45– 2:15 p.m 400 Years Since Galileo

Invited - Jordan Raddick, Johns Hopkins University, Baltimore, MD 21218; raddick@jhu.edu

In 1609, Italian scientist Galileo heard reports of a recent Dutch invention to magnify faraway objects—what we would today call a "telescope." Fascinated, he began to build his own. Over the next two years, Galileo used his telescope for an amazing period of scientific discovery—he discovered peaks and valleys on the moon, spots on the Sun, phases of Venus, and four moons orbiting Jupiter—the last of which provided the first unmistakable evidence supporting Copernicus's idea of a Sun-centered Solar System. In the last 400 years, other scientists have followed Galileo, and have used better telescopes to make even more amazing discoveries about our universe. In this talk, I will give a brief history of astronomy since Galileo, focusing on the interlocking stories of improving instruments and the insight of scientists using observational evidence to learn about the universe.

GI02: 1:45–3:45 p.m. The Meaning of Thought Experiments in Physics and Its Implications to Physics Teaching

Poster - Igal Galili, Science Teaching Center, The Hebrew University of Jerusalem; igal@vms.huji.ac.il

Thought experiments are abundant in physics teaching, but their status and meaning is often fuzzy and unclear to physics teachers and students. The misinterpretation of the meaning of historical experiment of falling bodies, discussed by Galileo, might be indicative when it is stated that it proves the equal acceleration of free falling by heavy and light object. The confusion is due to neglecting of definition of thought experiment. Such a definition could be provided by variation of meaning in two conceptual dimensions thought and experiment (Galili 2007). This approach produces a family of close mental activities that are often confused in teaching physics as well as in literature of physics teaching research. We will exemplify these mental constructs by producing them regarding the common problem of ballistic motion. Galili, I. (2007). "Thought Experiment--establishing conceptual meaning," Science & Education, http://www.springerlink.com/content/p80643648020310v/.

GI03: 1:45–3:45 p.m. The International Year of Astronomy at BYU

Poster - Eric G. Hintz, Brigham Young University, Provo, UT 84602; doctor@tardis.byu.edu

Michael D. Joner

Over the course of the International Year of Astronomy, the Astronomy Research Group is planning a number of displays and activities. We will have a display of historical astronomy texts, including a first edition of Galileo's Dialogo dei Massimi Sistemi at the special collections area of our library. We are also planning a display of astronomical art, a telescope display in the science center, and a number of faculty lectures. These events will be open to the general public, but also be designed to support our introductory astronomy classes. Finally we are looking at involving the public in real research projects using our newly installed 0.9-m telescope and other research facilities.

Session PST4: Poster Session IV: PER: Introductory Course/Student Understanding of Specific Topics / Assessing Student Understanding / Issues in Instructional Reform

Location: ETLC, Solarium
Date: Tuesday, July 22
Time: 5–6 p.m.

PST4-01: 5–6 p.m. A Critical Analysis of Embedded Assessment of a Large-Scale Curriculum Reform

Wendi N. Wampler, Purdue University; wamplerw@purdue.edu

Lynn A. Bryan, Mark Haugan

Our research focuses on the use of embedded assessments to gauge student learning in a reformed introductory physics course that is a large-scale implementation of the Matter and Interactions curriculum [Chabay and Sherwood, Wiley (2007)]. In this study, we examined the characteristics of 39 instructor-designed and instructor-chosen/textbook-based free-response examination problems using qualitative analysis based on literature and open coding procedures. Findings of significance that emerged from our analysis related to the primary concepts assessed (e.g., a fundamental physics principle), the secondary concepts or skills assessed (e.g., a problem-solving learning goal), the level of scaffolding provided and explication of goal/problem statement. We found that inconsistencies in problem style, structure and emphasis, in the way in which primary and secondary goals are assessed and problematic scaffolding can compromise embedded assessment of student understanding and problem-solving skills. Our results have implications for embedded assessment design beyond the Matter and Interactions context.

PST4-02: 5–6 p.m. Assessment of General Education Objectives in Physics Courses

Lynn Aldrich, Misericordia University, Dallas, PA 18612; laldrich@usnetway.com

The assessment of whether students are meeting the general education objectives of an institution of higher education is becoming more common. The Middle States Accreditation process in the United States requires colleges and universities in the region to gather and analyze data showing whether courses, which are part of a general education requirement, are meeting the general education goals and objectives of the college or university. This talk will discuss the first year of a five-year plan to assess how well an introductory algebra/trig physics course meets some of the core curriculum objectives of Misericordia University. A rubric was designed and trialed to score the goal: Students will be able to use mathematics as a means of communicating ideas and relationships. The talk will discuss the design and modification of the rubric, and the results of the first year assessment of this goal.

PST4-03: 5–6 p.m. Expanding Learning Opportunities: The Value of Students' Own Experiments*

Maria R. Ruibal-Villasenor, Rutgers University, New Brunswick, NJ 08901; mruibal@eden.rutgers.edu

Anna Karelina, Eugenia Etkina

Traditionally in introductory physics laboratories, students' role is limited to following the directions provided in step-by-step handouts. Their activities are very far from the work of physicists who have to make innumerable decisions during their investigations such as when designing experimental procedures, making assumptions, minimizing uncertainty, interpreting the data, hypothesizing explanations, testing their hypothesis and solving experimental problems. We believe that if students have the opportunity to experience laboratories closer to the practice of real science—by having to design their own experiments—their learning opportunities would be greatly enriched. 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 the help of instructors, to explore students' approaches, interactions and reasoning.

* This work was supported by the NSF grant DRL0241078.

PST4-04: 5–6 p.m. What Knowledge Converts D to A?

Analia Barrantes, MIT, Cambridge, MA 02478; analiab@mit.edu

David E. Pritchard

We have compared performance of students scoring 1 standard deviation below average (D group) with students scoring 1 standard deviation above average (A group) on final exam problems requiring analytic solutions, some also requiring a written plan of attack. By classifying students' solutions on the basis of the extent to which they identified the relevant physical principles in the problem, we found that typically only 34% of the D group met this criterion vs. 80% of the A group. We also found that students' written plans of attack closely correlated with their analytic solutions. We suggest that our typical "one topic per week" organization of the course does not prepare students to identify the physical principles that apply to a problem that might cover any of a broad range of topics. We discuss implications of these findings for course organization and pedagogy.

PST4-05: 5–6 p.m. Effect of a PER-Based Textbook and Online Tutoring Systems on Two-Year College Students

Tom Carter, College of DuPage, Glen Ellyn, IL 60137;carter@fnal.gov

Trevor Smith, Michael Wittman

I will compare indicators of student knowledge and performance from 1) a class using the newer PER based textbook by Knight and the associated MasteringPhysics online tutoring system, 2) a class using the more standard text by Halliday, Resnick and Walker and a less complex online tutoring system, and 3) a class using the more standard text and paper homework. Indicators of student performance will include average normalized gain on the FCI, performance on a locally produced standardized exam and fraction of students successfully retained in the class.

PST4-06: 5–6 p.m. Modeling-Based Physics Courses as a Vehicle for Physics Community Reform*

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

Eric Brewe, George O'Brien, Jeffery M. Saul

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.

* Work supported by NSF Award #0312038 and also by the FIU PhysTEC Project, a grant from APS, AIP, & AAPT.

PST4-07: 5–6 p.m. Investigating the Conceptual Content of Major Physics Textbooks

John Stewart, University of Arkansas; johns@uark.edu

Richard Campbell

The conceptual problem content of the electricity and magnetism chapters of seven physics textbooks was investigated. The textbooks presented a total of 1600 conceptual electricity and magnetism problems. The solution to each problem was decomposed into its fundamental reasoning steps. These fundamental steps are, then, used to quantify the distribution of conceptual content among the set of topics common to the texts. The variation of the distribution of conceptual coverage within each text is studied. The variation between the major groupings of the textbooks (conceptual, algebra-based, and calculus-based) is also studied. A measure of the conceptual complexity of the problems in each text is presented. A measure of the degree each problem is conceptual is also presented.

PST4-08: 5–6 p.m. Measuring Students' Connections Between Physics and Real-World Problem-Solving*

Mathew Martinuk, 4368 West 14th Ave., Vancouver BC V6R 2Y1; martinuk@physics.ubc.ca

A major goal of introductory physics education is improving students' ability to apply their scientific knowledge to situations they encounter outside their physics class. However, prior research shows a decline in students' belief in the real-world relevance of physics after introductory physics instruction, which may prevent them from ever attempting to utilize their knowledge. To address this disconnect, UBC's introductory physics course for non-majors was completely revamped in fall 2007. The course curriculum was reworked to present physics in terms of real-world issues of energy and climate change and applications of physics were emphasized through classroom examples and context-rich tutorial problems. This presentation focuses on measuring the impact of these changes on student attitudes and problem solving skills. A survey is presented.

* This work is supported by the Carl Wieman Science Education Initiative.

PST4-09: 5–6 p.m. Student Understanding of Force, Velocity, and Acceleration: Is It Hierarchical?

Rebecca J. Rosenblatt, Ohio State University; rosenblatt.13@osu.edu

Eleanor C. Sayre, Andrew F. Heckler

We describe our effort to design and implement an instrument to systematically test student conceptual understanding of simple relationships among force, velocity, and acceleration. While there have been a significant number of studies on this topic, here we focus on determining whether there is a hierarchy of understanding among these variables. For example, can students understand that net force and velocity need not be in the same direction, without first understanding that acceleration and velocity need not be in the same direction? We explore different variations of question formats and find a format that is reasonably valid and reliable. Preliminary results indicate that there may be some hierarchies in student understanding of moderate to weak strength. We describe experiments in progress designed to further test these results.

PST4-10: 5–6 p.m. Using EMField6* to Promote Student Understanding of Superposition in the E&M Lab

Andrew Boudreaux, Western Washington University; boudrea@physics.wwu.edu

James Stewart, Steven Kreft

At Western Washington University, efforts are under way to implement research-based laboratory curriculum in the introductory calculus-based physics course. When possible, existing, well-tested curricula such as Real Time Physics** and Tutorials in Introductory Physics are being adapted. Assessment of student learning is integral to the project. This poster will provide a brief overview of the labs and will present assessment results from CSEM. A closer look at the laboratory on the superposition of electric fields will then be taken. Documented student difficulties with superposition have been used to inform the design of instruction. Students are guided through a cycle of predict-observe-explain, using the simulation program EMField6.

*Program by David Trowbridge and Bruce Sherwood, 1998;
**David Sokoloff

PST4-11: 5–6 p.m. Student Understanding of P-V Diagrams and Conceptions about Integration

Evan B. Pollock, University of Maine; evan.pollock@umit.maine.edu

Brandon R. Bucy, John R. Thompson, Donald B. Mountcastle

As part of ongoing research into upper-level undergraduate student understanding of thermodynamics at the University of Maine, we report on students' understanding of thermodynamic work, internal energy and the associated mathematics. New interview data of physics majors, as well as written data obtained in a Calculus III class, support our previous findings[1] and provide for a more in-depth look into factors impacting student difficulties with thermodynamic quantities. Analysis of written and interview data has revealed student conceptions about integration that might otherwise be interpreted as conceptual difficulties with the physics. The data suggest that students' application of the state function concept to thermodynamic work may be due in part to incorrect conceptions regarding integration. The data also suggest that students lack the correct mathematical foundation of the state function concept, which may be a factor in its indiscriminate application.

1. E. B. Pollock, J. R. Thompson, and D. B. Mountcastle, *Student Understanding Of The Physics And Mathematics Of Process Variables In P-V Diagrams,* AIP Conf. Proc. 951, 168 (2007). Work supported in part by NSF Grants #PHY-0406764 and #REC-0633951.

PST4-12: 5–6 p.m. Identifying and Addressing Partial Differentiation Difficulties in Calculus and Thermodynamics*

Brandon R. Bucy, University of Maine; brandon.bucy@umit.maine.edu

John R. Thompson, Donald B. Mountcastle

We have reported previously that upper-level thermodynamics students demonstrate an inability to correctly equate the mixed second-order partial derivatives of the state function of volume (nonzero quantities in general), arguing instead that these derivatives must identically equal zero.[1] Here we document the presence of this difficulty among students enrolled in a multivariable calculus course. Data were gathered via diagnostic questions structurally identical to those administered in the thermodynamics course, yet devoid of physical context. We additionally present a guided-inquiry tutorial sequence that was specifically developed to address this and related student difficulties with partial derivatives encountered in our research. The sequence uses a graphical interpretation of partial derivatives in the context of an ideal gas P-V-T surface to bridge the abstract mathematical concepts with concrete physical properties. Preliminary results indicate that the sequence effectively addresses the above difficulty, and also positively impacts student performance on related topics.

* Research supported in part by NSF Grants #PHY-0406764 and #REC-0633951, and by the Maine Academic Prominence Initiative.
1. B.R. Bucy et al., 2006 Phys. Educ. Res. Proc. 883, 157 (2007).

PST4-13: 5–6 p.m. Assessing the Concepts of Integration and Differentiation in Multivariable Calculus

Warren M. Christensen, University of Maine; warren.christensen@umit.maine.edu

John R. Thompson, Donald B. Mountcastle

Previous work on students' understanding of graphical interpretation of slope, derivative, and area under curves in various physics contexts has shown substantial difficulties, most notably in kinematics.[1]

Concurrently, several reports point toward students' lack of algebraic acumen as a likely cause for their low achievement in a physics classroom.[2] In order to see if some of the documented issues arise from being asked mathematical questions about single- and multivariable calculus concepts in a physics course, we administered a brief survey on these basic concepts to students near the end of multivariable calculus. Some of the questions are based on our earlier work in thermal physics that are essentially stripped of their physics content. Initial findings show that even after three semesters of university-level calculus students struggle with basic concepts of integration and derivative. Individual survey items and summative scores will be presented.

1. Beichner, *Am. J. Phys.,* **62** 750 (1994).
2. Meltzer, *Am. J. Phys.*, **70** 1259 (2002).

*Supported in part by NSF Grants PHY-0406764, REC-0633951, and the Maine Academic Prominence Initiative.

PST4-14: 5–6 p.m. Student Understanding of Measurement and Uncertainty in Quantum Physics

Charles R. Baily, University of Colorado at Boulder; Charles.Baily@Colorado.EDU

Noah D. Finkelstein

Students in our introductory physics courses appear to be learning classical physics in a way that promotes a local-realist perspective—one where physical quantities such as position and momentum have well-defined values at all times. Such a perspective can be problematic for students as they learn quantum physics: a shift away from the realist position is required when learning to interpret what it means to measure a quantum observable. We document this shift through pre/post-instruction evaluations of student beliefs using the CLASS survey. We further examine responses to coupled exam questions designed to characterize several aspects of "quantum sophistication" in students: their ontological commitments in the context of both classical and quantum uncertainty; their epistemological commitments through the degree of sense-making used in support of their positions; and their understanding of completeness in quantum theory.

PST4-15: 5–6 p.m. Scientific Reasoning Skills in Introductory Science Classes: A Preliminary Study

Kimberly A. Shaw, Columbus State University, Columbus, GA 31907; shaw_kimberly@colstate.edu

Zodiac Webster

Success in physics, or in science, requires an ability to reason logically and consistently using a premise or hypothesis. However, the reasoning skills so necessary for success may not be common among incoming students to universities currently. Identifying factors contributing to the poor performance of students in STEM courses is a necessary step in improving the learning of students in those courses. However, college science and math faculty may be unaware of these developmental milestones and may make the incorrect assumption that all students in their classrooms are equally ready to tackle the cognitive tasks required for reasoning in science and math. Faculty teaching STEM courses at Columbus State University have administered Lawson's Classroom Test of Scientific Reasoning[1] to their students. Preliminary results and future directions of the study will be presented.

1. A.E. Lawson, *Journal of Research in Science Teaching*, **15**(1) pp. 11-24.

PST4-16: 5–6 p.m. Student Scientific Reasoning Ability and Academic Performance

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

Tianfang Cai, Jing Han, Jing Wang, Lei Bao

Although students' general abilities of learning have attracted much attention recently, the relationship between scientific reasoning ability and academic performance remains essentially unexplored. We investigated this relationship for students at multiple grades levels including middle school, high school, and college. Lawson's Classroom Test of Scientific Reasoning was used to measure students' scientific reasoning ability and student performance data was gathered in the form of exam scores from math and/or science classes. Gender and ethnicity data was gathered when possible. This poster presents a summary of our findings in addition to next steps for this important area of research.

PST4-17: 5–6 p.m. Assessing Scientific Reasoning Ability: Analysis of Skill Dimensions

Lei Bao, The Ohio State University; lbao@mps.ohio-state.edu

Tianfang Cai, Jing Wang, Jing Han, Kathy Koenig

Students' general ability in reasoning such as scientific reasoning, logical reasoning, and critical thinking has been intensely studied for decades by psychologists, cognitive scientists and education researchers. A number of standardized instruments have also been developed and adopted by researchers and educators. In this presentation, we will review popular work and derive an operational definition of skill dimensions for scientific reasoning ability from the perspective of discipline-based education research. Based on the definition, we will compare several existing instruments on how specific skills are measured and discuss examples of student performances on these skill dimensions.

PST4-18: 5–6 p.m. The Effect of Accompanying Figures in Force Concept Inventory on Students' Response

Jinsu Hwang, Korea National University of Education, South Korea; vidon@hanmail.net

Jung Bog Kim, Jaesool Kwon

Force Concept Inventory (FCI) tool has been used to investigate students' conceptions on force, however, we have found that some problems do not give enough information to figure out an exact meaning. We have tried to modify or insert figures into the original FCI. Improved FCI has diagnosed effectively students' conception.

PST4-19: 5–6 p.m. Fine Structure of the Force Concept Inventory

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

Richard D. Dietz, Matthew Semak

At the start of the 2007 fall semester, two introductory physics classes (n = 114) at the University of Northern Colorado took the Force Concept Inventory (FCI) and the Lawson Classroom Test of Scientific Reasoning Ability. Both groups also took the FCI again at the end of the semester. Information about each student's gender and high school preparation in mathematics and physics was also collected. Several previous investigations of the improvement in FCI scores (and its correlations) have focused only on the total score. We present an analysis of the students' improvement on each question on the FCI and how it correlates with other factors.

PST4-20: 5–6 pm. A Comparison of Two Researched-Based Conceptual Surveys: CSEM and BEMA

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

We measured pre-post learning gains in a large large-enrollment (n = 425) Calculus-based Physics II course, randomly assigning half the class to the Brief Electricity and Magnetism Assessment (BEMA)[1] instrument (for which we have seven earlier semesters of data), and half taking the Conceptual Survey of Electricity and Magnetism.[2] We present our results comparing student outcomes (pre, post, and gains), including common questions on the two instruments. We find similar distributions and statistically indistinguishable gains, with lower absolute BEMA scores. We also investigate gender differences, and present correlations of both pre- and post-conceptual scores with traditional measures of student learning, including exam scores and course grades, as well as with results from the Lawson test of scientific reasoning,[3] and the Colorado Learning Attitudes about Science Survey[4] (pre- and post).

1. L. Ding et al, *Phys. Rev. STPER.* 2 (2006) 010105.
2. D. Maloney et al., *Am. J. Phys.* **69** (2001) S12.
3. A. E. Lawson, *J. Res. Sci. Teach.* **15**(1), 11-24 (1978).
4. W. Adams et al., *Phys. Rev. STPER.* 2 (2006) 010101.

PST4-21: 5–6 p.m. The Persistence of the Gender Gap in Introductory Physics

Lauren E. Kost, University of Colorado at Boulder; Lauren.Kost@colorado.edu*

Steven J. Pollock, Noah D. Finkelstein

Our previous research[1] showed that despite the use of interactive engagement techniques, the gap in performance between males and females on a conceptual learning survey persisted from pre- to post-test at our institution (differences are about 10 percentage points). Such findings were counter to previously published work.[2] A follow-up study[3] suggested the gender gap may be more a result of differences in previous physics knowledge than gender. Our current research continues to analyze the factors that may influence the observed gender gap in our courses. We perform a multiple regression analysis and find that the average gender difference, after controlling for previous physics knowledge, math skill, and attitudes and beliefs, is about 4 percentage points. These findings indicate that the gender gap exists in interactive physics classes at our institution, but is due in large part to differences in previous physics knowledge, math skills, and attitudes and beliefs.

1. Pollock, et al., *Phys Rev: ST: PER* 3, 010107.
2. Lorenzo, et al., *Am J Phys* **74**, 118.
3. Kost, et al, *PERC Proceedings* 2007, 137.

*Sponsored by Noah D. Finkelstein.

PST4-22: 5–6 p.m. Studying the Impact of Testing Conditions on Conceptual Survey Results

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

Lin Ding, Albert Lee, Lei Bao

Pre-/post-testing with conceptual surveys is frequently used to assess student learning gains. Though it is recognized that timing and incentives can impact test results, these variables frequently are not controlled across different studies. Pretests are administered either at or near the beginning of a course, while post-tests are given at or near the end of a course. There also is no accepted norm for offering incentives. To study the impact of such variations, we analyzed four years of data that were collected at The Ohio State University from over 2100 students, who were pre-/post-tested with the Conceptual Survey of Electricity and Magnetism. Results will be presented indicating that the time frames for giving this test had marked effects on results, and incentive-granting had a significant influence. This study suggests that testing conditions should be carefully controlled and documented.

PST4-23: 5–6 p.m. Why Variability Matters: Understanding Student Thinking and Learning*

Brian W. Frank, University of Maryland; bwfrank@physics.umd.edu

Rachel E. Scherr, David Hammer

A central aim of physics education research has been to characterize the ideas that students have about physical phenomena prior to and often continuing through instruction. The existence of common patterns in students' responses to physics questions makes it possible to categorize student ideas in ways that are practical for both research and instructional design. However, the search for and use of broad categorizations contributes to the wide-spread tendency to attribute singular conceptions to students thinking about specific topics. We present examples in which the patterns of student responses to motion questions suggest a significant amount of variation in the ways students think about these situations, undermining the utility of singular-attribution characterizations in these cases. We discuss theoretical arguments for recasting measures of variability as being central to understanding student thinking, and discuss how variability may be exploited methodologically to bring further insights into student thinking and learning.

*This work is supported in part by NSF Grant No. REC-0440113.

PST4-24: 5–6 p.m. The Difficulties in Turning Students into Numbers

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

John R. Thompson, Michael C. Wittmann

We are engaged in a project to systematize the process of quantitatively measuring student answers. We show that the type of question influences the methods used to measure the difference between two students' answers. Student responses are then grouped based on similarity. However, some students are halfway between two well-populated groups. We look at ways of handling these students in our classification system and discuss how that affects the final classification of the whole class.

PST4-25: 5–6 p.m. Robust Assessment Instrument for Student Problem Solving

Jennifer L. Docktor, University of Minnesota; docktor@physics.umn.edu

Ken Heller

Problem solving is one of the primary teaching goals, teaching tools, and evaluation techniques of physics courses. Unfortunately, there is no standard way to evaluate problem solving that is valid, reliable, and easy to use. Such an assessment instrument is necessary if different curricular materials or pedagogies are to be compared. This tool might also be useful to diagnose student difficulty and direct instruction. The main challenges with constructing such an instrument include defining relevant categories and obtaining evidence for validity and reliability. We will report progress on instrument development, including results from our ongoing pilot study.

PST4-26: 5–6 p.m. Colorado Assessment of Problem Solving (CAPS)—Design and Validation*

Wendy K. Adams, University of Colorado; wendy.adams@colorado.edu

Carl E. Wieman

The education and cognitive science literature contains a wide range of ideas about problem solving in math and science and the teaching of scientific problem solving. Some claim the evidence shows that skills and processes used while solving a problem are all domain specific while others say there are general skills and processes that are used and can be taught across disciplines. A close look at the existing research shows only a very small range of problems and people have been studied resulting in limited data. We have developed and validated a problem-solving evaluation tool that measures competence in 44 specific cognitive processes that people use when solving a wide range of in-depth problems including classical mechanics and quantum mechanics problems. Understanding the specific processes that impact how a person solves a problem explains the previous contradictions in the literature, identifies which components are domain specific and those that transfer across domains, and provides insight for improved methods for teaching.

* Supported in part by funding from National Science Foundation.

PST4-27: 5–6 p.m. Reasoning Modes, Knowledge Elements, and Their Interplay in Optics Problem-Solving

Adriana Undreiu, Western Michigan University; adriana.undreiu@wmich.edu

David Schuster, Betty Adams

We are investigating how students tackle problems in geometrical optics involving ray constructions, after being intrigued by certain strange solution attempts. We find that students use various reasoning modes and knowledge elements in conjunction. Their thinking may usefully be described as an interplay of principle-based, procedure-based, case-based and experiential-intuitive reasoning. This draws on a knowledge mixture of basic principles, procedures, specific cases and recalled result features. Even though we usually present solutions and teach problem-solving as a systematic application of principles, real cognition is more complex. Associative thinking in terms of prior case results seems to be a strong natural tendency of both novices and experts. Novices are not easily able to discriminate the specific from the general. Our research findings will be illustrated by examples of student thinking on problems involving reflection, refraction and images. The instructional implications of the research will be discussed.

PST4-28: 5–6 p.m. What Are Ill-Structured or Multiple-Possibility Physics Problems?

Vazgen Shekoyan, Rutgers University, New Brunswick, NJ 08901; vazgen@physics.rutgers.edu

Eugenia Etkina

One important aspect of physics instruction is helping students develop better problem-solving expertise. Besides enhancing the content knowledge, problems help students develop different cognitive abilities and skills. This poster focuses on ill-structured problems (or multiple-possibility problems). These cognitively rich problems are different from traditional "end of chapter" well-structured problems. They do not have one right answer and thus the student has to examine different possibilities, assumptions and evaluate the outcomes. The poster describes the structure of such problems, provides examples of multiple possibility physics problems, and presents a rubric for scaffolding and assessing student work.

PST4-29: 5–6 p.m. Observing Differences in Problems Apparently Similar

Hugo Alarcon, Tecnologico de Monterrey, Monterrey 64849, Mexico; halarcon@itesm.mx

Alejandro Mijangos

The purpose of this research is to understand why sometimes a student can solve a problem correctly and cannot solve another problem when both of them are apparently similar, in terms that those problems assess the same concepts and mathematical skills. We have used resource graphs[1] to analyze the solutions presented by physics students in a course of Mathematical Methods in problems that involve the application of the expansion of functions in power series. The different solutions of students were translated in diagrams, which have clarified the differences between problems that are apparently similar.

1. M. C. Wittmann, *Phys. Rev. ST Phys. Educ. Res.* 2, 020105 (2006).

PST4-30: 5–6 p.m. Student Perceptions and Changing Attitudes: A Window on Curriculum Reform

Daniel R. Able, Purdue University, W. Lafayette, IN 47907; dable@purdue.edu

Lynn Bryan, Melissa Yale, Mark Haugan, Deborah Bennett , Jennifer Brodar

This study is part of a larger longitudinal research agenda examining the large-scale implementation of a reform-based introductory physics curriculum, *Matter & Interactions* (Chabay and Sherwood, Wiley, 2007), at a science and engineering research institution in the Midwest. We used a mixed methods approach to analyze responses to an undergraduate student perception survey (USPS) and pre- and post-course administration of The Colorado Learning Attitudes about Science Survey. We triangulated our results between the CLASS, quantitative USPS and qualitative USPS data. Students' attitudes, reflected in the CLASS data, and their perceptions concerning five major themes (course design, assessment, technology, instructor pedagogy and resources/support) will be discussed in terms of the implications and challenges for a large-scale implementation of Matter and Interactions.

PST4-31: 5–6 p.m. Do They See It Coming? Expectancy Violations in Reformed Classrooms

Jon D. H. Gaffney, North Carolina State University; jdgaffne@ncsu.edu

Amy L. Housley Gaffney, Robert J. Beichner

When students enter the classroom for the first time, they have certain expectations regarding what and how they are going to learn. In pedagogically reformed classrooms, these expectations are often at odds with the actual class structure, and much of the beginning of the term is spent negotiating a new social contract. Therefore, both teachers and students could benefit from better understanding precisely what students expect at the beginning of a class and how those expectations evolve. This study of students enrolled in an introductory physics SCALE-UP class at N.C. State draws on expectancy violation literature in communication and education to provide a comparison of student expectations and classroom reality. While results are preliminary, this study should encourage larger, broader studies to better understand what students expect and how reformed pedagogy classes may violate those expectations.

PST4-32: 5–6 p.m. Gender Differences in Conceptual Physics Lab Technology*

Dave Van Domelen, Kansas State University; dvandom@phys.ksu.edu

Physical World Lab is a standalone conceptual physics laboratory course at KSU taken by non-STEM majors who need a laboratory credit. Recently the course was revised with the help of a grant of tablet PCs, and the students have been surveyed over the course of two semesters to determine their reactions to the new technology and procedures. Given that this course is traditionally majority-female, we decided to look at gender differences in their responses, and this poster will present the more interesting results.

* Tablet PCs provided by a grant from Hewlett-Packard.

PST4-33: 5–6 p.m. Relationship Between Student Epistemology and Approach to Physics Problem Solving

Bernard Griggs, II, Purdue University, W. Lafayette, IN 47907; griggsii@physics.purdue.edu

Mark P. Haugan, Lynn A. Bryan, Deborah E. Bennett

Research has shown that students' beliefs about how they learn can affect they way in which they learn. Their beliefs can vary greatly and often differ from the beliefs instructors hold about learning and about the purposes of assigned tasks. Given that problem solving is an integral part of students' experience in introductory physics courses, we investigated the relationship between students' epistemologies (their personal philosophies about learning) and their approaches to physics problem solving. Using a case-study design, we conducted think-aloud interviews with students while they solve a series of mechanics problem. Interview data was analyzed using constant comparative method and students' problem solving was analyzed using a rubric developed at our institution. This study was conducted in the context of a large-scale implementation of Matter & Interactions, an innovative introductory curriculum emphasizing reasoning from fundamental physics principles and the microscopic structure of matter.

PST4-34: 5–6 p.m. Exploratory Study of Freshman Cohort in Reformed Math, Chemistry, Physics

Wendell H. Potter, University of California, Davis; whpotter@ucdavis.edu

David E. Webb, Thomas G. Sallee, Emily L. Ashbaugh, Cassandra A. Paul

A cohort of 48 entering freshmen is closely followed beginning F07 as they take specially created lab/discussion sections of chemistry using active learning activities, special calculus lecture sections using a large-group questioning approach, and the previously reformed physics course. Chemistry and calculus sections are taught by specially trained senior Tas. Evaluation includes both quantitative and qualitative methods. Data include performance in the target courses as well as in subsequent courses for both the cohort and the much larger group of non-cohort students, at both the course grade level and at the individual exam-problem level. Admissions data and various GPAs are used to control for individual student variation in order to isolate the effect of simultaneously taking the modified courses. Pre-post surveys and interviews are used to uncover changes in attitudes toward STEM courses, approaches to studying and learning, and epistemological factors. Analysis of the first year's data will be presented.

PST4-35: 5–6 p.m. Assessing Pre-service Teachers Using an Interview Protocol Based on C-LASS*

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

Eric Brewe, Laird Kramer, George O'Brien, Leanne Wells

We report results from an interview study of prospective pre-service teachers serving as undergraduate Learning Assistants (Las) in Florida International University's (FIU's) PhysTEC Project. The goal of the study was to investigate both characteristics of students drawn to the PhysTEC program and how they changed as a result of their first early field experience. Their early field experiences included assisting in reformed physics classrooms and laboratories. Seven students were interviewed prior to and after their field experiences, using a protocol based on the Colorado Learning Attitudes about Science Survey (C-LASS) instrument[1]. Students completed the C-LASS and then were asked to explain their responses in interview sessions. Students were also asked about their background and experiences in physics courses. Results of the interview study and measured impact on course reform will be presented.

* FIU PhysTEC is supported by a grant from APS, AIP, & AAPT. Also supported by CHEPREO, NSF Award #0312038.

1. W.K. Adams, et al., *Phys. Rev. ST PER* 2006, 2, 010101.

**Sponsored by Laird Kramer.

PST4-36: 5–6 p.m. How TA Teaching Affects Student Achievement in a Reformed Setting

Cassandra A. Paul, University of California, Davis; capaul@ucdavis.edu

Emily L. Ashbaugh, Wendell H. Potter

In our reformed introductory Physics course at UC Davis, our students do the majority of their learning in the 5-hour per week discussion/lab, rather than in the single 80-minute lecture. The lecture supplements the discussion/lab, rather than the other way around as in a traditional course. This arrangement puts a tremendous amount of responsibility on the discussion/lab instructors, most of whom are graduate student TAs. These TAs are expected to engage in dialogue with students, use Socratic questioning techniques in place of explaining, and hold whole class discussions in which the bigger conceptual picture is addressed. In spite of extensive TA training that stresses these reformed teaching techniques, many TAs rely on the traditional teaching methods they are more familiar with. We present results of a 150-hour observational study of TA teaching behaviors, and how they affect student performance controlling for GPA and other demographic factors.

PST4-37: 5–6 p.m. How Physics Graduate Student TAs Frame Tutorial Teaching

Renee Michelle Goertzen, University of Maryland, College Park; goertzen@umd.edu

Rachel E. Scherr, Andrew Elby

The University of Maryland is investigating the specific nature of TAs' experience with reform instruction. The study uses reflective interviews and video of classroom interactions to investigate how TAs frame their role in tutorials, how they listen to students, what questions they ask, and what their goals seem to be in particular interactions in the classroom. We will discuss some of our preliminary findings about how the TAs that we observe view the nature of physics, their interpretations of instructional advice, and the utility of case studies to better understand how tutorial TAs behave in the classroom, as well as how we can better characterize productive TA actions.

PST4-38: 5–6 p.m. Separating Instructor Behavior from Instructional Format in Predicting Student Achievement

Emily L. Ashbaugh, University of California, Davis; ashbaugh@physics.ucdavis.edu

Wendell H. Potter, David E. Webb, Cassandra A. Paul

Student achievement in the introductory calculus-based physics course is analyzed as a function of course format and course-section instructor behavior. I investigate performance on the Force Concept Inventory by students in two 150-student lecture sections of the same course taught by the same faculty member, one taught in a traditional manner, the other taught with reduced lecture and with the discussion and lab sections combined into a 4.5 hr/wk discussion lab. The activities in the discussion/lab are based on the implications of a constructivist learning theory. Students in the modified course are further divided into those who have teaching assistants who embrace the modified course philosophy and those who do not. I find no significant difference based on the course format, but students experiencing instructional environments with "constructivist" TAs outperform students with traditional TAs. Performance differences on common final-exam questions will also be reported.

PST4-39: 5–6 p.m. "I Like These Problems But I Can't Use Them on My Test": How Instructors Lower the Bar for Student Performance*

Elisheva Cohen, Weizmann Institute of Science, Rehovot 76100, Israel; elisheva.cohen@weizmann.ac.il

Edit Yerushalmi, Charles Henderson, Kenneth Heller, Patricia Heller

Problems are an important teaching tool in introductory physics courses. Their structure influences how students approach both the subject matter and the problem-solving process. To understand how instructors design and choose problems, the Physics Education Research Group at the University of Minnesota has developed an interview tool to investigate instructors' views about the learning and teaching of problem solving. In one part of the interview, instructors were asked to evaluate a set of five problem formulations that might be assigned for students to solve. We found that although instructors frequently value many of the features of problems that enhance learning, their test problems rarely contain these features. In this presentation we will briefly describe the interview tool and discuss the results of data from 30 college instructors.

*Supported in part by NSF grant #DUE-9972470.

PST4-40: 5–6 p.m. Assessing Knowledge in a Graduate Course on PER *

John R. Thompson, University of Maine; john.thompson@umit.maine.edu

Warren M. Christensen, Michael C. Wittmann

The University of Maine Master of Science in Teaching program includes a pair of graduate courses titled Integrated Approaches in Physics Education. The courses integrate understanding of different elements of physics education research (PER), including research into student learning, content knowledge (CK) from the perspective of how it is learned, and reform-based curricula together with published evidence of their effectiveness. Course elements include equal parts studying physics through proven curricula and discussion of research results from PER literature. As part of our course development, we are researching course participants' understanding of content, pedagogy, and education research. We are also exploring assessment methods to analyze graduate student pedagogical content knowledge (PCK). Early findings indicate that the courses improve both CK and PCK. However, the improvement in these two arenas seems to be dependent on the background physics content knowledge of the student.

* Supported in part by the Maine Economic Improvement Fund and the Maine Academic Prominence Initiative.

PST4-41: 5–6 p.m. Conceptual Developments in the Methodological Domain in Lab: Students Physics Teachers

Maria M. Andrés, Universidad Pedagogica E. Libertador, Caracas DC 1060, Venezuela; maitea@cantv.net

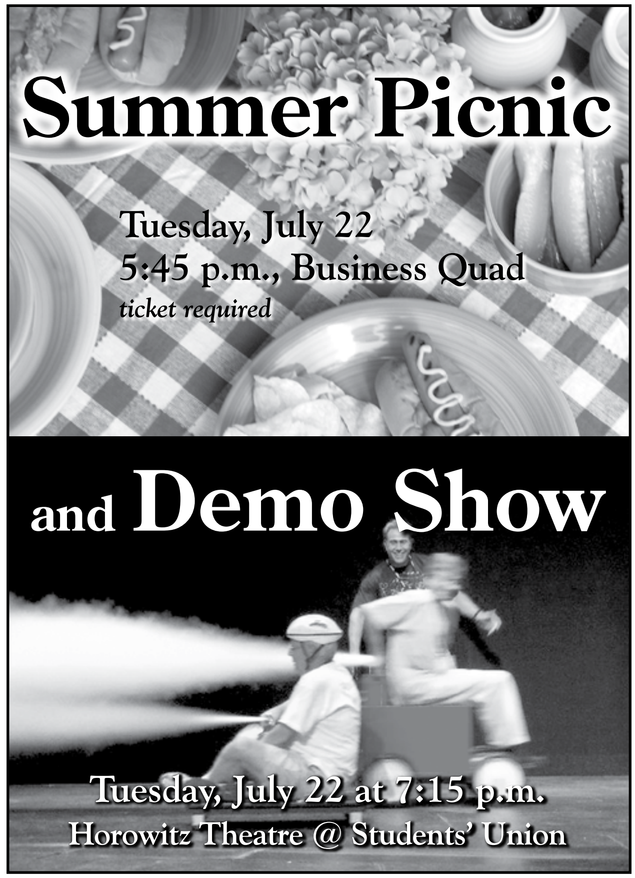
We present the results of learning in an introductory physics laboratory course for student physics teachesr at UPEL-IPC, in Venezuela. The study involves two semesters (2006-II/2007-II). The Laboratory Work (LW) focuses on problem-solving situations that can be of three types (exploration, relational, application). The solution of one LW involves the performance five sets of actions (phases) interrelation[1] that we derived from epistemological analysis of the scientific activity. For each phase, we established criteria achievements that are known by students and are used for evaluation and self-evaluation. Students discussed, planned, and executed each phase, making decisions in groups. This process is mediated by the teacher, with attention to a learning model that describes the conceptual development in the action. [2]

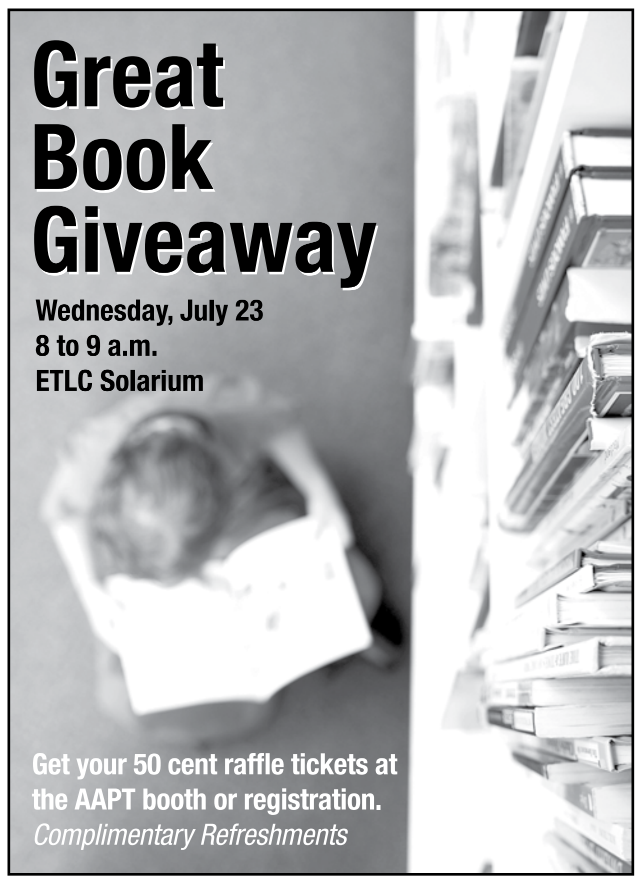
1. Action plan represented with V-Gowin. Andrés, M., Meneses, J. y Pesa M– Efectividad metacognitiva de la heurística V de Gowin en trabajos de laboratorio centrados en la resolución de situaciones problemáticas. V Encuentro Int. sobre Aprendizaje Significativo, 2006 Madrid CD.
2. Design from Vergnaud's theory of conceptual fields. Andrés Z, Ma. M., Pesa, M. A. y Moreira, M.A. —El trabajo de laboratorio en cursos de física desde la teoría de campos conceptuales. *Ciência & Educação.* Vol **XXII** no 2. 2006. pp 129-142.

PST4-42: 5–7 p.m. Student Responses to Interactive Teaching: What Are Students Really Thinking?

Jessica Watkins, 9 Oxford St., Cambridge, MA 02138; 512-659-6589, watkinsj@seas.harvard.edu

Interactive teaching methods are student-centered in their pedagogy, yet we know little about what students actually think about these methods. Using surveys and interviews of students in an interactive physics course, I present differences in student responses to interactive methods and more general data about their beliefs about learning physics both before and after instruction. This additional insight from students about interactive methods can benefit both new and experienced instructors.





Wednesday, July 23

Registration 7:30 a.m.–5 p.m.
ETLC, Solarium

AAPT Awards 11:15 a.m.–12:15 p.m.
Students' Union, Horowitz Theatre

Physics at University of Alberta 1:45–3:15 p.m.
ETLC, E1-001

PER Conference Reception & Banquet 6–10 p.m.
Students' Union, Dinwoodie

Session HA: Down from the Ivory Tower: Physics Teachers and Education Researchers as Activists

Location: ETLC E1-001 (Engineering Teaching & Learning Complex)
Sponsor: Committee on Research In Physics Education
Date: Wednesday, July 23
Time: 9–11 a.m.

Presider: Melissa Dancy

HA01: 9–11 a.m. Promoting Physics Education Research as a Scholarly Field for Physicists

Panel - Lillian C. McDermott, University of Washington, Seattle, WA 98195-1560; lcmcd@phys.washington.edu

From the perspective of this participant on the panel, the title of the session "Down from the Ivory Tower" could be replaced by "Within the Ivory Tower." There is a need for activism, both local and external, that promotes physics education research as an appropriate field for scholarly inquiry in physics departments. Reflection on many years as an activist in this cause has led to the formulation of a few guidelines for achieving this goal. Their effectiveness will be illustrated by example.

HA02: 9–11 a.m. Activism Through Research: Inequitable Physics Access and Proposed Policy Reforms

Panel - Angela M. Kelly, Lehman College, City University of New York, Bronx, NY 10478; angela.kelly@lehman.cuny.edu

Research has shown that physics is not universally available for high school students in the United States, and this is particularly true for urban youth, most of whom are children of color and the poor. In an era of high-stakes accountability in public education, the focus has been on standardized testing performance, rather than on examining whether students have the resources and opportunities to participate in advanced science courses such as physics. The emphasis on proficiency rather than opportunity-to-learn considerations has removed physics access from policy discussions, and the achievement gap has been situated in the context of performance rather than fundamental curricular options. Chronic inequities in physics access require political solutions that are informed by data. Statistics on physics access in urban schools will be analyzed to suggest policy reforms to expand secondary physics opportunities on the local, state, and national levels.

HA03: 9–11 a.m. Recognizing the Political Role of Physicists and Physics Teachers

Panel - Noah D. Finkelstein, University of Colorado at Boulder; noah.finkelstein@colorado.edu

As educators we are acting politically, shaping what and how students learn. This talk will examine ways in which educators can promote civic engagement at each of three levels: in the classroom, at the institution and nationally. In the classroom, we can construct environments that empower students and support students' development as learners and educators. At the institutional level, we can work with the university to substantively address its role in the communities and society in which it is housed. Nationally, as scientists and educators, we have the opportunity and responsibility to engage with our representatives on Capitol Hill. I will briefly describe models of each of these levels of activism, and focus on my personal perspective on this last area: how to reach Congress, and the convoluted maze of budgets, authorization, appropriation and lobbying.

HA04: 9–11 a.m. Making Physics Relevant by Academic Squatting

Panel - Denis G. Rancourt, University of Ottawa, Ottawa, ON K1N 6N5, Canada; dgr@uottawa.ca

The critical pedagogue is in solidarity with the oppressed. In solidarity there is no room for any subject to be constrained within disciplinary boundaries and removed from social relevance. To teach physics as a subject disconnected from social justice issues, on a continent where 80% of physicists work for the military in one form or another, is to be political in the classroom to the highest degree—while embracing state violence, continental-scale oppression, and planetary destruction driven by the profit motive. The critical pedagogue counters this using academic squatting, collaborating with the student occupants to motivate learning via consciousness, compassion, and morality. I will describe my experiments with academic squatting at all levels of university physics, from service liberal arts courses to graduate courses: http://www.science.uottawa.ca/~dgr/. Essential ingredients include the elimination of all institutional performance evaluations and total student freedom in deciding content and schedule. The oppression stops here.

Session HB: Middle School and High School Teaching Strategies

Location: ETLC E1-017 (Engineering Learning & Teaching Complex)
Sponsor: Committee on Physics in High Schools
Date: Wednesday, July 23
Time: 9–11 a.m.

Presider: Patrick Callahan

HB01: 9–9:30 a.m. TRIUMF's Program of Animated Physics Education Videos for High Schools

Invited - Marcello M. Pavan, TRIUMF, 404 Wesbrook Mall, Vancouver, BC V6T 2A3, Canada; outreach@triumf.ca*

TRIUMF has embarked on a program to create a variety of animated physics education videos to be made available for FREE to high schools. The videos aim to show how the physics formulas/principles taught in schools are manifest "in the real world" at a lab like TRIUMF. The videos present problems to solve, including graphing assignments. Our first video was a pilot effort created by high school graduates showing how special relativity is used in our particle beamlines. This talk will focus on our recent video, produced with professional animators, which shows students that only high school physics is needed to understand and design much of the TRIUMF cyclotron and isotope production system. Future plans also will be presented.

*Sponsored by Alex Dickison, AAPT President Elect and Program Chair.

HB02: 9:30–9:40 a.m. The Benefits of Allowing Mistakes: Students' Experimental Design*

Maria R. Ruibal-Villasenor, Rutgers University, New Brunswick, NJ 08901; mruibal@eden.rutgers.edu

Anna Karelina, Eugenia Etkina

The work of scientists is in essence creative as they need to generate new knowledge. However for many students in introductory physics courses, science is reduced to the application of heuristics and the following of directions. What would happen if students emulate the work of scientists by designing their own experiments? We videotaped groups of students solving a complex experimental problem in an area of physics new for them. They received no help but could consult the Internet and physics textbooks. We found that none of the groups was able to complete the task, yet, while they struggle to produce a solution, students became highly metacognitive, expended a significant amount of time on sense making and generated important questions. When assigning tasks to the students, we need be mindful that there are fundamental benefits these assignments can bring in addition to a right answer which maybe is not fully comprehended.

* This work was supported by the NSF grant DRL0241078.

HB03: 9:40–9:50 a.m. Virtual TIPERs: A Progress Report

Karim Diff, Santa Fe Community College, Gainesville, FL 32606; karim.diff@sfcc.edu

Tasks Inspired by Physics Education Research (TIPERs)are pencil-and-paper exercises that target known conceptual difficulties in introductory physics. Virtual TIPERs offer additional options with interactive, computer-based simulations developed with Easy Java Simulation (EJS), part of the Open Source Physics (OSP) project. The simulations are accessible online but can also be installed locally. They can be used as in-class group activities or as individual tutorials. The exercises implement the TIPER formats (see http://tycphysics.org/TIPERs/tipersdefn.htm) that are most appropriate for computer simulations.

HB04: 9:50–10 a.m. International Students and Native Students—A Unique CASTLE Collaboration

Chitra G. Solomonson, Green River Community College, Auburn, WA 98092-3622; csolomon@greenriver.edu

*Vivette Beuster **

The international student population has increased three-fold since 2003 at our college.This has affected the demographics in Physics 101 which follows the CASTLE curriculum. Understanding and expressing physics concepts in their own words and adapting to inquiry-based learning often pose challenges for international students. Their presence also changes group dynamics as domestic and international students struggle to communicate meaningfully. To improve the classroom climate and enhance learning for all, we designed a bridge program where international students go through an intensive English language curriculum with CASTLE as their first academic course. An English language teacher attends class with them and follows up with language and study skills sessions in the context of CASTLE. The result is a dramatic change in classroom participation. We will share various techniques we used in bridging the gap between cultures and creating learning experiences that are rewarding for domestic and international students.

* Sponsored by Chitra Solomonson.

HB05: 10–10:10 a.m. Two Useful Inexpensive Experiments on Sound

Larry Robinson, Austin College, Sherman, TX 75090; lrobinson@austincollege.edu

I will describe two experiments dealing with sound that are good potential experiments for use in the introductory laboratory. The first experiment, measuring the speed of sound in air, is widely known, but is worth mentioning because of the ease and low cost with which it can be implemented and the generally good results most students achieve. The technique uses a microphone and computer data acquisition system to measure the time for a sound pulse to reflect back and forth between the ends of a pipe. The second experiment is a study of the resonant frequencies of an air column, both open and closed; this activity also uses a microphone and computer system. There are many variations of experiments dealing with air column resonances; this version incorporates a novel method to introduce the sound wave into the column. A simplified flute that is easy to construct will be described.

HB06: 10:10–10:20 a.m. Learning to Think About Gravity

Esther L. Zirbel, Walden University, Medford, MA 02155; ezirbel@gmail.com

Claudine I. Kavanagh

Instructors widely teach Newton's 300-year-old gravitational theory, despite the fact that gravity was radically reinterpreted by Einstein almost 100 years ago. We propose the benefit of discussing gravitational theories in a comparative fashion and student views on the essence of each historical interpretation: Aristotle, Newton, and Einstein. We provide a classification rubric to assist college students in understanding how each thinker would account for free fall, projectile motion, and orbital motion. Preliminary results indicate that there are strong similarities between the Aristotelian interpretation and Einstein's ideas, which provide sharp contrast to the Newtonian conception. We argue that the foundations of Einstein's theory should be taught in pre-college classrooms. In the proposed approach, while learning about gravity, students also learn about: 1) the process and nature of science, 2) the methodologies to construct theories and 3) how to critique theories, including their own.

HB07: 10:20–10:30 a.m. Bringing Robotics into the Classroom

Jose J. D'Arruda, University of North Carolina Pembroke; jose@uncp.edu

As a teaching tool, robotics creates an environment that encourages students to: 1) Learn by inquiry and hands-on experimentation; 2) Research and solve a real-world problem based on a challenge; 3) Learn how to write a computer program that performs real-world tasks; 4) Encourage students to be designers and inventors; 5) Build an autonomous robot using engineering concepts; and 6) Present their research and solutions. We will discuss two programs that we are involved with using LEGO Mindstorm Robotic as a learning tool. One program involves more than 300 middle school children who are actively learning science and the other involves a workshop for STEM teachers to be presented in June 2008. We believe that these activities could fundamentally change how students think about (and relate to) science, computers and computational ideas. Support for these programs comes from NSF and the North Carolina Space Grant Consortium.

HB08: 10:30–10:40 a.m. Motion Reproduction: A Challenge Activity to Generate Motion Descriptor Concepts

David Schuster, Western Michigan University, Kalamazoo, MI 49008-5252; david.schuster@wmich.edu

Adriana Undreiu, Betty Adams, David Brookes, Marina Milner-Bolotin

We demonstrate a minds-on challenge activity used to introduce motion and motion concepts. One person enacts a motion, students observe and translate into verbal descriptions, followed by attempted translation of descriptions back into a reproduced motion by a person who did not see the original. First attempts are usually hilarious but instructive, with the reproducer deliberately producing "wrong" motions from inadequate descriptions. This leads students to generate for themselves the basic kinematic quantities required as motion descriptors, in a process of successive refinement. Thus the important concepts of initial position, speed, direction, speed change and rate arise naturally from a perceived need. We find that this simple activity also offers teaching opportunities for other relevant ideas, such as point particle representation, frame of reference, rate of change quantities, qualitative vs. quantitative, ordinary or scientific language, etc. We discuss instructional rationale and students' responses and reactions.

HB09: 10:40–10:50 a.m. Physics Concepts Learning Based on In-class Demonstrations and Animations

Sergio Flores, Universidad Autonoma de Ciudad Juarez, Chihuah 32310, Mexico; sergiflo@hotmail.com

Luis leobardo Alfaro, Sergio Miguel Terrazas

Many physics teachers persuade physics concepts learning by stimulating students with the use of at most two representations: the analytical and graphical representations. These teachers believe that equations and two-dimensional graphs are enough to learn most of the fundamental physics topics. The research group named Physics and Mathematics in Context from the University of Juarez in Mexico has developed a teaching proposal based on in-class demonstrations and animations. In this presentation, we will share some ideas to achieve students' physics concepts learning through in-class demos and animations, by using Power Point and the geometry software Cabri.

Session HC: Scientific Communication and Writing

Location: ETLC E2-001 (Engineering Learning & Teaching Complex)
Sponsors: Committee on Physics in Undergraduate Education, Committee on Science Education for the Public
Date: Wednesday, July 23
Time: 9–11 a.m.

Presider: Jean-Francois Van Huele

HC01: 9–9:30 a.m. It's the Audience, Stupid!

Invited - Stephen G. Benka, Physics Today*, One Physics Ellipse, College Park, MD 20740; sbenka@aip.org*

Too often, we think of communication as imparting information to others. But nothing gets communicated unless it is received with some measure of understanding. I will discuss some of the pleasures and pitfalls of real communication, which is a two-way street.

HC02: 9:30–10 a.m. Science Journalism, the Local Perspective

Invited - Keith Gerein, Post-Secondary Education Reporter, Edmonton Journal*, Edmonton, AB; kgerein@thejournal.canwest.com*

How does one get into science journalism? How does one effectively communicate science to nonscientists? How does one pitch science stories to the media? And finally, how does all of this inform us on how to train science students to become good communicators?

HC03: 10–10:30 a.m. Writing: An Active Learning Tool in Physics and Engineering Education

Invited - Dan Budny, University of Pittsburgh; budny@pitt.edu

Teresa L. Larkin

During this presentation, various strategies in which writing can be used to enhance student understanding in introductory physics and engineering classrooms will be presented. These strategies focus on the role of writing in terms of the assessment of student learning. Writing strategies first piloted with introductory physics students at American University and then later adapted for use with freshmen engineering students at the University of Pittsburgh will be described. Emphasis will be placed on a writing technique now used at both institutions which requires students to go through the entire process of researching, writing, and presenting a scientific paper to an audience of their peers. Students are exposed to all aspects of preparing a professional paper for publication. The process includes: the submission of an abstract, the preparation of a draft paper for formal peer review, and the preparation of a revised, camera-ready copy for publication. Students then present their final papers at a class conference at the end of the semester. In addition, links will be made to the importance of making physics and engineering topics more accessible to majors as well as to non-majors through the active process of writing.

HC04: 10:30-10:40 a.m. Using Summary Writing for Textbook Engagement and Student Class Preparation

Dedra Demaree, Oregon State University, Corvallis, OR 97330; dedra.demaree@gmail.com

Saalih Allie, Michael Low, Julian Taylor

The majority of "special access" students at the University of Cape Town are also second language English speakers for whom reading the physics textbook is daunting. As a strategy a) to encourage meaningful engagement with the text and b) to prime students for class activity, students wrote textbook summaries due the day the material was covered in class. The summaries were returned to the students, and they were encouraged to use them while studying. They could also bring their summaries to their final examination. Interviews with students were conducted for their views on summary writing, a survey was given to all students mid-semester, and some survey questions were included on their final exams. The qualitative student perspective of textbook summary writing will be presented. The study was carried out in the 2007 spring semester of the "Foundation Physics Course," a component of the special access program.

HC05: 10:40–10:50 a.m. Students Reflect on Understanding in Short Email to Instructor

Jim Stewart, Western Washington University, Bellingham, WA 98225-9164; jstewart@physics.wwu.edu

Cassandra Cook, Michael Greiner

Students in a calculus-based introductory course reflect on conceptual difficulties encountered while completing questions found in the student workbook that accompanies their text. Following a carefully structured format that includes prompts such as, "For one idea with which you have had difficulty, describe what you know and discuss what you need to know in order to understand," these students compare their responses to responses posted by the instructor and report on their success in a short email. We present a preliminary analysis of the effectiveness of the activity in promoting metacognitive skills.

HC06: 10:50–11 a.m. Physics Formula Recollection Through a NEVER BEFORE SEEN Mnemonic Technique!

Shannon A. Schunicht, M & W inc; mnemonicmind@alpha1.net

While in the Army, Mr. Schunicht was involved in a mid-air collision rendering him unconscious for three weeks. Everything had to be 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 sign, 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" and "z" -> "altitude." *That's it! With this technique ANY formula may be algebraically manipulated into a word/series for ease of recollection. Additional letters may be added to enhance a letter combination's intelligibility, but these additional letters need only be consonants!

*Examples will be shown to illustrate such applicability to common physics formulas, as well as those submitted by attendees upon arrival.

Session HD: College Physics: From Introductory to Advanced

Location: NRE 1-001 (Natural Resources Engineering Facility)
Sponsor: Committee on Physics in Two-Year Colleges
Date: Wednesday, July 23
Time: 9–11 a.m.

Presider: Paul D'Alessandris

HD01: 9–9:10 a.m. It's Not About Winning: Teaching Statistics with Sports Team Records

Jon D.H. Gaffney, North Carolina State University; jdgaffne@ncsu.edu

Utilizing students' familiarity with sports, we have designed an activity to introduce statistical principles and calculations. This activity begins with an analysis of a fictional youth soccer team, where fundamental assumptions of statistical mechanics might be valid, and progresses to professional sporting events, where the assumptions clearly are not. However, commentators often discuss the idea of parity (teams being of approximately equal strength) among professional teams and the attempts of some leagues to increase parity to make matches more exciting. Unfortunately, some comparisons are inappropriate (e.g., comparing a 14-2 record in football to a 141-21 record in baseball). Students use the fundamental assumption to address this issue and discuss when application of the fundamental assumption is appropriate. This activity was designed for and run in a reformed introductory physics course, but it is appropriate for any introductory physics or statistical mechanics course.

HD02: 9:10-9:20 a.m. Patterns, Consequences, and Reduction of Homework Copying

David E. Pritchard, MIT, Cambridge, MA02139; dpritch@Mit.edu

David J. Palazzo, Young-Jin Lee, Rasil Warnakulasooriya

The pattern of student responses while interacting with an online homework tutor was analyzed to give a probability that the students were copying their work. The observed patterns of copying suggest that time pressure on students with low motivation and poor time management skills is the main cause. Copying is a stronger 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 four. Homework copying is the strongest correlate of course failure and is the most amenable to improvement by the professor. Consider ways to REDUCE COPYING in your class.

HD03: 9:20–9:30 a.m. Stirling Is Not Stirling

Waldemar Feller, Kantonsschule Wohlen, Wohlen, CH-5610, Switzerland; waldemar.feller@gmx.net

Stirling is not Stirling. Stirling sounds Scottish. Especially physicists and engineers are immediately reminded of engines or, more exactly, hot air engines. Robert Stirling, the inventor of the hot air engine, was a Scottish reverend and engineer. And what about Stirling's formula? It is not from the same person but from another Scotsman with the same name, a mathematician who lived about 100 years earlier. Should our students know about Stirling more than this?

HD04: 9:30–9:40 a.m. Non-unique Solutions for Two Parallel Resistive Loads in DC Circuits

John E. Tansil, Dept. of Physics & Engineering Physics, Southeast Missouri State University, Cape Girardeau, MO 63701; jtansil@semo.edu

Direct current (DC) electric circuits with resistive loads in parallel across a constant voltage source V are a common topic in general physics courses. For the simplest case of two resistive loads, there will be 10 measurable circuit quantities V, I, Rp, P, I1, R1, P1, I2, R2, P2. If the source voltage V and two other quantities are specified, the other seven quantities can be found in the majority of cases, and, in fact, yield unique solutions. However, if the source voltage is not included in the set of three specified quantities, it can be shown that, in some cases, the source voltage is nonunique and can have two possible values. Each of these two possible values of source voltage will then yield a unique set of values for the other seven initially unspecified quantities. We will discuss solutions where the source voltage is initially specified and solutions where it is not initially specified and, in fact, may not be unique.

HD05: 9:40–9:50 a.m. Differential Equations in the Context of Liquids

Karla Carmona, University of Juarez, Ciudad Juarez, Chih 32310, Mexico; carmona.karla@gmail.com*

Sergio Flores, Luis Leobardo Alfaro

During a lecture in Caltech, Fyenman said to his freshman-year students: "Because I intuitively understand what's going on physically, I find it difficult to communicate: I can only do it by showing you examples." This is the main idea that the professors in the research group named Physics and Mathematics in Context from the University of Juarez in Mexico are working with. This is done by means of examples whereas the student can see, touch, and repeat until the concept is clear. A result of this effort is an easy-to-make set of containers that help our students to understand the concepts of flow, velocity and emptying time of rectangular containers. Through emptying containers, the student will understand the connection between the relationship of areas (cross and output) with the flow. Finally, through observation, the student reaches a differential equation with their boundary conditions associated with the experiment, as is required in advanced physics courses.

*Sponsored by Sergio Flores.

HD06: 9:50–10 a.m. Inconsistencies in Some Quantum Mechanics Problems

David Keeports, Mills College, Oakland, CA 94613; dave@mills.edu

During my years of teaching quantum mechanics to chemistry majors at Mills College, I have been bothered by some inconsistencies in a few of the simple standard problems that illustrate quantum mechanics at work. Several well-known problems are defined in ways that violate the uncertainty principle. Another standard problem requires a redefinition of the meaning of all allowable space in order to enable normalization while avoiding an uncertainty principle violation. Additionally, for some common problems, accepted wavefunctions fail to satisfy all of the conditions required for a wavefunction to be "well behaved." It is the purpose of my talk to point out a number of inconsistencies in some of the illustrative problems of quantum mechanics.

HD07: 10–10:10 a.m. Physics in the Pharmacy

Richard P. McCall, St. Louis College of Pharmacy; rmcccall@stlcop.edu

Because I teach at a college of pharmacy, I often look for items sold in pharmacies that have relevant physics applications. Three such items include reading glasses, syringes (and needles), and earplugs. Important physics concepts concerning reading glasses include the power of the lens and vision correction techniques using eyeglasses or contacts. For syringes and needles, topics such as pressure and fluid flow, including Poiseuille's law, are discussed. For earplugs, sound intensity and intensity level are important to understand, along with a discussion of the NRR (Noise Reduction Rating). All of these topics help to make physics relevant for the medical science major.

HD08: 10:10–10:20 a.m. Physics for Engineers: Content and Labs

William H. Bassichis, Texas A&M University, College Station, TX 77843; bassichis@physics.tamu.edu

Modifications in first-year calculus-based physics courses have focused mainly on teaching techniques and the use of technology. A "one size fits all" philosophy has led to courses that to a large extent do not prepare engineering students for their subsequent courses in engineering. In addition to course content, which may not be satisfying the needs of the student, the standard laboratory experiments are not deemed appropriate by engineering faculty. Under the sponsorship of an NSF STEPS grant, a course has been designed and implemented where both the course content and the laboratory experiments are based on extensive consultation with engineering faculty. According to student surveys and grades, this course does prepare the students for subsequent courses significantly better than the traditional courses. Furthermore, the student response to the new labs is much more favorable than for the previous labs.

HD09: 10:20–10:30 a.m. A Survey of What to Teach in Introductory Physics

Analia Barrantes, MIT, Cambridge, MA 02478; analiab@mit.edu

David E. Pritchard

We will ask you the question "what should we be teaching in calculus-based introductory physics? Specifically to nonphysics majors? The alternatives we'll offer were developed from interviews with expert teachers and physicists. They are: wider content (gyroscopes, quantum, modern physics), discovery lab, scientific method, how physics is constructed from a few ideas, epistemology (how do I know, derivations), to read science news critically, vocabulary of physics, concepts: (be Newtonian thinkers), problem solving (understand, plan with concepts), problem solving (make sense of answer, scaling, estimation), write/present scientific argument, and relation to everyday things. We will then compare the audience's answers with the answers of physics educators, physics researchers, the CEEB "best practices" study, and finally with the desires of beginning students. The first three mostly agree, but the students have quite different objectives, and we discuss why from the perspective of the development of human expertise.

HD10: 10:30–10:40 a.m. Recurrent Studies: Lectures on Conceptual Physics

Mikhail M. Agrest, College of Charleston, Charleston, SC 29424; agrestm@cofc.edu

Recurrent methodology originally proposed for methodology of laboratory experiments brought certain flavor into the learning process in labs. This paper is expending recurrent methodology on teaching conceptual material in lectures on Introductory and General Physics. In the forward study the professor describes the phenomenon, then creates a model based on the description. An unknown parameter is determined based on the data. In the backward study students use the magnitude of the parameters determined in the forward performed study to find parameters of the same phenomenon at changed conditions. Cross examination of the results permits us to check whether the results are correct or not.

1. M. Agrest, *Lectures on Introductory Physics I and II*. 249 pp. and 252 pp. with illustrations (Thomson Learning 2006).
2. M. Agrest, *Lectures on General Physics I and II*. 257 pp. and 237 pp. with illustrations. (Thomson Learning 2005).

HD11: 10:40–10:50 a.m. Transferring Instructional Reforms into New Urban Learning Environments in Physics and Astronomy*

*Kim Coble,** Chicago State University, Dept. of Chemistry and Physics, Chicago, IL 60628; kcoble21@csu.edu*

*Sean Gallardo,** Virginia L Hayes,** Samuel P Bowen,** Mel S. Sabella*

The physics program at Chicago State University (CSU) continues to make revisions in the instructional materials used in our algebra- and calculus-based introductory physics sequence. Supported by a new NSF CCLI grant, we have expanded the program to include the introductory astronomy course at CSU and the introductory physics sequence at Olive Harvey College, a nearby urban community college. We have adopted an instructional environment that embraces inquiry-based instruction, research on student learning, and instructional revision. In this talk we describe our implementation, as well as the successes and challenges we face as our project expands to different instructional environments.

*Supported in part by NSF grant #DUE 0632563.
**Sponsored by Mel S. Sabella.

HD12: 10:50–11 a.m. A General Space Science Curriculum for All *

Abebe Kebede, North Carolina Agricultural and Technical State University; abkebede@gmail.com

Recently NC A&T State University won a NASA award to develop Research and Education programs in Space Science. We have successfully developed a space science curriculum within the physics major at graduate and undergraduate level. In this communication we present the current status in the development and implementation of the curriculum and propose a generalized template curriculum applicable to institutions, particularly to Historically Black Colleges and Universities (HBCU) that plan to launch similar programs.

* National Aeronautical and Space Administration: Grant # NNG04GD63G.

Session HE: Historical Experiments in Physics

Location: NRE 1-003 (Natural Resources Engineering Facility)
Sponsors: Committee on History & Philosophy of Physics, Committee on Apparatus
Date: Wednesday, July 23
Time: 9–11 a.m.

Presider: Zoltan Berkes

HE01: 9–9:30 a.m. Early Measurements of the Mechanical Equivalent of Heat

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

The classic way to measure the mechanical equivalent of heat is to use the energy derived from slowly falling bodies to increase the temperature of a bath of liquid. Paddles driven by the mechanical system are used to stir the bath, usually water, that is placed in an adiabatic container. Most of the experiments done by James Joule over a span of nearly 25 years in the middle of the 19th century used this technique. But Joule and others used different methods to supply the energy to the system, including electrical heating of water, forcing water through small apertures, compressing air and the spectacular collision of two large bodies.

HE02: 9:30–10 a.m. Using Selected Nobel Lectures in Physics to Teach the History of Early Modern Physics to Future Physics Teachers

Invited - Art Stinner, University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada; stinner@cc.umanitoba.ca

More than two decades ago, Clifford Swartz wrote an editorial in *The Physics Teacher* titled: "On the teaching of Newtonian physics to Aristotelian minds in the days of quantum operators." Swartz challenged physics teachers to keep abreast of contemporary physics for their own development and then urged them to introduce physics using ideas that allowed students to connect to modern physics more easily. In this presentation I will describe the course I am teaching to "teacher-candidates," using a selected number of Nobel lectures, from Roentgen (X-rays, 1901) to James Chadwick (discovery of the neutron, 1936). The concepts and foundational experiments contained in these lectures cover the basic ideas of modern physics. Presenting these ideas and their experimental confirmation in this manner provides a richer context and a more sophisticated level of learning, which in turn leads to a more self-confident approach to the teaching of modern physics to young students.

HE03: 10-10:30 a.m. The Eotvos Balance

Invited - Zoltan Berkes, Concordia University College of Alberta, Edmonton, AB T5B 4E4, Canada; zberkes@concordia.ab.ca

In 1889, Baron Roland Eotvos (Hungary) modified the well-known "dumb-bell" shaped torsion balance used by Cavendish and Coulomb a century before, and started a new series of investigations into gravity. By placing one of the two masses on the horizontal bar about 20 cm below the original position, the new torsion balance became sensitive enough to measure incredible small spatial changes in the gravitational field. Further improvements of the Eotvos balance (known also as "Eotvos Pendulum") brought continuing success both in geophysics (mapping inhomogeneities in subsurface rock-formations), and in "modern" physics (supporting the Equivalence Principle by showing no difference between the inertial and the gravitational mass to a high accuracy). The story of the Eotvos Balance should encourage both students and teachers to do their physics measurements with utmost care. This is the only way one can feel good about doing experimental physics.

Session HF: K-12 Partnerships and Community Outreach

Location: NRE 2-003 (Natural Resources Engineering Facility)
Sponsor: Committee on Science Education for the Public
Date: Wednesday, July 23
Time: 9–11 a.m.

Presider: John L. Roeder

HF01: 9–9:10 a.m. A Model for Creating All-Girl After-School STEM Programs

Maxine C. Willis, Dickinson College, Carlisle, PA 17013; willism@dickinson.edu

Kristen Bechtel, Deborah Yokum

The YWCA of Gettysburg and Adams County has teamed with the Gettysburg Area School System and Gettysburg College to create successful all-girl after-school STEM programs in Grades 4 and 5 and also in the high school. The grade 4-5 program is a six-week after school Lego Robotics program and the high school after-school program participates in the TARC Rocketry Challenge. The structure of the cooperative model for these programs will be described as well as the outcomes. The logistics of who does what, how the programs are financed and how the participants and advisors grew will be focused on.

HF02: 9:10–9:20 a.m. Model of University-Community Science Partnerships to Engage K12 Students

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

Noah D. Finkelstein

We describe a model program and innovative uses of technology to engage and educate underrepresented K12 students in the sciences. We describe the University of Colorado Partnerships for Informal Science Education in the Community (PISEC) program in which undergrads, grads, and faculty participate in classroom and after school activities with K-12 students in the local community. First, we assess students' prior knowledge with a challenge in which they make a stop-action-motion movie predicting what will happen in a certain scenario. Then we provide hands on and/or physics simulations in which the students can observe the phenomenon in an inquiry-based activity. We provide a final challenge in which the students get an opportunity to show what they have learned. The programs are designed to benefit both children and university educators. We present results on evaluation of the children's interest in science, understanding of content, and potential for this program to be sustained.

*Sponsored by Noah D. Finkelstein.

HF03: 9:20–9:30 a.m. Supporting Inquiry in the Chicago High School Physics Classroom*

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

*Richard Daubert,** Joel Hofslund*

The Physics Van In-service Institute is currently in its seventh year of support from the Illinois Board of Higher Education. This program addresses the specific needs of inner-city teachers and students in Chicago by utilizing inquiry-based physics modules and making all necessary equipment available so that teachers can borrow the equipment and conduct the activities in their schools. In this talk we describe how our model of professional development helps foster an active learning environment in the Chicago area high school. In addition, we discuss how we are taking steps to institutionalize the program.

* Supported by the Illinois Board of Higher Education (NCLB).

** Sponsored by Mel S. Sabella.

HF04: 9:30–9:40 a.m. A Research / Outreach Partnership

Brian Jones, Colorado State University, Fort Collins, CO 80623; bjones@lamar.colostate.edu

Recently the Little Shop of Physics program has developed a partnership with CMMAP, the Center for Multiscale Modeling of Atmospheric Processes at Colorado State University. This NSF-funded Science and Technology Center is required to have an education component, and the Little Shop of Physics forms a vital piece. The benefits are mutual; we provide a valuable service to the Center, and, in doing so, have been able to expand our work into new areas. The intellectual stimulation of working with an active research group has been an excellent motivator for us. Our collaboration has given us stable funding, new ideas, new directions and new colleagues. In this talk I will discuss these benefits and some practical details of the work we are doing.

HF05: 9:40–9:50 a.m. Project WISE: Working in Informal Science Education—Results from Year 1

Gregory A. DiLisi, John Carroll University, University Hts., OH 44138; gdilisi@jcu.edu

Keith McMillin, Gretchen Santo, Toni Mullee

At the 2008 AAPT Winter Meeting in Baltimore, we presented the concept behind PROJECT WISE. In this three-year project, we pilot educational programs at Cleveland's International Women's Air and Space Museum while simultaneously conducting a research project to see if high school students can be hooked into STEM-based careers through an initial, positive exposure to informal science settings. Our goal is to develop materials for K-3 children that focus on women's contributions to aeronautics/aviation via the creation of an "informal science academy" for high school students. In this academy, diverse cohorts of secondary-level students perform preparation activities to give them specialized knowledge in content and pedagogy. Volunteers collaborate with university faculty, student-teachers, and education specialists to develop, test and evaluate permanent displays, classroom activities, and biographical portrayals of aviators. Now, we present results from year one, sharing some of the successes, challenges and lessons-learned following our first year of implementation.

HF06: 9:50–10 a.m. The Surprising Effectiveness of College Scientific Literacy Courses

Art Hobson, University of Arkansas, Fayetteville, AR 72701;ahobson@uark.edu

Research by Jon Miller, professor of Interdisciplinary Studies and Director of the International Center for Scientific Literacy at Michigan State University, shows that the U.S. scientific literacy course requirements 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 today's crying need for scientific literacy, physics educators should make physics for nonscientists their top priority.

HF07: 10–10:10 a.m. The 2nd Law: Gateway to Discuss Socially Relevant Physics

Peter Lindenfeld, Rutgers University, New Brunswick, NJ 08901; lindenf@physics.rutgers.edu

Suzanne White Brahmia

The second law of thermodynamics gives us a chance to talk about cars and their engines, fuel, and efficiency, but it barely makes it into our introductory courses. And when it does it is weighed down by cumbersome calculations of processes and cycles, with unfamiliar terms, symbols and procedures. We don't need most of that traditional material to discuss the basic facts: energy is conserved, but not all transformations are possible; energy easily becomes random internal energy, but it's not so easy to go the other way. The entropy change can then be introduced as a measure of that irreversibility. With these basic concepts we can discuss the applicability and relevance of the second law and the limitations on our use of energy. It opens the opportunity for the scientific discussion of issues of social importance and of energy policy decisions.

HF08: 10:10–10:20 a.m. Global Warming, or Global Warning?

Michael J. Ponnambalam, University of the West Indies, Kingston 7, 00007 Jamaica; michael.ponnambalam@uwimona.edu.jm

Global warming is now accepted as a fact by nearly all. The melting of ice in the arctic and the melting of the snow to increasingly higher levels in the Himalayan mountains make it obvious. Reducing the carbon emission is the talk of the day. Are there other lessons that Mother Nature has been struggling to communicate to us—scientists and society alike? This paper presents some answers to the above question.

HF09: 10:20–10:30 a.m. Application of Physics to Environmental Concerns—Part II: Geothermal Energy

Celia Chung Chow, Colorado State University; cchungchow@comcast.net

We are at the critical time in selecting energy sources and power plants. It is necessary to include this topic in our undergraduate (and graduate) physics classrooms, and consider the implementation of geothermal heating system at homes. Many important references will be introduced to new learners.

Session HG: Physics Teacher Preparation Around the U.S.

Location: ME 2-3 (Mechanical Engineering Building)
Sponsor: Committee on Teacher Preparation
Date: Wednesday, July 23
Time: 9–11 a.m.

Presiders: Ted Hodapp, Monica Plisch

HG01: 9–11 a.m. Advancing Web Support for Physics Teachers*

Poster - Brian W. Adrian, Kansas State University, Manhattan, KS 66506; badrian@phys.ksu.edu

Dean Zollman, Scott Stevens

The Physics Teaching Web Advisory (Pathway) is a dynamic digital library that now covers an entire curriculum of introductory physics topics. Teachers of all levels can easily obtain valuable assistance preparing for their classes from peers and nationally known experts in physics pedagogy and high-quality content. Combining Carnegie Mellon University's digital video library and synthetic interview technologies with pedagogical advances developed at Kansas State University and materials contributed by master teachers, Pathway provides continuously improving assistance and expertise. With most common introductory physics topics now represented, and several major upgrades to the project completed, this talk will present some of these advances as well as improvements projected for the near future.

* Supported by NSF grant numbers DUE-0226157, DUE-0226219, ESI-0455772 & ESI-0455813.

HG02: 9–11 a.m. Fondly Finding Funding for Physics Teacher Preparation from Alternative Sources*

Poster - Mark E. Mattson, James Madison University, Harrisonburg, VA 22807-7702; mattsome@jmu.edu

In terms of providing funding for physics/physical science teacher preparation programs, corporate and other private foundations are a less-commonly utilized resource. Such sources often provide unusual opportunities when compared with more typical, government-based sources of funding. Private foundations often have a less focused mission than a government solicitation, allowing for the combination of several different programs within one proposal and creating a more coherent vision with a concurrent decrease in paperwork. As an example, at James Madison University the Toyota USA Foundation has provided funding that allows for a physics teacher-in-residence as well as week-long summer workshops for in-service teachers. This presentation will highlight features and results from the first year of this program along with other suggested sources of funding.

*This program has been funded by a grant from the Toyota USA Foundation.

HG03: 9–11 a.m. UNC-BEST: A New Teacher Preparation Program at a Research University*

Poster - Laurie E. McNeil, University of North Carolina at Chapel Hill; mcneil@physics.unc.edu

Mark Enfield

UNC-CH has had no bachelor's-level secondary school teacher preparation program for over a decade, but we have now launched a new program as a partnership between the College of Arts & Sciences and the School of Education. Students in the UNC-BEST (University of North Carolina Baccalaureate Education in Science and Teaching) program are physics or biology majors who also complete the requirements for teacher licensure by taking a focused and intensive set of education courses. As part of their physics or biology major requirements, they take a course in the pedagogy of their discipline taught by faculty in their major department who are well-qualified in science education. Student teaching is accomplished either in the last semester of their undergraduate studies or in the following semester via a lateral entry program. The first graduates of the program can be expected as early as May 2009.

* Partially supported by the PhysTEC program with funds from NSF, individual and corporate contributions to APS, and the FIPSE program of the U.S. Department of Education.

HG04: 9–11 a.m. Brigham Young University's Physics Teacher Preparation

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

Robert Beck Clark

The Brigham Young University model in training physics teachers in the department of physics will be featured. The move of the Physics Teaching Program from the College of Education to the College of Mathematical and Physical Science will be highlighted. Brigham Young University's efforts and changes made to the physics teaching program will be presented. A look at the numbers of students enrolled as well as recent graduate numbers will be shared. Ideas for further improvements in quality and quantity of physics teaching majors will be solicited and shared during this paper session.

HG05: 9–11 a.m. Expanding Identities: From Science Major to Science Teacher

Poster - Valerie K. Otero, University of Colorado Boulder; valerie.otero@colorado.edu

Vera N. Lyman

Two complementary, nationally recognized programs are designed to capitalize on students' identities in efforts of recruiting and preparing more and better elementary, middle, and high school physics teachers. The CU Boulder Learning Assistant (LA) Project is designed to help students expand their identities from physics majors to physics teachers. The Physics and Everyday Thinking Project is designed to help non-majors expand their identities from elementary teachers to elementary physics teachers. Both programs have demonstrated success in facilitating change among students. These data will be presented and discussed. Inferences will be made about the extent to which explicit instruction on how students (and scientists) learn must take place in order to maximize the impact of physics instruction on physics learning and teacher quality. A former LA will describe two years of experience as a teacher and how the LA program has impacted her as a professional teacher and as a professional learner.

HG06: 9–11 a.m. The Physics Teacher Education Coalition

Poster - Monica J. Plisch, American Physical Society, College Park, MD 20740; plisch@aps.org

The Physics Teacher Education Coalition (PhysTEC) project has been working to address the critical shortage of high school physics teachers and to improve the education of physical science teachers. PhysTEC sites, institutions with significant project support to develop model teacher education programs, have more than doubled the number of physics teachers produced annually. These institutions engage in a spectrum of activities to support and encourage future teachers, including recruitment, course reform, early teaching experiences, mentoring, working with master teachers, and collaboration with education departments and local schools. The project has developed a national coalition, PTEC, which provides information and advocacy for improving physics and physical science teacher education. PTEC now has more than 100 institutional members, and conducts an annual national meeting and other conferences. PhysTEC is a project of the American Physical Society (APS), the American Association of Physics Teachers (AAPT) and the American Institute of Physics (AIP).

HG07: 9–11 a.m. UTeach: An Innovative, Collaborative Model for Teacher Preparation

Poster - Janice Trinidad, Manor New Tech High School, Austin, TX 78759; JaniceTrinidad@manornewtech.org

Jill Marshall

UTeach started at The University of Texas at Austin in 1997 as a new way to prepare secondary science, math and computer science teachers. Its strength lies in the unique collaboration between the Colleges of Natural Sciences and Education, its strong reliance on master teachers, and involvement of faculty who are engaged in cutting-edge research in science, math, and technology education. From its beginning just over 10 years ago, the program has grown to graduate more than 70 math and science teachers a year and garnered national attention when it was held up as a model in Rising Above the Gathering Storm. In 2007, the National Math and Science Initiative was established with replication of the UTeach program among its primary objectives. In the first year of operation, NMSI and the Texas High School Project funded 12 institutions at $2.4 M each to develop UTeach programs on their campuses.

HG08: 9–11 a.m. Physics Teacher Education at Illinois State University

Poster - Carl J. Wenning, Illinois State University, Normal, IL 61790-4560; wenning@phy.ilstu.edu

While the number of physics majors was down across the nation in the mid- to late-1990s, the Illinois State University physics teacher education program began to flourish. Starting with only five physics teaching majors in 1994 and two physics teaching methods courses, four additional physics teaching methods courses were added to the PTE major. By 2001 physics teaching majors were taking six required physics teaching methods courses spanning 2.5 years and consisting of 12 semester hours. Today there are more than 40 declared physics teaching majors making up approximately 1/3 of the major enrollment in our department. Our seven-step sequence for teacher preparation now includes the following foci: 1) introducing inquiry,

HH: Awards Ceremony – AAPT and AIP

Location: Students' Union, Horowitz Theatre
Date: Wednesday, July 23
Time: 11:15 a.m.–12:15 p.m.

Presider: Harvey Leff

Mark Davids

AAPT's Excellence in Pre-College Physics Teaching Award

Mark Davids, Grosse Point South High School, Grosse Point Farms, MI 48236; markdavids@comcast.net

Best Practices

Our colleagues in Physics Education Research (PER) have provided teachers with a treasure chest of information about "best practices" in the classroom. But what do we know and believe about these "best practices" that will allow us to expand and improve on them and influence the next generation of physics teachers? After 35 years in the classroom, I am still excited to engage my students by employing many of these "best practices." This talk will reflect on the many positive influences that have inspired me to continue in my professional development and to pass on my love of teaching and learning. A few examples are great teachers, Nobel Prize winners, presentations at state and local meetings, taking and teaching summer workshops, participating in national conferences, etc.

Corinne Manogue

AAPT's Excellence in Undergraduate Physics Teaching Award

Corinne Manogue, Oregon State University, Dept. of Physics, Corvallis, OR 97331; corinne@physics.oregonstate.edu

The View from the Other Side of the Mountains: Exploring the Middle Division

In 1997/98, Oregon State University undertook to re-envision its entire curriculum for physics majors, paying particular attention to helping students make the transition from lower- to upper-level courses—the middle division. We changed so many aspects of our curriculum that we are now in an entirely different ecosystem from where we started. It has been a long and fascinating journey, over a large potential-energy barrier. Our new environment is one where students and faculty can grow and thrive. Now, 10 years later, I hope to entice you to explore with us.

AIP 2008 Science Writing Awards, Broadcast Media Category

Bob McDonald
CBC's Quirks & Quarks

Pat Senson
CBC's Quirks & Quarks

Him Handman
CBC's Quirks & Quarks

2) modeling inquiry, 3) promoting inquiry, 4) developing inquiry, 5) practicing inquiry, 6) deploying inquiry, and 7) supporting inquiry. We graduated nine new physics teachers this year, and anticipate at least 13 next year.

HG09: 9–11 a.m. CDC: Instructional Approach for Teaching Physics to Pre-Service Science Teachers

Poster - Osnat Eldar, Oranim Academic College of Education & The Weizmann Institute of Science, Timrat 36576, Israel; eldar@oranim.ac.il

Miky Ronen, Bat-Sheva Eylon

Pre-service programs for science teachers consist of subject matter courses and pedagogical courses, often offered in different academic departments. As a result, the way teachers are taught physics may be quite different from what they learn about effective teaching strategies. This poster presents an instructional strategy attempting to integrate the subject matter and the pedagogical subject matter aspects in an optic course. The instructional strategy involves Collaborative Diagnosis of scientific and pedagogical Conceptions (CDC). The strategy starts with elicitation of the learners' initial conceptions and continues with collaborative group work on mutual diagnosis of those conceptions. The strategy is followed by class discussions aimed to expose the learners to the conclusions of the groups, and to build a common knowledge-base. This approach was implemented in a teachers' college for the last four years. Our findings demonstrate the potential benefits of using this strategy, for the integrated acquisition of content and pedagogical content knowledge by pre-service teachers.

HG10: 9–11 a.m. Mission Impossible: How to Prepare a Physics Teacher Who Stays

Poster - Eugenia Etkina, Rutgers University, New Brunswick, NJ 08901; etkina@rci.rutgers.edu

Maria Ruibal-Villasenor

This poster will describe a 45-credit Master of Education in Physical Science combined with physics teacher certification program at Rutgers, The State University of New Jersey. The program has been in place for six years. It attracts a high number of students—we graduate about six to eight physical science teachers every year who remain in the profession. One of the program's goals is to prepare a teacher who is equipped with the knowledge of how people learn physics by actually experiencing this process and with the knowledge of the many complexities of high school classroom including planning and assessment. Another goal is to prepare a teacher who already had experiences in reformed teaching. These goals are achieved through a large number (6) of physics-based teaching methods courses and students' teaching experiences in reformed university courses. Both course work and teaching experiences are structured through a model of cognitive apprenticeship.

HG11: 9–11 a.m. New Required Integrated Physical Science Course In Georgia's Teacher Education

CANCELED

Poster - Ulrike G.L. Lahaise, Georgia Perimeter College, Decatur, GA 30034; ulahaise@gpc.edu

James Guinn, Pamela Gore

The Board of Regents of the University System of Georgia requires two new integrated science courses (Life Science and Physical Science) for early childhood education majors starting fall 2007. These courses are housed in the science department rather than the education department. They are intended to reduce the science apprehension of many education majors, familiarize them with the scientific method, and make them comfortable with basic laboratory experimentation practices. These collegiate-level courses are activity based, student centered, yet content driven. The scope and purpose of the Integrated Physical Science course will be discussed in light of student surveys. The pros and cons of the structure of student activities, other student-centered learning methods, and student assessment by various teachers will be outlined. Finally, first-year teaching experiences and the implementation of the course will be discussed specifically for Georgia Perimeter College, a two-year unit of the University System of Georgia.

HG12: 9–11 a.m. Learning Assistants: Re-imagining Tas as Future Pre-college Physics teachers

Poster - Lane H. Seeley, Seattle Pacific University, Seattle, WA 98119; seelel@spu.edu

Stamatis Vokos, Hunter Close

Most physics departments use undergraduate or graduate TAs to enhance the learning experience for the students enrolled in the course. An effective Learning Assistant program combines the goal of enhancing student learning with the goal of transforming the beliefs, attitudes, and career choices of the LAs themselves. In the context of a critical shortage in K-12 physics and physical science teachers, an LA program should have an explicit goal of recruiting and preparing talented physics majors for careers in teaching. In this poster we will briefly describe the LA program at Seattle Pacific University, describe recent efforts to encourage our LAs to reflect critically on the challenge of teaching and learning physics and suggest some critical elements for a successful LA program. Finally, we will speculate about opportunities to reconstruct a physics major that is centered on collaborative communication of complex ideas.

IC: Plenary Session: Physics at the University of Alberta

Location: ETLC E1-001 (Engineering Teaching and Learning Complex)
Date: Wednesday, July 23
Time: 1:45–3:15 p.m.

Presider: Alex Dickison

Mark Freeman

Professor and Canada Research Chair in Condensed Matter Physics, U of A

Nanomagnetism: A Case History of Nanoscience and Technology

Mark Freeman

A touchstone of nanoscience is the study of systems that are not merely small, but also different as a consequence of small size. Magnetism provides natural examples of this—important length scales governing the properties of many magnetic materials are in the nanometer range. Nature figured this out 2 billion years ago, in the instance of magnetotactic bacteria. The past two decades have seen the emergence of new magnetic nanomaterials, and of laboratory tools capable of detailed analysis of individual nanomagnets. A significant milestone in this story was the award last fall of the Nobel Prize in Physics to Fert and Gruenberg. Selected examples will illustrate what has been achieved so far and give some indication of what might be expected in the future.

Roger Moore

Associate Professor of Physics, U of A

The Standard Model and Beyond with ATLAS

Roger Moore

For more than 30 years, the Standard Model of particle physics has successfully described the fundamental structure of matter and, with the exception of gravity, how it interacts. Only one building block remains undiscovered, the Higgs boson, which could explain how the fundamental particles, like the electron, have a mass. However, cracks have already started to appear in the model—such as neutrino oscillations and the preponderance of dark matter, as well as other issues such as the Hierarchy Problem. This year the ATLAS experiment on the LHC at CERN, Geneva, will test the Standard Model at energies seven times higher than have ever before been achieved in the laboratory. It will either discover or exclude the Higgs boson and has excellent prospects for finding possible new physics, beyond the Standard Model, such as Supersymmetry or extra dimensions of space.

Aksel Hallin

Professor and CRC Tier I Chair in Astroparticle Physics, U of A

Astroparticle Physics in Canada: Deep Underground Measurements of Neutrinos and Dark Matter

Aksel Hallin

Astroparticle physics investigates the profound connections between the fields of particle physics and the cosmos. We focus on two fundamental problems: What is the particle nature of dark matter, which makes up about 85% of the matter in the universe? What are the masses and character of the neutrinos, the second most abundant particles in the universe, and how have they influenced the evolution of the universe? The SNOLAB underground physics laboratory in Sudbury and the experiments that will be sited there have been built to answer these questions. The laboratory, the DEAP/Clean dark matter experiment, and the SNO+ double beta decay experiment will be discussed.

HG13: 9–11 a.m. Impact of the FIU PhysTEC Reform of Introductory Physics Labs

Poster - Leanne M. Wells, Florida International University, Miami, FL 33199; wells.leanne@gmail.com

Eric Brewe, Laird Kramer, George O'Brien, Jeff Saul

We report results from a study of pre- and post-assessments of students enrolled in reformed and nonreformed introductory physics laboratory sections. Florida International University's (FIU's) PhysTEC Project* trained and placed prospective pre-service teachers serving as undergraduate Learning Assistants (LAs) in six lab sections implementing tutorial-based curriculum. LAs facilitated epistemological and metacognitive discussions designed to challenge and then refine student understanding of physics concepts. The goal of the study was to asses the results of the impact of the FIU PhysTEC reform of introductory physics labs. Conceptual understanding and beliefs about physics of students in the six reform sections were compared with students enrolled in traditional laboratory settings. Students completed the Force Concept Inventory (FCI),[1] the Maryland Physics Expectation Survey (MPEX 2),[2] and common exam questions embedded in the exams for their regular physics classes. Results of the study and measured impact on lab reform will be presented.

* FIU PhysTEC is supported by a grant from the Physics Teacher Education Coalition funded by APS, AIP, & AAPT. Also supported by CHEPREO, NSF Award #0312038.

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.

HG14: 9–11 a.m. Improved Pathway: Web-based Pedagogical Support for Teaching*

Poster - Dean A. Zollman, Kansas State University, Manhattan, KS 66506; dfzollman@phys.ksu.edu

Brian Adrian, Scott Stevens, Michael Christel

The Physics Teaching Web Advisory (Pathway) provides advice on pedagogical issues for teachers of an introductory physics course. Recent additions enable Pathway to offer full coverage of a standard introductory course. An enhanced user interface will enable teachers to easily obtain valuable assistance from nationally known experts in physics pedagogy and view resources that can be used in the classroom. This major upgrade to the project has incorporated user suggestions and added many new features.

* Supported by NSF grant numbers DUE-0226157, DUE-0226219, ESI-0455772 & ESI-0455813.

Session IA: Crackerbarrel: Professional Concerns of PER Faculty

Location: ETLC E1-017 (Engineering Teaching & Learning Complex)
Sponsor: Committee on Research in Physics Education, Committee on Professional Concerns
Date: Wednesday, July 23
Time: 12:15–1:45 p.m.

Presider: Tom Foster

Session IB: Crackerbarrel: Professional Concerns of PER Graduate Students

Location: ETLC E2-001
Sponsors: Committee on Research in Physics Education, Committee on Professional Concerns
Date: Wednesday, July 23
Time: 12:15–1:45 p.m.

Presiders: Trevor Smith, Mary Bridget Kustusch

Session JA: PERC Bridging Session

Location: ETLC E1-001 (Engineering Learning & Teaching Complex)
Sponsor: Committee on Research in Physics Education
Date: Wednesday, July 23
Time: 3:30–5:15 p.m.

Presider: Mel S. Sabella

JA01: 3:15–3:45 p.m. Inequities in Physics Access and Enrollment in Urban High Schools

Invited - Angela M. Kelly, Lehman College, CUNY, Bronx, NY 10468; angela.kelly@lehman.cuny.edu*

Despite reports to the contrary, the availability of physics as a course for secondary students is not equitably distributed throughout the United States. While some schools provide physics access for all, a more common scenario is limited availability to select students. This is particularly true in urban districts, where this study examined access to and availability of high school physics. New York City's secondary schools were surveyed to determine where physics was offered and how many students were enrolled. Statistics were performed to compare differences between physics and nonphysics schools. Additionally, organizational factors were examined that relate to physics availability, such as the magnet school configuration, the AP Physics and conceptual physics options, and science curricular sequence. Overall, it was determined that physics availability is limited in NYC schools, a serious inequity that disproportionately affects students of color and poor children. Strategies for improving access and enrollment will be discussed.

*Sponsored by Mel S. Sabella.

JA02: 3:45–4:15 p.m. A Race-Identity Perspective on Mathematics Learning and Participation

Invited - Danny B. Martin, University of Illinois at Chicago; dbmartin@uic.edu*

I discuss how race and identity have emerged as primary considerations in my research and teaching. This program spans 20 years and has focused on mathematics learning and participation among African American adults and adolescents in school and non school contexts. While mainstream mathematics education research has conceptualized learning and participation as cognitive and cultural activities, my work pushes these perspectives to consider mathematics learning and participation as racialized forms of experience; that is, as activities structured by the larger relations and discourses of race that exist in the broader society. For many African American learners, African American identity has served as a marker for degradation in mainstream research and policy contexts. Meanwhile, the concept of race has remained under theorized. One consequence is a widely accepted, yet uncontested, racial hierarchy of mathematical ability that constructs African American learners as mathematically illiterate relative to other learners. My work challenges these constructions.

* Sponsored by Mel S. Sabella.

JA03: 4:15–4:45 p.m. Impact of Chemistry Teachers' Knowledge and Practices on Student Achievement

Invited - Kathryn Scantlebury, University of Delaware; kscantle@udel.edu

Professional development programs promoting inquiry-based teaching are challenged with providing teachers content knowledge and using pedagogical approaches that model standards-based instruction. Inquiry practices are also important for undergraduate students. This talk focuses on the evaluation of an extensive professional development program for chemistry teachers that included chemistry content tests for students and the teachers and the impact of undergraduate research experiences on college students' attitudes towards chemistry. Baseline results for the students showed that there were no gender differences on the achievement test but white students scored significantly higher than nonwhite students. However, parent/adult involvement with chemistry homework and projects, was a significant negative predictors of 11th grade students' test chemistry achievement score. This talk will focus on students' achievement and attitude results for teachers who are mid-way through the program provide evidence that ongoing, sustained professional development in content and pedagogy is critical for improving students' science achievement.

* Sponsored by Mel S. Sabella.

AAPT Gift Basket Raffle

This year AAPT will hold a raffle to raise funds for the future of physics education. In exchange for a raffle ticket, you will get the opportunity to win great items. A laser pointer, autographed copies of Professor Freeman Dyson's books on physics, and a full meeting registration for the AAPT/AAAS 2009 winter meeting in Chicago are just some of the items you can win. So, look for the raffle basket and gain wonderful items by supporting our profession.

Thank you for Raffle Donations: Professor Freeman Dyson, Educational Innovations, Inc., Innovation Frontier, Inc., www.Xump.com!

Riverdale NetZero House Tour

Sunday, July 20 • 3:30 p.m. to 5:00 p.m.

The **Riverdale NetZero Project** is one of Canada's first 12 Net Zero Energy (NZE) homes and the first of its kind in Edmonton. This NZE house generates at least as much electricity and heat as it consumes over the course of a year, making its net annual energy use zero, or a slight surplus!
Join us for a tour of this ultra energy-efficient home design Sunday, July 20th at 3:30 p.m.

Visit: www.riverdalenetzero.ca

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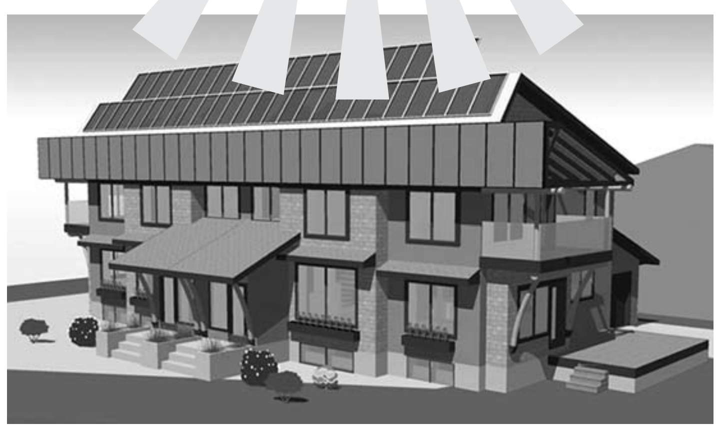

National Institute for Nanotechnology Tours
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Index of Advertisers

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Decker, Fred
Desbien, Dwain
Detar, Charleton
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Dibble, William
Dils, Robert
Dimicco, Ernest
Djurek, Danijel
Donaldson, John
Dukes, Robert
Easley, David
Edwards, Harry
Ekstein, Daniel
Elliott, Stuart
Emery, Guy
Emmert, Charles
Ezrailson, Cathy
Fa'Arman, Alfred
Famellette, Judith
Ferbel, Thomas
Ferstl, Andrew
Fischer, Gaston
Fisher, Wayne
Fizell, Richard
Flinner, Jack
Ford, Kenneth
Frank, Christine
Franz, Judy
French, A.
Fried, Herbert
Friedman, Kenneth
Frisch, Henry
Fukushima, Eiichi
Fuller-Mora, Wendy
Gaisidis, Giannis
Galik, Richard
Garrett, John
Garstang, R.
Geller, Zvi
Gettman, David
Goldberger, Marvin
Goldwasser, Edwin
Gollin, George
Gordon, Howard
Gottfried, Richard
Graebner, Mark
Grannis, Paul
Greer, Michael
Grike, Leo
Guemez, Julio
Guerra-Vela, Claudio
Hadley, Nicholas
Hafner, Catherine
Hakim, Toufic
Han, Tao
Hanau, Richard
Harris, Arthur
Hartline, Beverly
Hawkins, William
Hawley, Danny
Hein, Warren
Helrich, Carl
Herrick, David
Hicks, James
Hodson, Richard
Holcomb, Donald
Holstein, Barry
Hoover, Herbert
Hubisz, John
Huschilt, John
Huston, Douglas
Jackson, James
Jafari, Anooshirvan
Jones, Roger
Kane, Gordon
Kaplan, John
Kern, Mark
Kieffaber, Lois
King, J.
Kingsbury, Paul
Kleinsteuber, T. C .W.
Konno, Rikio
Kral, Stephen
Kronfeld, Andreas
Kuhlman, William
Lam, Harry
Lane, Kenneth
Lauffer, Donald
Layman, John
Lee, Edward
Leinbach, Harold
Little, William
Lowry, Matthew
Maasha, Ntungwa
Mallinckrodt, A.
Mallmann, A.
Maloney, David
Mangelsdorf, Paul
Martin, Richard
Mason, Bruce
Mathews, Wesley
Mellen, Walter
Mellendorf, Kenneth
Merzbacher, Eugen
Meyers, Peter
Miller, William
Mogge, Mary
Moir, David
Morse, Robert
Moses, Clement
Myers, Jimmie
Nelson, Charles
Newby, Neal
Nielsen, Paul
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Okun, Boris
Oostens, Jean
Osheroff, Douglas
Papirio, Anthony
Paschos, Emmanuel
Pedigo, R.
Pedrotti, Leno
Perez, Cesar
Perlman, Herbert
Peskin, Michael
Peterson, Randolph
Peterson, Richard
Pribram, John
Purcell, Kay
Purohit, Milind
Quigg, Chris
Reay, Neville
Redwine, Robert
Reeder, Don
Rees, John
Regula, Donald
Rennert, Abraham
Rhodes, Charley
Roberts, Richard
Robertson, Charles
Robertson, Roderick
Robinett, Richard
Roeder, John
Roll, Ronald
Rosner, Jonathan
Rossing, Thomas
Rubin, Morton
Salinger, Gerhard
Saul, Jeff
Savickas, David
Schmelzle, Philipp
Schultz, Jonas
Sears, Stephen
Serway, Raymond
Sessler, Andrew
Shaffer, Peter
Shanack, Sheldon
Sharber, James
Sharon, Yitzhak
Shepherd, Giles
Sherman, Joel
Sherwood, Bruce
Simmons, Elizabeth
Sivers, Dennis
Smith, David
Stacey, James
Stahl, Frieda
Sternheim, Morton
Stover, David
Sugarbaker, Evan
Sullivan, Jerry
Talman, Richard
Tam, Francis
Taylor, James
Thiessen, David
Tigner, Nancy
Trimble, Virginia
Turner, Michael
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Vecchio, Lisa
Wagner, Robert
Wales, Walter
Wallace, William
Wallach, David
Walter, Mario
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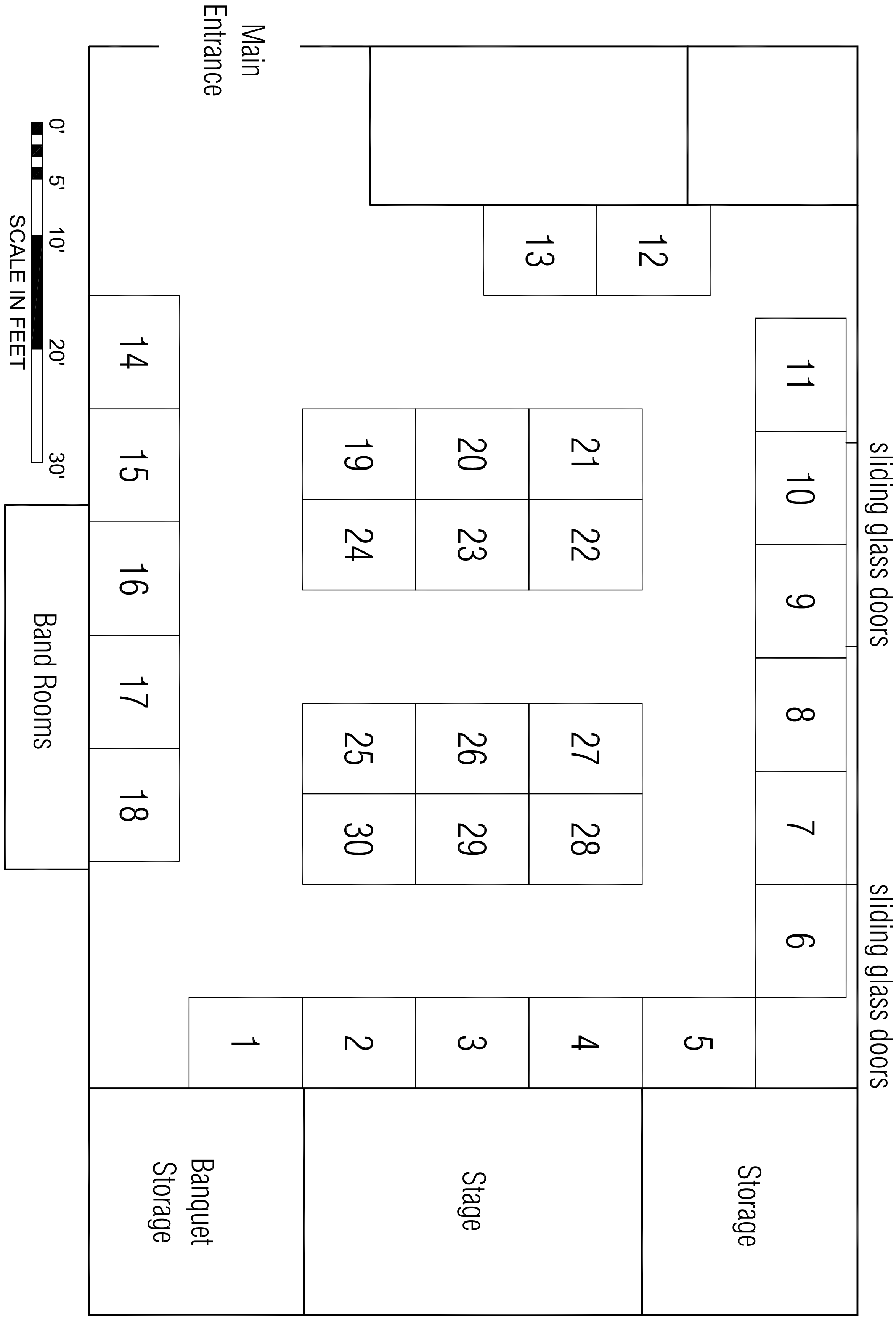

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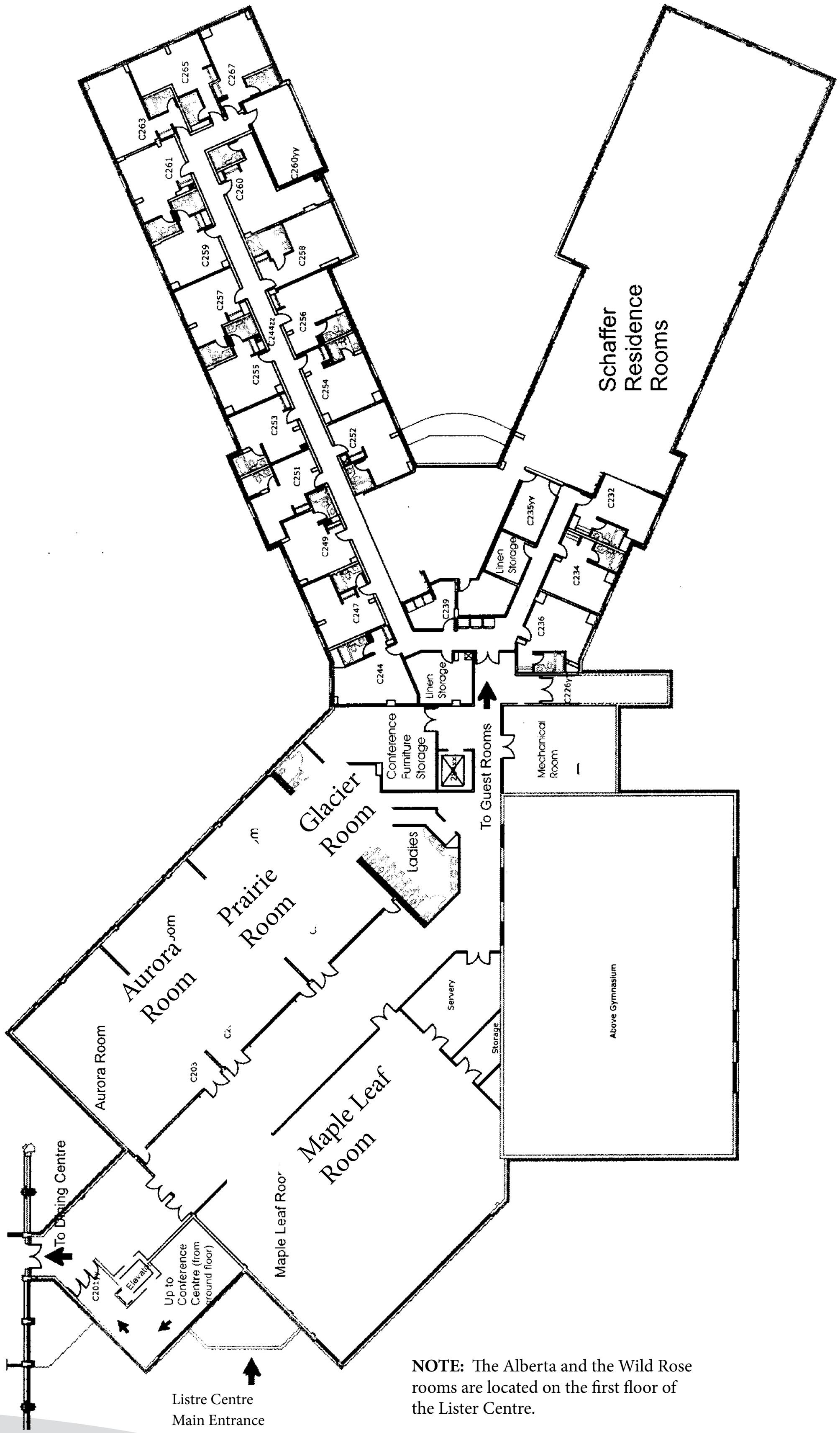

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