Forum on Education
American Physical Society

Spring 2011 Newsletter

Paul J. Dolan, Jr., Editor

IN THIS ISSUE

From the Chair

Larry Woolf

In this article, my last as chair, I want to again bifurcate and include both Forum on Education (FEd) business as well as some personal views on physics education. First, let's get down to business.

Both the March and April meetings are imminent and I again want to thank the FEd Program Chair Chandralekha Singh, the FEd program committee, and all the session organizers for putting together a fine collection of invited sessions and speakers. Also thanks to Renee Diehl and her Nominating Committee for assembling an outstanding slate of candidates for the FEd Executive Committee and also thanks to the nominees for running. I want to thank Peter Collings, chair of the Fellowship committee and his team for their efforts, which are described in Peter's article. And, as always, thanks to Bruce Mason, our very hard working Secretary/Treasurer for the past 6 years, for keeping the wheels of the Forum turning smoothly. I want to extend my appreciation to Paul Dolan for editing this newsletter. Paul is one of the many volunteers that make the FEd and the APS successful organizations. If you'd like to join the FEd family, we're currently looking for a newsletter editor for the Fall 2011 issue. Finally, I'd like to congratulate the new Fellows sponsored by the FEd.

One issue discussed extensively by FEd Executive Committee members over the past few months concerned the recently approved Forum on Outreach and Engaging the Public. Education outreach has long been one of the focus areas of the FEd, so members were concerned about the effect of this new Forum on that part of the FEd's mission. While the details are still not finalized, it seems clear that we will work in a complementary and cooperative way with this new Forum.

Now for the personal views. Although new social media and web based materials cover a wide variety of topics, I have been an ardent reader of physics and other scientific popular books for many decades. The popularization of science via books may be in a golden age, with many prominent scientists contributing, even as the book publishing industry is stressed. Many outstanding books cover areas rarely discussed, but nevertheless useful, in typical physics or science courses. Popular expositions can extend student's understanding of science into areas such as the intertwined history of science, the personal and messy nature of scientific discovery, the relationship of science to technology and society; they can even improve conceptual understanding. Books can also educate and excite the public about science. Some of my favorites: In the Biographical category: All of Richard Feynman's books, especially *Surely You're Joking Mr. Feynman* (one of the rare books that I've read twice) and *Something Incredibly Wonderful Happens: Frank Oppenheimer and the World He Made Up* by KC Cole, the unique life of the creator of the Exploratorium. For history: *The Maxwellians* by Bruce J. Hunt and *Oliver Heaviside* by Paul J. Nahin, both accounts dealing with the genesis and early use of Maxwell's equations and their application to solving problems in telegraphy; *Longitude* by Dava Sobel; *The Age of Wonder: How the Romantic Generation Discovered the Beauty and Terror of Science* by Richard Holmes; and *The Disappearing Spoon: And Other True Tales of Madness, Love, and the History of the World from the Periodic Table of the Elements* by Sam Kean. For physics topics, my favorite books are *Clouds in a Glass of Beer* and *What Light Through Yonder Window Breaks* by Craig Bohren. These books provided a deeper conceptual understanding of the optical properties of materials than from any of my optics courses. For other areas of science: *Full House* and *Bully for Brontosaurus* by Stephen Jay Gould (and most of his other books), *The Selfish Gene* by Richard Dawkins, *The Brain that Changes Itself* by Norman Doidge, *Life's Matrix* by Philip Ball, *Chaos* by James Gleick, and *Blink* by Malcolm Gladwell.

Science stories are part of many K-8 science curricula, extending and elaborating on the science learned. The Lawrence Hall of Science FOSS program has science stories for K-6, and readings in the student resource books for grades 6-8 (Ref 1). It may be useful to consider popular science books for more advanced science and physics courses, such as at the high school or even college level. One could also imagine using popular science books as curricula for English classes, instead of some fiction, co-taught with science classes.

If you are using science books to complement your physics courses, consider writing an article about your experiences for the *FEd newsletter*. Or if you have personal favorites to share with others, consider writing a short note. Our summer newsletter editor, Nic Rady, will welcome your contributions.

It has been my pleasure to chair the Forum on Education during the past year. I leave this post secure with the knowledge that the next year with be a successful one with the very capable Chandralekha Singh at the helm.

Reference 1. FOSS Components, <http://www.lhsfoss.org/components/index.html>

Larry Woolf is principal optical scientist and senior program manager at General Atomics, where he has been active in education activities since 1992, mostly focused on K - 12 science.

2011 APS Fellows Nominated by the Forum on Education

Peter Collings

At its November meeting, the American Physical Society Council elected to Fellowship six people nominated by the Forum on Education. The contributions of these new Fellows range from seminal scholarship in physics education to extraordinary leadership of a national society.

Bruce Mason, an Associate Professor at the University of Oklahoma, was cited for his outstanding leadership as director of the ComPADRE project and as the editor of the MERLOT physics collection of educational resources. Bruce received his B.A. from Oberlin College and his M.S. and Ph.D. from the University of Maryland. He has been at the University of Oklahoma since 1989 and before that he performed research at the University of Illinois.

John Mateja, Director of Undergraduate Research and Scholarly Activities at Murray State University, has worked tirelessly to improve undergraduate education through the participation of undergraduates in research. His efforts have been at the local, state, and national levels. John earned his B.S. and Ph.D. degrees at the University of Notre Dame and recently completed a term as a program officer at NSF.

Jose Mestre, Associate Dean for Research and Professor of Physics and Educational Psychology at the University of Illinois, has made ground-breaking applications of the principles and methodologies from cognitive science to physics education research. He received his B.S. and Ph.D. from the University of Massachusetts and was on the faculty there before moving to the University of Illinois.

David Van Baak currently is a Professor at Calvin College and was honored for developing equipment and tutorials for use in laboratory-based physics education. He earned his B.S. from Calvin College and his M.A. and Ph.D. from Harvard University. Before joining the faculty at Calvin College, he was an NRC postdoctoral fellow at JILA.

Gary White, who works at the American Institute of Physics, was cited for his inspired leadership of the Society of Physics Students, successfully facilitating the participation of undergraduates in local and national activities. Gary earned his B.S. degree at the University of Louisiana (now Northeast Louisiana University) and his Ph.D. from Texas A & M University. Before coming to AIP, he taught at NSU in Natchitoches, Louisiana.

Lawrence Woolf is Principal Optical Scientist in the Advanced Technology Group at General Atomics in San Diego and was commended for his extensive work in teacher professional development, for his assistance to California school districts, and for his leadership in K-12 science education at the national level. He received his A.B. from Rutgers University and his Ph.D. from the University of California, San Diego.

Peter J. Collings, Chair
Forum on Education Fellowship Committee

APS Excellence in Physics Education Award

Paula Heron

The AAPT Physics Teaching Resource Agents (PTRA) program has been recognized by the 2011 APS Excellence in Physics Education Award "for providing peer-led professional development for 25 years to more than 5000 physics and physical science teachers nationwide through a network of more than 500 master teachers." The PTRA program (http://www.aapt.org/Programs/projects/PTRA/) has a long history. In 1985, in response to concerns about the quality and quantity of physical science and physics teachers, the AAPT, with support from the NSF, established a model teacher professional development program.

Aimed at middle and high school teachers, the program provides professional development on physics content, teaching techniques based on research in physics education, and integration of technology into curriculum. The program currently maintains a nationwide cadre of more than 150 accomplished high school teacher-leaders who are trained and continually involved in professional development. The program has partnered with more than 30 college and university physics departments.

The program has passed through several stages in its history, responding to emerging including workshops aimed at the specific needs of teachers in urban districts and rural schools. The central goal of providing peer-led mentoring and support has remained a hallmark of the program and has played a major role in its sustained and enthusiastic embrace by the physics teaching community.

Though the program has involved hundreds of individuals in many roles, the following individuals were identified as deserving of special recognition:

George Amman

Robert Clark

Karen Jo Matsler

James Nelson

Lawrence Badar

Jan Mader

From The Newsletter Editor

Paul Dolan

Hello and Welcome to the Spring APS *Forum on Education Newsletter!* I'd like to introduce myself to you (and in the process invite submissions for future Newsletters).

I am a Professor at Northeastern Illinois University (NEIU) in Chicago. At a recent FEd meeting, I raised my hand to say "I'll help" (perhaps having been lulled into comfort by both the refreshments and the friendly collegial atmosphere), and the new FEd chair Larry Woolf heard me (and made note of my offer), so here I am.

NEIU is an urban, commuter, state supported school of about 10,000 students, with major programs in all the sciences, (and a few graduate programs–regrettably not currently in physics). NEIU began as a teachers college, and we retain our strong programs in education. My own background is in Low Temperature Physics, and my current research interests are superconductivity (point contacts between superconductors and ferromagnets), and granular materials (which is closely linked to fluid dynamics). My teaching interests include education of pre-service middle-school math/science teachers (which is how I also happen to be on the AAPT Committee on Pre-High School Education) and the "Advanced Labs" (which includes participation in ALPhA, the Advanced Labs Physics Association, www.advlab.org,–see more information of ALPhA and its activities below). You are likely to find me at an APS March Meeting, at an AAPT Summer or Winter Meeting, or at one of the many Chicago area section and local 'alliance' meetings. You may also have met me at the Topical Conference on Advanced Labs in Ann Arbor.

I think I knew quite early that my passion would be teaching (once I had decided to not follow my dad into the practice of Law), but as I proceeded through graduate school, I knew that a research component would also be essential to keeping me from stagnating as an educator.

That has proven to be true. My time spent doing research, and in particular regular attendance at research conferences, invigorates and enhances my classroom time, as much as attendance at more educationally-focused meetings like AAPT or NSTA.

I'm sure that this is true for many (probably most) of us, so I will try to not preach to the choir. However, there is all too often a delay and disconnect between 'researchers' and 'educators', especially involving pre-graduate education. I strive quite hard to 'reconnect'. Upon returning from a research meeting, I will scan my notes to find what I can share that is "new and neat" at the "frontiers of research" with my class, be it an upper level class, an introductory class, a general education class, or my future-teachers class. This is not just a question of assuaging my guilt from possibly missing a class period, or for scheduling an exam or activity that does not need my presence. I make a point of bringing ideas from the "frontiers" to not only student research projects, but to new/modified lab experiences (at all levels), and to class demonstrations. I have even co-taught a class on High-Temperature Superconductivity (including making and testing the "1-2-3" Yttrium Barium Copper Oxide (YBCO) compound) for local high school students. If you are not already consciously doing this, I strongly invite you to do so- you likely will find that not only you but your students becoming reinvigorated. Maybe you will even find a few new physics majors!

I also invite you to share your ideas and insights. (Most of) my time this current year is being devoted to putting my thoughts/ideas/demonstrations to paper, to share in suitable venues–something I have put off for quite some time. I am finding this particular experience also invigorating. The FEd is here to help you, and we need you to help us (and the physics community) with your submissions to a future FEd newsletter.

Along with this invitation, let me also issue a Challenge to the Readers: As you attend your various research meetings this year, be thinking about what new techniques and phenomena can be incorporated into physics education. Not things you'd like your graduate students to try, but new demonstrations, new labs, improvements to existing labs–at any level. If you have not thought this way before, it may be easiest to consider this as additions to 'advanced labs', but you may be surprised where else something "current" could fit in. This could be as dramatic as an entirely new experiment, or as simple as an improved method for sample preparation, or perhaps a new application for an existing (possibly considered outdated) apparatus. Send me what you find, with a couple of sentences of explanation, (and a reference, if you have one), and we will plan to publish a list of these ideas in a future FEd newsletter. Let's shorten the time from the "frontiers of research" to the physics lab and classroom.

Upcoming FEd Sessions at APS and AAPT

Chandralekha Singh, FEd Program Chair

The Forum on Education program committee and the session organizers have put together an exciting program for the 2011 APS meetings.

March Meeting: March 20-25, Dallas, TX
Invited Sessions sponsored or co-sponsored by the FEd

1. Enhancing graduate education in physics: Focus on skills, organized by Renee Diehl, Penn State University (sponsored by FEd, co-sponsored by FGSA), Thursday Morning Session V8
2. Educating physicists for industrial careers, organized by Mary Lanzerotti, Pacific Lutheran University (sponsored by FIAP, co-sponsored by FEd), Thursday Noon Session W5
3. Broader Impact: Partnerships and resources to achieve successful public and K-12 outreach and engagement, organized by Eric Marshall, (sponsored by FEd, co-sponsored by FPS), Wednesday Morning Session P5
4. Mentoring undergraduate research, organized by Sue Coppersmith, University of Wisconsin (sponsored by DCMP, co-sponsored by FEd), Monday Noon Session B5
5. Physics Education Research in upper-division physics courses, organized by Paula Heron, University of Washington (sponsored by FEd), Tuesday Noon Session J8

Focus Sessions sponsored or co-sponsored by the FEd

1. New ways of communicating physics, organized by Leonardo Colletti (sponsored by FEd), Monday Morning Session A14
2. Teaching computational physics to classroom and research students, organized by Vicky Kalogera, Northwestern University and Amy Bug, Swarthmore College (sponsored by DCOMP, co-sponsored by FEd), Thursday Morning Session V21

Contributed Sessions sponsored or co-sponsored by the FEd

Physics Education Research, Tuesday Afternoon Session L14

Other Sessions you should note

Water Cooler Discussion: APS Minority Bridge Program, Peter Muhoro and Ted Hodapp

The American Physical Society is launching a national effort to dramatically increase the number of underrepresented minorities who receive PhDs in physics. Come hear a brief description of the project and ask questions about how to get involved. (minoritybridgeprogram.com) Tuesday, 12 noon to 1.00 pm, (Room D166)

Tutorials and Workshops sponsored or co-sponsored by the FEd

Improving Your Skills as a Research Mentor, a Pre-Meeting Workshop, Sunday March 20, 1:30 – 5:30 p.m.

Scientists often are not trained for their crucial role of mentoring the next generation. Based on a research mentor training program developed at the University of Wisconsin and modified for physics by APS, this workshop is designed to help you start to become a more effective mentor. Through case studies, activities and small-group discussion, participants will define the role of a mentor, practice communication strategies, and learn how to facilitate a more extensive version of this workshop at their home institution.

More information about workshops is available at www.aps.org/meetings/march/events/workshops

April meeting-April 30 - May 3, Anaheim, CA

1. Excellence in physics education award session, organized by Paula Heron (sponsored by FEd)
2. Physics Education Research: Solved problems and open questions, organized by John Thompson (sponsored by FEd jointly with the American Association of Physics Teachers (AAPT))
3. Best practices in undergraduate research experiences, organized by Juan Burciaga (sponsored by FEd jointly with AAPT, co-sponsored by FGSA)
4. Educating and exciting the public about physics, organized by Larry Woolf (sponsored by FEd, co-sponsored by FGSA)
5. Best practices in K-12 physics teacher preparation programs, organized by Alice Churukian (sponsored by FEd)
6. Effective use of technology: engaging students inside and outside classrooms, organized by Homeyra Sadaghiani (sponsored by FEd)

Focus Sessions sponsored or co-sponsored by the FEd

Integrating modern physics into the K-12 curriculum, organized by Peggy Norris (sponsored by FEd, co-sponsored by DNP)

Tutorials and Workshops sponsored or co-sponsored by the FEd

Improving Your Skills as a Research Mentor, a Pre-Meeting Workshop, Friday April 29, 1:30 – 5:30 p.m.

APS Excellence in Education Award Session, Sunday May 1, 8:30 a.m.

FEd Reception/Awards/Business Meeting, Sunday May 1, 12:30 p.m.

Summer AAPT meeting-July 30 - August 3, Ontario, CA (California)

Plenary Session: Frontiers in Nanoscience (Monday Afternoon)

FEd Program Committee for 2011 March and April meetings

Juan Burciaga (Denison University), Alice Churukian (University of North Carolina), Paula Heron (University of Washington), Ruth Howes (Ball State University), Laird Kramer (Florida International University), Eric Marshall, Peggy Norris (Sanford Laboratory), Homeyra Sadaghiani (Pomona College), Amber Stuver (California Institute of Technology-LIGO), John Thompson (University of Maine), Lawrence Woolf (General Atomics), Chandralekha Singh (University of Pittsburgh).

2011 Physics Teacher Education Coalition Conference

Sustainability for Teacher Education Programs

May 23-24, AT&T Conference Center, Austin, TX

The **2011 Physics Teacher Education Coalition (PhysTEC) Conference** is the nation's largest meeting dedicated to physics teacher education. It features workshops, panel discussions and presentations by national leaders, as well as excellent networking opportunities.

The 2011 conference will focus on building sustainable teacher education programs, and will be held jointly with the UTeach Institute Annual Conference. The UTeach Conference will be on May 24–26.

www.ptec.org/conferences/2011

Physics Teacher Education Coalition

THE UTEACH INSTITUTE

Using Astronomy To Teach Physics

APS and AAPT Endorsed Workshop, July 27–30, University of Nebraska, Lincoln

Challenge

The past decades' discoveries and technologies of astronomy, astrophysics, and space science are remarkable, engaging, and rich in physics. This summer there will be a workshop at University of Nebraska, Lincoln to explore ways to use these materials to enrich college and university physics instruction. This is a challenging task. Do you want to help?

Stars orbiting a black hole at the center of our Galaxy, exo-planets, and quantitative cosmology–and the technologies that underlie them–such as IR detectors, multi-mirror telescopes, long baseline radio interferometry, orbiting x-ray and gamma-ray telescopes–are only a few examples of topics that are both exciting and rich in physics. They engage students.

These and other discoveries shape our understanding of humanity's place in the universe. Every student should know this story. And every physics student should know the physics that supports this modern version of Newton's System of the World.

The challenge of the UATP workshop is to find practical ways to encourage the effective use of astronomy to enhance college and university physics instruction. By participating in the workshop you can help define the challenge and meet it.

Workshop Goals

Some fifty astronomers and physicists will work together to identify materials derived from astronomy, astrophysics, and space science suitable to use in physics instruction. They will propose actions to produce useful teaching materials and suggest strategies to encourage their use in physics courses. Possible actions might be to

- outline possible physics texts with a strong astronomical flavor (at least one such text is now in preparation);
    - ◊ paper text
    - ◊ wiki text
    - ◊ syllabus of physics study using web-based astronomy and space science materials
- construct, compile, and disseminate physics problems that use discovery data from astronomy to illustrate physics principles, e.g.
    - ◊ Andrea Ghez's beautiful orbits of stars around the Galactic center that reveal the black hole there or
    - ◊ Dave Charbonneau's exoplanet data from Kepler
- describe themes for organizing a physics course around research results from astronomy and space science, e.g.
    - ◊ the modern version of Newton's system of the world, our current perception of Earth's situation in the Universe,
    - ◊ the physics that explains the properties of stars
    - ◊ the physics students need to know to understand important parts of the astronomers' latest decadal study.
- prepare modules of instructional material based on discoveries or technologies of astronomy.
    - ◊ different modules for different physics courses, e.g.,optics of multi-mirror telescopes
        - infra red astronomy–detectors and their physical properties
        - Interferometry in several modes – optical, radio, gravitational radiation – LIGO
        - nuclear physics of gamma-ray astronomy–Fermi
- recruit authors to write articles describing the modules with the aim of publishing these in the *American Journal of Physics* special issue "Using Astronomy and Space Science Research in Physics Courses" to be published in the spring of 2012.

Where and When

The University of Nebraska, Lincoln will host the workshop on the UNL campus from July 27 to July 30, 2011. AAPT is handling the registration details. These include links to lodging arrangements–there is a dormitory option as well as a convenient hotel with special rates for workshop participants. The registration website will be at AAPT.org and will open in early February. The registration fee is $250 which includes the welcome dinner the evening of July 27. The registration fee for non-participating companions is $50.

Contact Kevin Lee at UNL (klee6@unl.edu) or Charles H. Holbrow (cholbrow@colgate.edu) for more information or if you wish to be invited. The capacity of the workshop is limited, so it is a good idea to inquire soon.

Related Events

The UNL workshop is part of a larger effort to encourage and help physicists to introduce more astronomy research results into their courses.

- In June 2012 there will be a Gordon Research Conference–Physics Research and Education, on using research results from astronomy to teach physics.

- The April 2012 issue of the *American Journal of Physics* will be devoted to the theme of using astronomy in physics instruction.
- May 25, 2011 there will be a special session "Using Astronomy to Teach Physics" at the American Astronomical Society's (AAS) meeting in Boston. The speakers in the session will be David Charbonneau (Astronomy & CfA, Harvard U.), Max Tegmark(Physics, MIT), Joseph Amato(Physics & Astronomy, Colgate U.), Karen Kwitter (Astronomy, Williams College), Philip Sadler (CfA, Harvard U.) and Chris Impey (Astronomy, U. Arizona).

Forum on Engaging the Public

Dan Dahlberg and Philip W. Hammer

At its November 2010 meeting, the APS Council approved the formation of a new forum, the Forum on Outreach and Engaging the Public (FOEP). The FOEP was motivated by the need to increase the public's awareness of physics while also providing a "home" within APS for the large number of physicists currently involved in a diverse array of outreach and public engagement activities. The idea emerged from the APS Committee on Informing the Public (CIP), which had a growing sense that there is strong APS member interest in forming a new APS unit focused specifically on outreach and public engagement. The CIP felt strongly that addressing this need is important to the health of the physics community.

Physicists are increasingly involved in creative public engagement activities such as blogging, multimedia, video, pop culture, popularizations, press relations, politics, "amateur" and distributed science, science cafes, and public shows and lectures. Many do so as part of broader impact and outreach requirements of grant applications. Others do so as a core element of their professional activities. The creation of the FOEP will foster the development and dissemination of such programs, ideas, best practices, and lessons learned. Our goal is that the FOEP will encourage more APS members to engage the public as partners in the enterprise of physics. Some examples of expansion include improving our contact with members of Congress, public lectures such as the one at the March meeting last year and this year by Jim Kakalios (the author of *The Physics of Superheroes* discussing the materials aspects of superheroes), and the hugely successful Laser Haunted House at the 2010 USA Science and Engineering Festival.

We anticipate public engagement will be at the core of FOEP activities. This entails putting more science in the eyes of the public so they can appreciate/understand/engage with what science does and what it does for them. A big goal of the new forum could be how to connect to the average person. To accomplish this we also recognize we need to learn how to gain support from media people in TV, radio, and the internet. We also need to nurture and grow a community of physicists with a real interest in outreach to pass on programs that work, along with disseminating best practices, and promoting new ideas.

FOEP would provide an intellectual venue for like-minded APS members to share their work on engaging the public about physics. The outcomes would be an increase in the number of physicists involved in public engagement, improvements in the effectiveness of such activities, and a growth in creative new ideas for building appreciation of and support for physics.

Why "engage"? Engagement implies interacting with the public in ways that stimulate thought, activity, follow up, and lasting positive impressions. In other words, FOEP hopes to engage the public as active supporters and aficionados of, and participants in, physics. We see this as a battle for the hearts and minds (and hands) of the public as a way to maintain the relevance of, and their passion for, physics. Engagement is something different than education or a focus on particular issues; engagement is active involvement that takes advantage of the full spectrum of venues where the public can be found. Engagement is part outreach, part informing, and part communicating; but it is also more than these things combined. Engagement is an aspiration to establish a two-way connection between APS members and the general public.

To join FOEP at no cost prior to renewing your APS membership, send an email to membership@aps.org with your request to add FOEP to your membership. Please note that if you currently belong to two or more forums, FOEP will be added at no charge for the remainder of your membership term. On your next membership renewal notice, you will see a Forum subtotal that will include $8 for every Forum membership over two.

For more information on FOEP, go to: www.aps.org/units/foep or contact either of the authors.

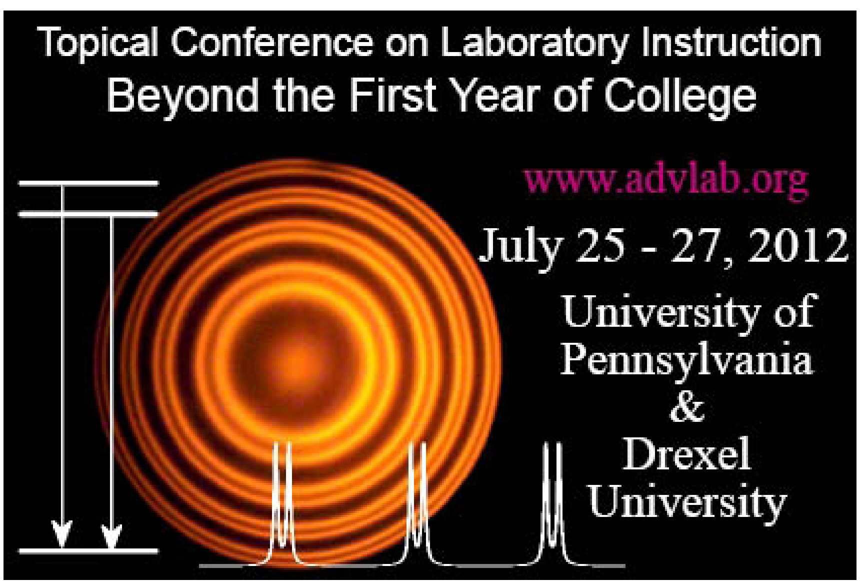
Learn More About the Advanced Labs You Teach

David Van Baak, Paul Dolan, Gabriel Spalding

Those of you who teach an advanced laboratory, whether it is your department's formal "Advanced Lab" course, or a lab that goes along with an upper-level course such as Optics, Electronics or Materials, may feel that you are alone. Survey results indicate that the most likely number of professors who have EVER taught the 'advanced lab' at an institution is either two or one. However, you are NOT alone–the Advanced Laboratory Physics Association (ALPhA) was started with you in mind, to create a community of fellow instructors who also teach these labs. Among the first actions of ALPhA was the AAPT/ALPhA Advanced Lab Topical Conference preceding the 2009 Summer AAPT Meeting in Ann Arbor. For those of you who might have missed that meeting (or who just wanted even MORE), put July 2012 on your calendar–ALPhA & AAPT are planning the next topical conference on labs "Beyond the First Year", to be held on July 25–27, 2012, preceding the Summer AAPT Meeting in Philadelphia.

Didn't learn enough about that ONE experiment you really want to do? Then consider coming to one of the ALPhA Immersions. These are 2–3 day sessions that concentrate on a particular experiment, so that you can learn about it in detail, and be prepared to share what you know with your students. The first ALPhA Immersions were held in Summer 2010 at four locations, covering such topics as Pulsed NMR, High Temperature Superconductivity and Saturated Absorption Spectroscopy (to name just a few). The next round of Immersions will be held in Summer 2011 at Bethel University (St. Paul, MN), at Buffalo State College (Buffalo, NY), at Caltech (Pasadena, CA), at Reed College (Portland, OR), at Colgate College (Hamilton, NY), and at the University of Rochester (Rochester, NY). More information on these and other ALPhA initiatives can be found at www.advlab.org.

The authors are members of the Board of ALPhA, and also of the Steering Committee for the 2012 Topical Conference.



Celebrate NanoDays™ 2011

Christina Akers, cakers@smm.org, 651-221-9434

NanoDays is a nationwide festival of educational programs about nanoscale science and engineering.

NanoDays is organized by the Nanoscale Informal Science Education Network (NISE Net), and takes place nationally from March 26 through April 3, 2011. This community-based event is the largest public outreach effort in nanoscale informal science education and involves science museums, research centers, and universities from Puerto Rico to Alaska.

NanoDays celebrations bring university researchers together with science educators to create unique new learning experiences for both children and adults to explore the miniscule world of atoms, molecules, and nanoscale forces. Most NanoDays events combine fun hands-on activities with presentations on current research. A range of exciting NanoDays programs demonstrate the special and unexpected properties found at the nanoscale, examine tools used by nanoscientists, showcase nano materials with spectacular promise, and invite discussion of technology and society.

The local community can experience many of these activities firsthand. Visitors will investigate super thin materials used in solar cell technology, forces stronger than gravity, and sand that doesn't get wet–even under water! Other activities include using your nose as a nanodetector and measuring yourself in nanometers.

More about Nano and NISE Network

Many scientists and engineers believe that advances in nanotechnology have the potential to bolster the U.S. economy through innovations providing clean, secure, affordable energy, techniques to clean up hazardous chemicals in the environment, and medical devices and drugs to detect and treat diseases more effectively and with fewer side effects. Despite this promise, the public knows little about research and development being carried out today by 25 departments and agencies of the federal government and by universities and corporations in their own communities.

Originally launched by the Museum of Science in Boston, the Science Museum of Minnesota, and San Francisco's Exploratorium, the NISE Network is now led by 14 museums and universities across the nation. In 2005, an initial grant funded formation of NISE Network to collaboratively develop and distribute innovative approaches to engaging Americans in nanoscale science and engineering. The NISE Network has won its second five-year $21 million grant from the National Science Foundation allowing partners to continue the work of the NISE Net into the next decade.

Through activities like NanoDays, the NISE Network is actively building partnerships between science museums and research centers to increase their capacity to engage the public in learning about nanoscale science and engineering. In addition to the individual museums and research centers, two major professional organizations–the Materials Research Society and the Association of Science-Technology Centers–support the NISE Network and annual NanoDays activities.

For more information about NISE Net or to download a digital NanoDays kit please visit http://www.nisenet.org/nanodays.

For more information about Nano please visit http://www.whatisnano.org

This project is based on work supported by the NSF under Award Numbers ESI-05322536 and 0940143. NanoDays™ is trademarked by North Carolina State University and used by NISE Net with permission.

NOTE added by the editor–This is a really fun, exciting, and educational event–I encourage your participation, at whatever level you can do. However, a caution–if you are accepted as a 'full participant' to receive a "NanoDays" Kit, then a GIANT box of Nano-Activities will arrive in your office–so be prepared!!

NanoJapan: Connecting U.S. Undergraduates with the Best of Nanoscience Research in Japan

By Dr. Cheryl Matherly, University of Tulsa, Sarah Phillips, Rice University, and Prof. Junichiro Kono, Rice University

Jeffrey Lee, a sophomore majoring in mechanical engineering at Rice University, described the moment during the 2010 NanoJapan Program in which he really understood the global nature of science research. "The best example . . . came when a professor from Boston University came to [Professor Tonouchi's] lab and gave a talk at an Osaka University symposium. Sometime that week, I found myself eating dinner with an American professor, a doctorate student from China, all hosted by a Japanese professor and his lab, and I realized truth behind the statement that science transcends international borders."

Jeffrey Lee at the Bunraku National Theater in Osaka, Japan

Lee's experience reinforced one of the learning objectives of the NanoJapan International Research Experience for Undergraduates. The NanoJapan International Research Experience for Undergraduates (IREU) program is the key educational initiative of the National Science Foundation funded Partnerships for International Research and Education (NSF-PIRE) grant awarded to Professor Junichiro Kono of Rice University and his collaborators at the University of Tulsa, University at Buffalo (SUNY), University of Florida, Texas A&M University, and Southern Illinois University, Carbondale. Initially just one of twelve projects selected for the PIRE program in 2006, the PIRE: U.S.-Japan Cooperative Research and Education on Terahertz Dynamics in Nanostructures renewal grant will support the expansion of a unique interdisciplinary U.S.-Japan research and education partnership focused on terahertz (THz) dynamics in nanostructures over the next five years. The U.S. and Japan are global leaders in both THz research and nanoscience, and stimulating cooperation is critical to further advance THz science and develop commercial products from new ideas in the lab. However, obstacles exist for international collaboration–primarily linguistic and cultural barriers–and this PIRE renewal project aims to continue to break down these barriers by providing future generations of researchers with a better understanding of both the culture and the state-of-the-art technology in each country.

The strong educational portfolio of this project focuses on cultivating interest in nanotechnology among young U.S. undergraduate students, especially those from underrepresented groups, and encouraging such students to pursue graduate study and academic research in the physical sciences. NanoJapan is a twelve-week summer program that involves first and second year undergraduate science and engineering students from U.S. universities in research internships with Japanese nanoscience laboratories. While the heart of the program is the summer research experience, NanoJapan places strong emphasis on preparing students to work effectively in cross-cultural laboratory settings. Before beginning work in their research labs, students complete a three-week orientation program based in Tokyo that combines 45 hours of Japanese language instruction, an orientation to Japanese life and culture, and an introduction to nanoscale science in Japan. At the completion of the orientation, the students depart for their research labs, working for eight weeks at universities throughout Japan–Hokkaido University, Tohoku University, the University of Tokyo, Chiba University, Tokyo Institute of Technology, Keio University, Shinshu University, Osaka University, and Osaka Institute of Technology. At the end of the summer, the students return to Rice University to participate in a re-entry seminar and present their summer research with other students who completed domestic research projects as part of the Rice Quantum Institute Annual Research Colloquium.

Each of the participating labs agreed to host a NanoJapan student to work on a research project under the supervision of a mentor, usually an English-speaking graduate student or post-doc. It is unusual for first and second year undergraduate students to conduct research in Japanese universities, yet the hosting professors report that the students contribute both to the research and the general "internationalization" of the lab. The Japanese graduate students must speak English with the U.S. students, providing them essential practice with the language necessary for their participation in the international science community. One hosting professor explained, "It is very important for Japanese young generation to work in an international environment. In this sense, it is highly beneficial for my students to work together with foreign students who are conducting activities across national boundaries. All the NanoJapan students in these three years we welcomed were excellent, well-educated, and active for scientific research. They provided very nice stimuli and atmosphere to our laboratory, leading to enhance research activities."

Aleksandra Simicevic (LA State University) working in the Nojiri Lab at Tohoku University

As noted by Prof. Kono, "The status of the United States in science and engineering is changing. More and more people outside the U.S. are doing cutting-edge research. Graduate students today

Former NSF Director Arden Bement meets with NanoJapan 2008 participants at the Tokyo Institute of Technology

are more likely to succeed if they are prepared to work in a cross-cultural, multinational environment." By involving and training students in cutting-edge research projects in nanoscale science and engineering, NanoJapan aims to increase the numbers of U.S. students who choose to pursue graduate study in this field while also cultivating a generation of globally aware engineers and scientists who are prepared for international research collaboration.

"International cooperation in science is not a luxury; it is a necessity – and the foundation for the future."~ Former NSF Director, Arden Bement, "Investing in America's Future: Strategic Plan FY 2006-2011."

To learn more about the NSF-PIRE TeraNano Center and NanoJapan program, see http://nanojapan.rice.edu. To learn more about the NSF Partnerships for International Research & Education (PIRE) program, see http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=12819

A LaserFest Teachers' Day: Outreach to Local Science Teachers at the SESAPS Meeting

Amber L. Stuver

It isn't everyday that physicists gather in a teacher's region to discuss their profession. When meetings and conferences like this do take place, it is an exceptional time for us to reach out to the educators in that area to share our expertise in physics with them and to learn what challenges they face in preparing the scientists of tomorrow.

Dr. Ken Schafer presents a lecture on lasers to the teachers. Photo by J. Giaime.

When I was asked to help with the local organizing of the Southeast Section APS (SESAPS) Meeting, I immediately wanted to organize an outreach event for teachers much like the Teachers' Days that take place at the APS March and April Meetings. With 2010 being the 50th anniversary of the laser and the LaserFest celebrations taking place across the country, this was the perfect topic for a LaserFest Teachers' Day.

I first turned to the APS Outreach Department and inquired about getting 30 of the 2009 PhysicsQuest (http://www.physicscentral.org/experiment/physicsquest/) classroom kits that featured comics with the new laser superhero, Spectra. They agreed to supply me with these kits. Because of this, the participating teachers not only received training and interaction with physicists but they also received supplies to take back and use in their classrooms.

With the topic and materials accounted for, I sought financial support to fund expenses for a breakfast for the teachers and a lunch with scientists, where the teachers got to informally interact with physicists attending the SESAPS Meeting. The FEd helped to fund this effort through their Mini-Grant program (http://www.aps.org/units/fed/meetings/mini-grants.cfm) that seeks to fund outreach efforts that target K-12 teacher professional development events. The AAPT also supported this event financially and extended certification to this workshop so participants could option to earn National Continuing Education Units (http://www.aps.org/programs/education/teachers/teachers-days/aapt.cfm). Finally, the Optical Society of America (OSA) also financially supported this Teachers' Day as well as providing outreach materials.

The LaserFest Teachers Day took place on 23 October 2010 (the last day of the SESAPS Meeting) on the Louisiana State University (LSU) campus in Baton Rouge. The LIGO Science Education Center provided the staffing, including myself, for this event. About 20 teachers from 7 parishes attended and ranged from middle school to high school science teachers at all experience levels.

After breakfast, Dr. Ken Schafer (an Atomic, Molecular, and Optical professor at LSU) presented a lecture on the history of lasers, what makes laser light special, and how lasers are used in our everyday lives and in physics research.

When working through the PhysicsQuest classroom kit (which included activities on diffraction, polarization and phosphorescence), each activity was introduced with an explanation of the science being dealt with and going through the accompanying worksheets from the students' points-of-view (i.e. how they thought the students would answer the questions before doing the activity versus what the correct answers were). Since all of the activities were hands-on, special attention was also paid to the scientific method and the importance of determining correct physical outcomes through inquiry.

A teacher explores the diffraction pattern produced by a piece of fabric. Photo by J. Giaime

At lunch, several physicists attending the SESAPS Meeting joined us and had lunch with the teachers and had informal discussions. The conversations were a productive two-way discourse ranging from information on a physicist's research and teaching in the college classroom to teachers discussing the challenges they have in their classrooms.

By the end of the day I believe that I learned as much about the real-life challenges that teachers encounter in their day-to-day careers as the teachers learned from the presentations. In the evaluation of the day, teachers expressed their appreciation for workshops that provide them with classroom materials, especially those that are hands-on and their desire for more workshops like this regardless of the theme.

If you are interested in organizing a Teachers' Day like this, the APS has assembled a web page with information they've refined from planning workshops like this at http://www.aps.org/programs/education/teachers/teachersdays/manual.cfm. And if you are organizing an event that focuses on K-12 teacher preparation, please consider applying for a FEd Mini-Grant.

Amber Stuver is a postdoctoral scholar at the LIGO Livingston Observatory where she works with their Science Education Center as well as performing traditional gravitational wave research. She also serves the APS as an APS/AAPT Member-at-Large on the FEd Executive Committee, is the Councilor for the FGSA and is a member of the APS Executive Board. Amber writes an outreach blog about working as a physicist (www.livingligo.org) and can be contacted at stuver@ligo-la.caltech.edu.

Local Physical Science Alliances Now Developing in Illinois

Dr. Carl J. Wenning, President, Illinois Section of AAPT, wenning@phy.ilstu.edu

Illinois has a history of active local physics alliances. Illinois State Physics Project (ISPP), Quark Net, Physics Northwest, and Physics West have operated in the Chicago metropolitan area for many years. Southwestern Illinois has been active in the St. Louis Association of Physics Teachers for many years. Central Illinois had active physics alliances based in Peoria and Springfield and in years past. Statewide efforts are now taking place to renew and expand teacher alliances across the entire state of Illinois.

Recently, the Illinois Section of the American Association of Physics Teachers (ISAAPT) has taken the lead in developing Local Physical Science Alliances (LPSAs) outside the Chicago metropolitan area. LPSAs are designed to involve not only teachers of physics, but of chemistry and earth & space science as well. Recent joint activities between the ISAAPT and the Illinois Association of Chemistry Teachers (IACT) in part led to this initiative. During the summer of 2010, these organizations joined with the Illinois Science Teachers Association (ISTA) to promote and develop a statewide effort involving twelve zones outside of Chicago. The ISTA provided some $2500 to support a LPSA Zone Leaders Workshop during August.

Each LPSA serves as an informal professional science education society operating within a small geographic area. Zone leaders were successfully recruited from 10 of 12 academic centers around the state. Small zone sizes allow for teachers to attend after school meetings without having to travel more than 45 minutes.

LPSAs are being created to help achieve the ends for which the ISAAPT, IACT, and ISTA were organized. Once fully developed, the memberships of LPSAs will meet four times per academic year to forge and sustain links between elementary school, middle school, high school, community college, and university faculty members who teach physical science. Attendees will share ideas, develop learning-teaching modules, learn from one another, gain a sense of empowerment, and have a good time. Physical science teachers at all levels will increase their effectiveness by participating in these local alliances, but especially when they spend time promoting and developing horizontal and vertical relationships with other teachers.

The four draft Physical Science (PS) core ideas from the preliminary framework of the new science education standards (NRC, 2010) are being considered as the basis of the four school year meetings of LPSAs. These include the broad content themes of matter, forces, energy, and waves.

Not only will content themes serve as organizing elements for various LPSA meetings, but so will vertical and horizontal relationships. During the inaugural year, the meetings–each locally planned and based on the needs of participating teachers–will bring together physical science teaches from high schools, community colleges, and universities. They will pilot LPSA activities and improve them for utilization during the second year. During this second year, physical science teachers at the middle and elementary school will be invited to participate in these twice-per-semester meetings.

Ideally LPSA meetings will focus on inquiry-oriented teaching –especially the development of "inquiry sequences" based on the author's article, "Levels of inquiry: Hierarchies of pedagogical practices and inquiry processes" (Wenning, 2005). No longer should inquiry teaching be treated as an amalgam of interrelated activities. Rather, inquiry teaching will be seen as incorporated a set of activities based on a philosophically developed inquiry spectrum. The inquiry spectrum includes discovery learning, interactive demonstrations, inquiry lessons, and inquiry labs. Teachers at all levels will work cooperatively to create various inquiry sequences for physical science lessons from a single topic area as a professional development activity that they can immediately transport into their classrooms.

While teachers at the elementary and middle school levels might not implement certain inquiry lessons and labs, they certainly will want to participate in them during LPSA meetings to develop a better understanding of the concepts. Teachers at the high school level and above can learn from elementary and middle school teachers about conceptual difficulties that students at these levels seem to share. The goal is for teachers to teach teachers so that we can improve the quality and amount of science learning with which children of Illinois struggle each year.

Readers can learn more about this initiative by visiting the LPSA website at http://www.phy.ilstu.edu/lpsa/ which is currently under development, or by email at wenning@phy.ilstu.edu.

References:

National Research Council (2010). *A Framework for Science Education: Preliminary Public Draft.* http://www7.nationalacademies.org/bose/Standards_Framework_Preliminary_Public_Draft.pdf, retrieved 7/16/2010.

Wenning, C. J. (2005). *Levels of inquiry: Hierarchies of pedagogical practices and inquiry processes.* Journal of Physics Teacher Education Online, 2(3), 3-11.

Carl Wenning is the immediate past president of the Illinois Section of the American Association of Physics Teachers. He is a semi-retired member of the Illinois State University Physics Department, and continues to work part-time in teacher education. He was director of the Department's physics teacher education program from 1994-2008.

What Can We Learn From Physics Teachers In High Scoring Countries On The TIMSS And PISA International Assessments?

by Dr. Cherrill Spencer

Report on an invited session at the 2010 "April" APS meeting held in Washington DC on 16th February, 2010. The session was organized and chaired by Dr. Cherrill Spencer, a member-at-large of the Executive Committee of the Forum on International Physics, who has written this detailed summary for the Forum on Education newsletter so that more people than the 30 who attended the session can learn about this topic. This session was co-sponsored by the Forum on International Physics and the Forum on Education.

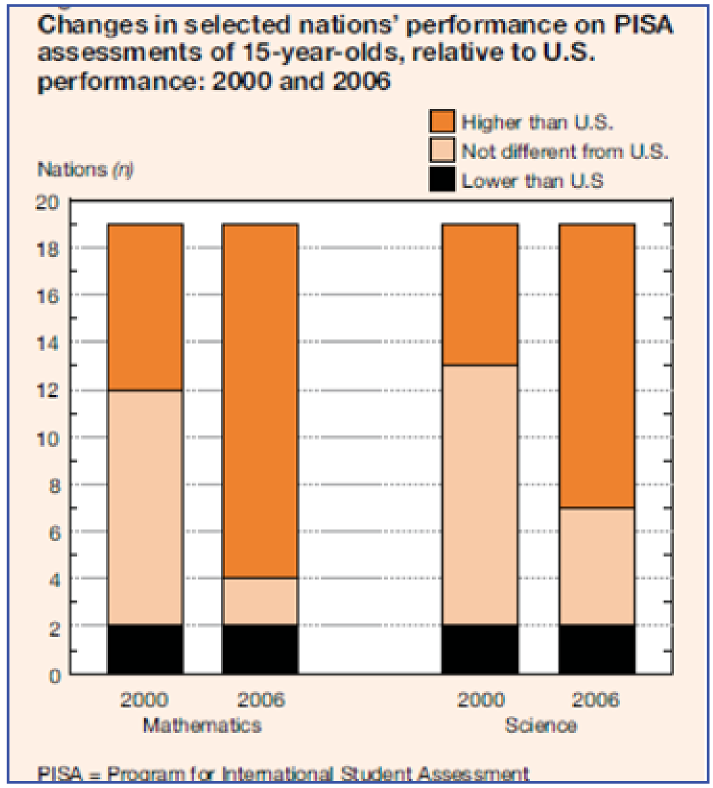
The slides of the three speakers are posted on the Web.

- **Turlo:** http://www.aps.org/units/fip/meetings/upload/turlo10.pdf
- **Bao:** http://www.aps.org/units/fip/meetings/upload/bao10.pdf
- **Hirvonen:**http://www.aps.org/units/fip/meetings/upload/hirvonen10.pdf and I recommend you look at the slides in conjunction with reading this summary.

Introduction by Dr. Cherrill Spencer, Chair of the session

High-school teachers are amongst the most important contributors to the development of the science and technology workforce of the future. Many of the more than 23,000 US high-school physics teachers are not adequately prepared to teach the subject. Only one-third of them, for example, majored in physics or physics education. Can inadequate teacher preparation be a factor in the poor performance of US students on international assessments of their achievements in science and physics? Since 1995 the Trends in International Mathematics and Science Study (TIMSS) has been administered four times to many hundreds of thousands of students in over 60 countries. TIMSS is used to measure trends in the mathematics and science knowledge and skills of fourth- and eighth-graders. The Program for International Student Assessment (PISA) has been administered three times since 2000, it focuses on 15-year-olds' capabilities in reading literacy, mathematics literacy, and science literacy. TIMSS Advanced (1995) assessed school-leaving students who have had special preparation in advanced mathematics and physics. In all these studies the US students, including the Advanced Placement physics students, scored below the international average, sometimes in the bottom third of countries! See the figure in the next column.

Three knowledgeable speakers were invited to talk about the physics K-12 education systems in other countries: one that consistently scores at the top of the PISA (Dr. Pekka Hirvonen, Finland) or score much higher than the USA on TIMSS (Dr. Jozefina Turlo, Poland, covering various Central European countries) and significantly better on recent bi-lateral comparisons (Dr. Lei Bao, covering China in comparison to the USA). This session was designed to find out what we can learn from the physics teaching systems in these high-scoring countries that might be pertinent to our efforts



to improve the teaching of physics and science to 8th through 12th graders in the USA.

There are several differences in the design and purpose of the TIMSS and PISA assessments, for example the TIMSS focuses on the application of familiar skills and knowledge often emphasized in classrooms, whereas the PISA tests emphasize students' abilities

L to R. Pekka Hirvonen (Finland), Jozefina Turlo (Poland), Cherrill Spencer (SLAC, USA) and Lei Bao (Ohio State University) to apply skills and information learned in school to solve problems or make decisions they may face at work. PISA test questions tend to deemphasize factual recall and demand more complex reasoning and problem-solving skills than those on TIMSS, requiring students to apply logic, synthesize information, and communicate solutions clearly.

"Physics teacher education in Finland and reasons underlying the top scores of Finnish students in international assessments"

"Physics teacher education in Finland and reasons underlying the top scores of Finnish students in international assessments" was the title of Dr. Pekka Hirvonen's presentation. He is the head of the Education Unit in the Department of Physics and Mathematics at the University of Eastern Finland. He is Vice President of the Finnish mathematics and science education research association and board member of the Finnish graduate school of mathematics, physics, and chemistry education. Finnish 15 year olds, a nationally representative sample, scored the highest on the science PISA in both 2000 and 2006. In 2006 they scored 563 points (on a 0-1000 scale), the second highest was Hong Kong with 542, and the US was the 16th country with 489 points.

Dr. Hirvonen said that many people have tried to explain the good results of the Finnish children, the Finnish policymakers claim they have made wise decisions and that is the reason, on the other hand, teacher educators say they are educating such good teachers, while the teachers say they are teaching so well. Probably they are all partially right. His favorite explanation is that education is highly appreciated in Finland. Since the Second World War the Finnish society has developed quickly from an agricultural country to a high-tech and education-oriented country and this development has been brought about through an improved education system; a good education in Finland has always been a way to achieve a job in their society, no matter their family's background.

Furthermore, because the Finnish population is quite homogeneous it is easy to teach the children the basic skills quickly. He contrasted this with classes (such as we have in USA schools) with children from 10 different countries who are trying to learn to read and write English first, this is a difficult environment for the teacher. Another typical feature of the Finnish school system is that it is organized so that even the weakest children learn basic skills; this system may not be best for the smartest children.

Dr. Hirvonen talked about the influences on teacher education in Finland. Their physics teachers are trained in universities and each university has much freedom in deciding the content of their teacher education program. These programs cover both the acquisition of the physics knowledge and learning how to teach (the pedagogy). The structure of their teacher training has been influenced by how it is done in other European countries, but they have some unique aspects too. One is that there is a school within the university where the student teachers teach real children well before they get their degrees; this is an expensive strategy but it produces good teachers. The pedagogical studies and training school are organized by the faculties of education. The Finnish national school curriculum is not completely defined, its aims and content are given in a general sense and the teachers are trusted to be competent enough to make good decisions, so the teacher education is taken seriously.

Dr Hirvonen described the physics teacher education program at his university. Student teachers can apply to the teacher education program straight out of high school; they must have good final's scores and pass a suitability test that consists of an interview and a group session. During the first three years the prospective teachers learn just the same physics as the prospective physicists, in addition there are two laboratory courses just for the student teachers. One is basic laboratory practise for teachers; they work in groups of 3 and carry out well-defined hands-on activities. A tutor talks to them during the labs about taking observations and the concepts, and afterwards all topics are discussed in interactive lectures. The second special course is called laboratory practise for physics teachers, their responsibility is much bigger, they have 9 hours of lab time to create a teaching sequence lasting about one hour, with a clear learning goal. Then everyone's sequence is tried out with the other students working as a school-student.

At the beginning of their second year the student teachers begin their pedagogical studies in the department of applied education and start student teaching in the university training school. To become a licensed physics teacher in Finland one must have taken a Master's degree, i.e. two more years of study beyond the bachelor's degree. There are special courses for student teachers during their 4th and 5th years, some involve repetition of basic physics concepts to ensure they have a profound understanding of physics and some concentrate on students' pre-knowledge and learning problems. Other courses give them historical, philosophical or structural perspectives on physics, they see that it is not an isolated domain of knowledge. The Finnish idea is that teacher students should get a multi-dimensional picture about physics. It is not only learning formulas and doing problem solving but much more. They should be prepared to know what to teach, why to teach and how to teach in many different circumstances.

Dr. Hirvonen's final points were that their graduating teachers are still just beginners, they have been given a driving license and with much practice they will develop into skillful drivers. The co-operation between the three partners: subject department, department of applied education and university training school, is crucial to the success of the teachers they produce; they have a common goal- a good physics teacher.

More information about physics and teacher education research that is carried out in Dr Hirvonen's university can be found here: http://www.uef.fi/fysmat/fysiikan-opetuksen-tutkimus (in English) and he can be reached at this e-mail address: pekka.e.hirvonen@uef.fi

"Teaching to Learn and Learning to Teach"

Our second invited speaker was Dr. Lei Bao, associate professor in the Physics Department at Ohio State University. He was educated through his undergraduate degree in China and obtained his Ph.D in Physics at the University of Maryland in 1999. His current research focusses on the large-scale quantitative assessment of learning in science and scientific reasoning in the international context. He is chair of the International Education Committee of the AAPT and holds guest professorships at 3 Chinese universities. His presentation was titled : "Teaching to Learn and Learning to Teach".

Dr. Bao noted that the TIMSS and PISA assessments offered a global view of K-12 science education and their data enables comparisons of education systems in different countries. Researchers such as he make the comparisons not in a competitive sense, but to learn about various systems. To experimentally prove that some way of teaching caused some better scores than another would need a totally randomized test (like a double blind experiment in medicine) and running such tests in real education settings is very difficult. Nevertheless, Dr. Bao is part of a physics education research community that is developing new research methodology and running comparison studies of Chinese and US physics high school and college students.

Dr. Bao observed that the competition to get into a Chinese university is fierce and he showed some math questions on the Chinese university entrance test for prospective science undergraduates. Everyone in the room gasped at the difficulty of the questions, then he showed some physics questions on the same entrance exam and we gasped again, especially as there were about 20 such difficult questions to be answered in two hours. The Chinese physics undergraduate must be able to really understand physics concepts and so their high school teachers must be able to teach them these concepts. High school teachers are trained in so-called "Normal" universities; it is their dedicated goal to produce teachers. Dr. Bao showed lists of mandatory and elective courses in the physics department at Huazhong Normal University, one can see the similarity to a US BS in physics in the mandatory courses (65 credits), and on top of those the physics teachers in training have to do 16 credits of professional education courses and 24 credits of elective courses:

The required courses in the physics department of Huazhong Normal University are listed as following.

- Mandatory courses:
  - Advanced Mathematics A(1,2), Linear Algebra A,
  - Mechanics, Thermodynamics and molecular physics, Optical, Static Electricity and magnetism, Analytical mechanics, Methods of mathematical physics, Atomic Physics, Electrodynamics, Quantum Mechanics, Statistical physics, Analog Electronics; Physics Experiments Level 1, 2, 3. Analog Electronic Experiments.

    Credits for the above courses total to 65.
  - 16-credits of professional education courses such as introductory education, psychology, teaching in physics, physics teaching skills, and modern educational technology.
- Elective courses: 24 credits including advanced physics courses, professional education courses, teaching practice, and graduation design.

But the Chinese Science, Technology, Engineering and Math (STEM) education system over-emphasizes the learning of content to the detriment of learning how to solve real world problems, so their graduates do not have good problem solving skills. Another concern in China is that the STEM students lose interest once they arrive at university, they have had to work so hard for many years to get into university and while they are there they do not try to do well anymore. The main concerns about science and engineering education in the USA is that the students are, on average, below the expected performance level (as shown in the TIMSS) and there is a widespread "fear" of science and mathematics. Dr Bao noted that in both countries physics teachers are "teaching to the test" and this is not the best way for students to learn.

Both countries are engaged in STEM education reform and they have common goals: to balance the STEM content learning with the development of problem solving abilities, so that the new generation has the right mix of knowledge, skills and attitudes so that they become not only effective problem solvers but also good "problem creators". In Dr. Bao's opinion, currently both countries seem to be moving towards each other. The best solution is probably midway.

What are Physics Education Researchers (PER) doing to understand science education and science teacher preparation so that they can move forward the reform? Dr. Bao described how, currently in PER, we often emphasize research on the study of specific student difficulties in various contexts and on the development of new instructions. There hasn't been much research on developing a consistent theory and methodology that can be used to model student's conceptual learning and to provide guidance for developing effective assessment technologies and instruments. Research is often conducted without the benefit of a strong theoretical foundation. Therefore, it is urgent to develop a coherent theory for research in physics education. Without a unified theory, different researchers don't have a common language to talk about their research work. In order to make physics education a strong field in physics, it is important to integrate different pieces of research together under a consistent research framework. Such a theory doesn't exist in education research. Dr. Bao said physics education researchers need to develop a theory for physicists with appropriate mathematical tools.

Dr. Bao is studying how students acquire scientific reasoning skills and whether the amount of STEM content knowledge they are learning has any effect on their domain-general skills, such as the abilities to systematically explore a problem, formulate and test hypotheses, manipulate and isolate variables, and observe and evaluate the consequences. He is using well-known physics concepts' tests and a scientific reasoning test as his measures and the variables are the K-12 science education systems in China and the USA, represented by thousands of Chinese 1st year college students (have taken 5~6 years of physics courses, mandatory, at complex level) and thousands of US 1st year college students (have taken 1~2 semesters' of physics, elective, at basic level).

To test their content knowledge the students all took (in their own language) the same FCI–force concept inventory test (mechanics, 30 questions, multiple choice) and same BEMA–brief electronic and magnetism assessment (E&M, 31 Questions, multiple choice). To test their scientific reasoning they all took a "Lawson" test with 24 multiple choice questions which tested abilities such as proportional reasoning , probabilistic reasoning and hypothesis deductive reasoning. Dr. Bao showed the three test scores of the Chinese and US students graphically. In the FCI the highest percentage of the Chinese students scored 28 correct answers and the highest percentage of the US students scored 12 correct answers; in the BEMA most of the Chinese students scored 22 correct answers, the US: 9 correct answers. So the Chinese students obviously knew/understood a lot more physics concepts than the US students. But the shape of their scores' histograms on the scientific reasoning test were statistically the same, leading to the same mean score of 17.9 correct answers out of 24.

So the conclusion of this series of tests is that under current education settings the learning of content knowledge doesn't seem to have an obvious effect on the development of general scientific reasoning abilities. But what methods are effective in developing scientific reasoning abilities? Dr. Bao's PER group did some further experiments: they administered the Lawson test twice and in between they taught some students some regular introductory physics courses, their scores did not change on the 2nd Lawson test; another group of students took some inquiry-based physics courses between the 2 Lawson tests and their 2nd test scores were significantly better. So Dr. Bao reported "It is not what we teach but how we teach that matters!"

Dr. Bao's team continues its research into how best to teach physics and they are evaluating the effectiveness of several education programs and developing a large scale national and international quantitative assessment database. They collaborate with researchers in 8 other countries and their work is reported in this journal: "Research in Education Assessment and Learning", which can be found at this website: www.iperc.org/REAL .

"Are the Competencies of Science Teachers and the Scientific Literacy of Society Essential for the Success of Physics Students?"

Our third invited speaker was Dr. Jozefina Turlo who was the head of the Physics Education Laboratory at the Institute of Physics, the Nicolaus Copernicus University, Toruń, Poland for 26 years. She graduated as a Ph.D in Physics from the same university and has been employed there since then as a researcher in solid state physics and in physics education. She is a member of the International Research Group on Physics Teaching-GIREP. She is the Polish Ministry of Education's referee on Teacher Training, Physics Textbooks and Educational Aids. Dr Turlo is Vice-President of the Polish Association of Science Teachers, partner in many European Union (EU) education projects and independent expert of a European Commission on Framework Project #7: "Science in Society". Her presentation was titled: "Are the Competencies of Science Teachers and the Scientific Literacy of Society Essential for the Success of Physics Students?"

Dr. Turlo reminded us what are the main features of our time: globalisation, economic development based on knowledge, social transformations and dramatically accelerating progress in new technologies [such as new communication methods based on a merging of information and communications technologies: ICT] which is leading to many new jobs. She described what these features imply for science education: that science must now be learnt by all, not just some, affecting the curricula and aiming for general scientific literacy; that science education must teach how to be innovative, best taught through inquiry teaching methods; and that the competency of science teachers and their enthusiasm affect the overall success of science education.

How does the science education community measure success, such that different countries can compare their education systems with others? There are several international studies that compare students in different countries and Dr. Turlo described the more important ones and their recent results.

Trends in International Mathematics and Science Study (TIMSS)
TIMSS is a series of assessments designed for fourth and eighth grade students to address concerns about the quantity, quality, and content of instruction. It is designed to identify progress or decline in student achievements. 50 countries from all over the world participated in the years 1995–2007. The best results were usually achieved by Singapore, Taiwan, Korea, Estonia, Japan, Hungary and the Netherlands (China has never participated in TIMSS).

Programme for International Student Assessment (PISA)
The PISA tests emphasize students' abilities to apply skills and information learned in school to solve problems or make decisions they may face at work, i.e. it measures their scientific literacy. Finland, with an average of 563 score points, was the highest performing country on the PISA 2006 science scale (as addressed by our first speaker Dr. Hirvonen). Six other high-scoring countries had mean scores of 530 to 542 points: Canada, Japan, New Zealand, Hong Kong-China, Taiwan and Estonia. Australia, the Netherlands, Korea, Germany, the United Kingdom, the Czech Republic, Switzerland, Austria, Belgium, Ireland, Liechtenstein, Slovenia and Macao-China also scored above the OECD [Organization for Economic Co-operation and Development] average of 500 score points.

On average across OECD countries, 1.3% of 15-year-olds reached Level 6 of the PISA 2006 science scale, the highest proficiency level. These students could consistently identify, explain and apply scientific knowledge, and knowledge about science, in a variety of complex life situations. The number of students at Level 6 cannot be reliably predicted from a country's overall performance. Korea was among the highest-performing countries on the PISA science scale, with an average of 522 score points, while the United States performed below the OECD average, with a score of 489. Nevertheless, the United States and Korea had similar percentages of students at Level 6.

The number of students at very low proficiency is also an important indicator in terms of citizens' ability to participate fully in society and in the labour market. At Level 2, students start to demonstrate the science competencies that will enable them to participate actively in life situations related to science and technology. Across the OECD, on average 19.2% were classified as below Level 2, including 5.2% below Level 1. Males and females showed no difference in average science performance in the majority of countries, including 22 of the 30 OECD countries. However, similarities in average performance mask certain gender differences: In most countries, females were stronger in i*dentifying scientific issues (using academic knowledge)*, while males were stronger at *explaining phenomena scientifically*.

Students' socio-economic differences accounted for a significant part of between school differences in some countries. This factor contributed most to between-school performance variation in the United States, the Czech Republic, Luxembourg, Belgium, the Slovak Republic, Germany, Greece, New Zealand, Bulgaria, Chile, Argentina and Uruguay.

There is no relationship between the size of countries and the average performance of 15- year-olds in PISA. There is also no cross-country relationship between the proportion of foreign-born students in countries and the average performance of countries.

International Physics Olympiads
The International Physics Olympiads were started in 1965 and around 70 countries have sent students to compete these last 5 years. Chinese students consistently appear in the top three highest scores in these Olympiads, this fits in with the data that Dr. Bao our second speaker presented.

The "First Step to Nobel Prize" competition is not as well-known as the Olympiads and Dr Turlo showed the rankings for 2005 to 2007 and in this arena of the brightest students the USA students came in the top 3 positions.

The ROSE study–the Relevance of Science Education, looks at children's attitudes towards studying science. Children from 36 different countries, including many in Africa who don't take part in the above studies, were asked how much they agreed with this statement: *"I like school science better than most other school subjects."* Their responses were plotted to show the percentage answering "Agree plus strongly agree" and they tracked female and male answers separately. At the top of the list with the highest percentage of children agreeing, and hardly any difference between girls and boys, is Bangladesh (~83%), with Uganda second (~80%); 5 other African countries: Ghana, Lethoso, Swaziland, Zimbabwe and Botswana all have agreement over 50%. Austria is the *only* European country where more than 50% of both girls and boys agree with the statement. The Scandinavian countries all cluster at the bottom of the plot with well under 40% agreeing with the statement, and Finland, who does so well in the PISA assessment has just 30% of boys and 21% of girls agreeing with the statement "I like school science better than most other school subjects". This is a fascinating set of results and during the discussion period after the speakers, Dr. Turlo told us how the researchers explained the wide range of country responses [Chinese children were not included in this study], see the description of the discussion period below.

There are many factors that influence the effectiveness of teaching, e.g. fiscal and other resources, the student's family background, the overall school quality, the curriculum quality, and, of course "quality of the teachers". Next Dr. Turlo discussed what competencies a science teacher needs to be an effective and good quality teacher:

- Subject knowledge
- Subject application (pedagogy, methodology of teaching – learning)
- Class management
- Assessment (evaluation), recording of students' progress
- Further professional development: for reflection and creativeness, being able to innovate, applying inquiry methods, using modern technology to communicate, use foreign languages, work in collaboration, etc.

To ensure that teachers gain these competencies they must be included in teacher training standards, but the enthusiasm and motivation of a teacher are characteristics that are difficult to imbue through training, they have to come from within the person!

Much of Europe is engaged in K-12 science education reform, like the USA and China are; there are shortcomings in curriculum, pedagogy, assessment and teacher quality, but the deeper problem is one of a fundamental nature. School science education has never provided a satisfactory education for the majority. Now the evidence is that it is failing in its original purpose, to provide a route into science for future scientists. To help develop a plan for science education reform across Europe a committee of 19 experts (including our speaker Dr. Turlo) was convened by the UK-based Nuffield Foundation and in 2008 they produced a report called *Science Education in Europe: Critical Reflections*, the two main authors being J. Osborne and J. Dillon. This important report was addressed to the Ministries of Education of all European countries.

This report makes 7 recommendations which are reproduced here because they set a framework for improving science education, and are applicable to the teaching of physics and the training of physics teachers *in any country*, the subject of the Forum of International Physics' invited session which this newsletter article is summarizing.

Recommendation 1
The primary goal of science education across the European Union (EU) should be to educate students both about the major explanations of the material world that science offers and about the way science works. Science courses whose basic aim is to provide a foundational education for future scientists and engineers should be optional.

Whilst science and technology are often seen as interesting to young people, such interest is not reflected in students' engagement with school science that fails to appeal to too many students. Girls, in particular, are less interested in school science and only a minority of girls select careers in physical science and engineering. The reasons for this state of affairs are complex but need to be addressed.

Let's exemplify the interest in science for boys and girls by listing the top 5 items boys would like to learn about in science and the top 5 for girls.

Top 5 items boys would like to learn about in science	Top 5 items girls would like to learn about in science
•Explosive chemicals; •How it feels to be weightless in space; •How the atom bomb functions; •Biological and chemical weapons and what they do to the human body; •Black holes, supernovae and other spectacular objects in outer space.	•Why we dream when we are sleeping and what the dreams might mean; •Cancer – what we know and how we can treat it; •How to perform first aid and use basic medical equipment; •How to exercise the body to keep fit and strong; •Sexually transmitted diseases and how to be protected against them

Recommendation 2
More attempts at innovative curricula and ways of organising the teaching of science that address the issue of low student motivation are required. These innovations need to be evaluated. In particular, a physical science curriculum that specifically focuses on developing an understanding of science in contexts that are known to interest girls should be developed and trialled within the European Union.

Recommendation 3
EU countries need to invest in improving the human and physical resources available to schools for informing students, both about careers in science–where the emphasis should be on why working in science is an important cultural and humanitarian activity–and careers from science, where the emphasis should be on the extensive range of potential careers that the study of science affords.

Recommendation 4
Student engagement or interest in science is largely formed by the age of 14. This situation has implications both for the formal curriculum and for opportunities to engage with science outside the classroom.

EU countries should ensure that:
- teachers of science of the highest quality are provided for students in primary and lower secondary school;
- the emphasis in science education before 14 should be on engaging students with science and scientific phenomena. Evidence suggests that this is best achieved through opportunities for extended investigative work and 'hands-on' experimentation and not through a stress on the acquisition of canonical concepts.

Recommendation 5
Developing and extending the ways in which science is taught is essential for improving student engagement. Transforming good teaching practice across the EU is a long-term project and will require significant and sustained investment in continuous professional development.

Recommendation 6
EU governments should invest significantly in research and development work on assessment in science education. The aim should be to develop items and methods that assess the skills, knowledge and competencies expected of a scientifically literate citizen.

Recommendation 7
Good quality teachers, with up-to-date knowledge and skills, are the foundation of any system of formal science education. Systems to ensure the recruitment, retention and continuous professional training of such individuals must be a policy priority in Europe.

Dr. Turlo brought her presentation to a close with a reminder that research physicists also have responsibilities in physics education. She told us that two-time Nobel Prize winning physicist, Maria Sklodowska–Curie, had created the Society of Scientists for Experimental Teaching in 1907, and had been a physics teacher for a class of 12 year olds. Here are the features of the active teaching methods this Society used 100 years ago:

Features of Active Teaching Methods Used by Marie Curie and other famous scientists in 1907:
- not verbal teaching,
- learning from nature and demonstration of exciting science hands-on experiments with the use of low-cost materials, explained by great scientists,
- students kept active by doing individual investigations,
- lively discussion (brainstorming) with the use of simple and understandable language,
- acquiring valuable social skills through the personal examples of teacher-genius: hard-working, persistence, honesty, sensitivity for needs of others, etc.

Dr. Turlo's final remark was to quote a Chinese proverb:

"If you think that education is not important or too expensive you didn't try ignorance yet."

Panel Discussion

Following the 3 presentations there was time for comments from the audience and a few questions to the speakers. Here are some of those comments, questions and the answers. Considering the amount of time spent on studying by high school students in different countries it seems that US kids spend much less than most as they do so many extra-curricular activities. Teachers have to find what motivates children to learn science and use those things in their teaching. Teacher-assistants were effective in helping lower performing children. Does a country with high Physics scores on the international assessments turn out more physicists?–no. Why do so many Chinese science students come to the USA for graduate school?–because the quality of US graduate school quality is better than that of Chinese graduate school and it is still hard to do basic science research in China. Is the USA draining the Chinese scientist population?–no.

There were many questions asked concerning not only the ways of training of pre-service teachers, but also methods for their in-service training, organization of schools, investment in education, teaching methods (student motivation), etc.

Furthermore, someone asked: Why do pupils in the less developed countries express more interest to learn about science topics as reported by the ROSE project? One can really notice a strong negative correlation between the average interest score and the level of development of particular country (HDI-human development index). The correlation between overall interest and HDI is - 0.85.

However, care should be taken when interpreting this overall result. One should *not* assert that children become less interested in science the more developed the country is. A better explanation for these data is rather to suggest that for children in (mainly) developing countries, going to school after the age of 15 is "luxury" or a "privilege". Hence, they are, in principle, happy to learn about nearly everything the school may offer. Kids in rich countries (with low rates of unemployment) can "afford" to see school more as a duty and an obligation more than as a privilege. Many students also think that school should be fun and entertaining. Therefore, they are more likely to express what they like and what they dislike. One might say that they are more "selective" in their choices. Additionally–A clear pattern is that topics that are close to what is often found in science curricula and textbooks have low scores on the rating of interest among young learners from Europe and other well developed countries–they have in the modern society much more interesting things around as : automobiles, TV, films, internet and computer games, etc.

The lively discussion period continued with many questions concerning not only the methods for training pre-service teachers, but also methods for their in-service training; organization of schools; investment in education; teaching methods and student motivation.

What can we learn from physics teachers in high scoring countries on the TIMSS and PISA international assessments? : Final words of advice from the three speakers.

Here is the final advice from our 3 expert speakers on what we can learn from the physics education systems in their countries:

- **Dr Pekka Hirvonen:** "Education should be taken seriously; it's an investment for the future"
- **Dr Lei Bao:** "It is not what we teach but **how** we teach that matters."
- **Dr Jozefina Turlo:** "Follow the recommendations of the 2008 Nuffield Foundation report, *Science Education in Europe: Critical Reflections*."

Cherrill Spencer was a member-at-large of the Executive Committee of the Forum on International Physics when she organized this invited session. While she served on the APS's Committee on Education from 1992 to 1994 she was a member of the first nominating committee for the Forum on Education. Spencer is a magnet engineer at the SLAC National Accelerator Laboratory.

Using Clickers in a University Physics Course to Improve Student Achievement

Judith C. Stull, David M. Majerich, Andria C. Smythe, Susan Jansen Varnum, Joseph P. Ducette, and Tiffany Gilles

University faculty are being charged to augment traditional methods of teaching in the large lecture hall with learner-centered, student-engaged, interactive strategies informed by what is now known about how many students learn [1]. To better preparing students for the skills needed for success in the 21st century [2], using new technologies during instruction that are interactive have shown to assist faculty in creating active learning environments where students can learn by doing, receive feedback during the process, construct new knowledge and improve skills, and continually refine their understandings of course material [3]. One way to create an active learning environment as just described is to integrate "clickers" [4] into instruction.

In brief, clickers are radio-frequency, battery powered, hand-held devices that are part of an electronic polling system. The predominant research about the clicker use has been shown that they promote student discussion, increase engagement and feedback, and improve attitudes toward science [5]. Although several research efforts report positive effects of clicker use on students' achievement [6,7], the empirical evidence that is needed to corroborate existing results and substantiate any claims for using clickers requires additional studies [8]. The research reported here provides evidence clicker use can improve student achievement in a university physics course.

Science Education Reform and Assessment

In recent years discussions of the role of assessments have taken center stage in the arena of science education reform debates. As generally understood, assessment is used by most instructors to determine what learning has occurred when compared to course expectations and is the basis for the assignment of grades to overall achievement. This type of assessment is summative and is the measurement of achievement at the end of a teaching-learning sequence. Assessment is formative when frequent evidence during the students' learning process is gathered and analyzed, where the results inform changes needed to instruction in order to meet students' needs, and provide students with feedback about their learning that they can then use to revise their studying strategies [9].

While the curriculum is already established in many college and university courses, and if assessment and learning are two sides of the same coin [10], it would seem reasonable that administering frequent assessments, analyzing their results, and sharing them with students, could inform changes to instruction needed in order to accommodate students' needs for continued learning.

Methodology

Learning Environment

This study was conducted to determine the effect of increased feedback from clicker episodes (formative assessment) on students' physics achievement (summative assessment) for students who used clickers when compared to students who did not. Students who enrolled in this physics course were mostly science and health profession majors and took this course to fulfill either a university core requirement or a major requirement. Taught in the large lecture hall, enrollment numbers generally ranged between 150-250 students per course. While all students were taught together during the lecture by the same instructor, the students were required to register for recitation and laboratory sections which generally have 25-40 students and were taught by other instructors.

Methods and Subjects

This study was conducted at a large, public, urban university in the mid-Atlantic region. Data were obtained from two fifteen-week introductory physics courses that met twice a week for 80 minute periods over two semesters taught by the same instructor. In all 157 and 152 students were enrolled in the two sections of the course, one taught in the fall semester and the other in the spring semester. The fall semester course was traditionally taught while the following spring semester course had clicker episodes (formative assessments) integrated into the instruction. Each learning object episode began with a multiple-choice question associated with a specific course topic, followed by a discussion of the results. The results of the clicker-based questions were collected, tabulated, and results displayed for students at the beginning of the next scheduled class. Problem areas were identified and provided the topic for discussion for the instructor and students. Based on the discussion, the instructor made appropriate adjustments to the instruction and hoped that the students would make the needed adjustments to their studying strategy. In the end, the spring semester students (clicker group) completed a total of seven formative assessments.

Results

Equivalent Groups

Both groups suffered loss of students. The attrition rates for the control and clicker groups were 20.4% and 23.0%, respectively; however the difference of proportions was not significant. It is expected that the more challenged students have a higher probability of withdrawing from the class. Accounting for self-selection bias, it is acknowledged that the groups' content and skill sets should be better at the end of the course than at the beginning.

Pretests composed of a mathematics and a physics section were administered in both courses. The maximum possible points for the physics and mathematics pretests were 7 and 25 points, respectively. Points for each component of the pretests were summed separately. Results of the pretests revealed the control group's pretest physics percentage scores (M=31.4%, SD=11.3%) were higher than the clicker group (M=30.7%, SD=11.3%), but the difference was not statistically significant. The clicker group's pretest mathematics percentage scores (M=57.3%, SD=23.1%) were higher than the control group (M=56.8%, SD=21.5%), but again were not statistically significantly different. Based on these results, the groups were deemed equivalent.

Regression Analyses

Regression analysis was used to control for differences among students and to quantify the effect of clicker use. In the model for predicting the students' physics achievement, the dependent variable was the student's final examination score and the independent variables were the physics/mathematics pretest score, the number of clicker quizzes taken, whether the course was a required one, the number of different types of assessments the student had previously experienced, the number of hours per week the student reported working, and whether the student was male. In specifying the model, the percentage of correct answers on any quiz were entered, but never proved significant. They were dropped from the analyses as a result. In entering the pretest score, we were estimating a "value added model" by taking into account the students' presenting knowledge base. Table 1 presents a summary of regression analysis for variables predicting students' Physics achievement.

The R Square equaled 33 indicating that the included variables explained 33% of the variation in the dependent variable. In the end, two variables proved significant–the number of clicker episodes and the number of different types of assessments the student had experienced. In all, there were seven clicker episodes. The regression results indicate that controlling for all of the entered variables, for every one more clicker episode the student took, the final grade was raised by 1.756 points. Thus, if a student took all seven of the "clicker quizzes," the final grade would have been 12.3 points higher, a difference of a grade. Interestingly, how well the student did on these "clicker quizzes" never proved significant. The number of different types of assessments the student has experienced is negatively related to how well they did on the final exam. Perhaps what is needed is consistency in assessing learning. One could speculate that students were using the clicker episodes to assess is they had studies enough or if they needed to study more. Thus explain that the number of clickers episodes and not the percentage correct proved to be significant.

Model	Unstandardized Coefficients	Standardized Coefficients		
	B	Beta	t	Sig.
Physics/Mathematics pretest score		-.059	-.952	ns
Number of clicker episodes taken	1.756	.230	3.298	.001
Was this a required course?	-1.799	-.030	-.485	ns
Number of types of assessments student had experienced	-1.881	-.413	-5.895	.000
Number of hours students works at a job per week	-.109	-.036	-.594	ns
Male student dummy	-.624	-.017	-.277	ns
(Constant)	58.142		9.567	w

Table 1. Summary of Regression Analysis for Variables Predicting Students' Physics Achievement

Conclusion

While there is an abundance of anecdotal information that advocates the use of clickers to improve student achievement in the science classroom, this study offers results to substantiate the claim. It is apparent that integrating clicker episodes, in this case weekly formative assessments consisting of multiple choice questions with in-class discussion of results, had a significant effect on student achievement. On average, students who used clickers achieved significantly higher scores on the cumulative final examination compared to the other group. The regression results quantified the effect. In sum, using clicker episodes did prove to be positively associated with improved achievement, but this is offered with caution as learning is a complex process and more data are needed on students' attitudes and behaviors.

The work reported herein was supported in part by the National Science Foundation grant 0455786 to Temple University. The opinions expressed do not necessarily reflect the position of the supporting agencies and no official endorsement should be inferred.

References

1. John Bransford, Ann Brown, and Rodney Cocking, *How People Learn: Brain, Mind, Experience, and School* (Washington, DC, National Academy Press, 2000).
2. Partnership for 21st Century Skills. (2010), "21st Century Learning Environments." Online at <http://www.p21.org/documents/le_white_paper-1.pdf>
3. Joel Mintzes and William Leonard(2006), *Handbook of College Science Teaching* (Arlington, NSTA Press, 2006).
4. Douglas Duncan, *Clickers in the classroom: How to Enhance*

Science Teaching using Classroom Response Systems (San Francisco, Pearson/Addison-Wesley, 2005).

5. Draper, S. W., & Brown, M. I. (2004). Increasing interactivity in lectures using an electronic voting system. *Journal of Computer Assisted Learning,* **20(4)**, 81-94.
6. Stephen Addison, Adrienne Wright, and Rachel Milner, "Using Clickers to improve Student Engagement and Performance in an Introductory Biochemistry Class." *Biochemistry and Molecular Biology Education*, **37(2)**, 84-91 (2009).
7. Erica Watkins and Mel Sabella, "Examining the effectiveness of clickers in promoting learning by tracking the evolution of student responses." *Proceedings of the 2008 Physics Education Research Conference, Edmonton, Alberta, CA*, **1064**, 223-226 (2008).
8. Richard Mayer, Andrew Stull, Krista DeLeeuw, Kevin Ameroth, Bruce Bimber, Dorothy Chun, and Hangjin Zhang, "Clickers in college classrooms: Fostering learning with questioning methods in large lecture classes," *Contemporary Education Psychology,* **34(1)** , 51-57 (2009).
9. Paul Black and Dylan Wiliam, D, "Assessment and classroom learning," *Assessment in Education*, **5(1)**, 7-74 (1998).
10. National Research Council). *National science education standards*. Washington, DC, National Academy Press, 1996).

Answer to the Challenge to the Readers

Paul Dolan, Northeastern Illinois University, Chicago

Having issued a Challenge to the Readership, it seems appropriate that I should lead the way in answering that Challenge. Here are a couple of the ideas that I have found at APS National Meetings that I have been able to bring back and use in my classes. These are intentionally terse descriptions (and perhaps I will enlarge on these for some future edition of the Newsletter).

"Granular Materials": One relatively calm (for me) day at a March Meeting I sat down in a session on 'granular materials'; I saw some names I recognized from my time working with superfluid helium, and saw some curiously interesting titles, things like 'Jamming and Unjamming', 'Flow of Beads through a Square Opening', and 'Measuring Stress in a Randomly Packed Material'. Not only did I bring this topic back for my undergraduates to use for research projects, but I realized that the 'everyday' applications (packing cereal, pouring sugar) would be ideal for a lab in the General Education course; in fact, when that course is offered as an Honors course, Granular Materials is the emphasis. I also retooled one of our 'Materials' course for physics majors to be focused on this topic.

I always share with my classes the latest innovation in using photoelastic disks for measuring forces & strains in granular materials, from Bob Behringer's group at Duke (http://www.phy.duke.edu/~bob), and have recently heard some neat talks on jamming experiments using large blocks and cylinders in long rectangular tubes, which I have also shared with the high school science fair students I mentor.

Reference: check out the many sessions at any APS March or DFD Meeting, or look in Phys. Rev. E or in the Springer Journal "Granular Matter".

"New Recipes for YBCO": This dates back some years, but as I noted in my editorial, I used the 'simple' recipe gleaned from a March Meeting for our enrichment course for high school students–where all the students MADE their own sample of the High-Tc material. This is also one of the modules in our Advanced Lab (and it is interesting to see how many physics majors are unable to balance simple chemical equations!) I'd be glad to send anyone my recipe –and would be interested in a good recipe for the BSCCO (Bismuth Strontium Calcium Copper Oxide) compound, starting from the base oxides & carbonates (or any other interesting & relatively safe High-Tc material, with a transition temperature above 77 K–no Hg compounds please!).

Physics Teacher Education Coalition

Section on Teacher Preparation

From the Editor of the Teacher Preparation Section

John Stewart, University of Arkansas

In the previous issue of this newsletter, two of the new PhysTEC sites, California State University Long Beach (CSULB) and Middle Tennessee State University (MTSU), discussed their plans for improving teacher preparation. In this issue, two more of the new sites are introduced, the University of California at Davis (UC-Davis) and Chicago State University (CSU). David Webb of UC-Davis will give an overview of their program and introduce a novel class structure in which the PhysTEC Learning Assistants will participate. Mel Sabella and Andrea Gay Van Duzor of CSU will discuss some of the exciting features of the PhysTEC project at CSU including the creation of a Teacher Immersion Institute and the use of partnerships with two-year colleges to aid in the recruiting of teachers. The CSU program may eventually provide a model for teacher preparation in the urban environment.

The 2011 PhysTEC Conference, focusing on Building Sustainable Programs, will be held May 23-24, 2011 in Austin, TX. The PhysTEC conference, formerly the PTEC conference, features presentations by members of many of the most successful institutions in physics teacher preparation. Registration information can be found at ptec.org. The 2011 conference will be held jointly with the UTeach-NMSI Institute Annual Conference. The UTeach Conference will be on May 24-26. For more information on Uteach visit http://uteach-institute.org/conference.

PhysTEC Program at the University of California, Davis

David Webb, Department of Physics, UC Davis

We are very pleased to be given the chance to build a new Physics Teacher Education Coalition (PhysTEC) site at UC Davis and we have several different kinds of goals in this work. The first goals are, of course, to increase our production of high school teachers credentialed in physics and to document that increase as well as the changes that made it possible and other changes that the program may have stimulated. A broader goal is to build, into both the faculty and the administrative culture at Davis, the idea that each of our academic departments (not just Physics) should be involved in the production of future teachers and involved in support of current teachers in northern California. Specifically, we hope to convince academic departments other than physics that this involvement must include not only teaching of the content knowledge that these teachers need (something we presumably already do) but, also, the pedagogical knowledge that will help these teachers teach content knowledge to their students. Finally, some of us dream of slowly growing a faculty who stay roughly as knowledgeable about research in teaching and learning as they do about research in their broad disciplinary fields. This would be an answer to the constant dilemma of how to improve university teaching without degrading research.

Regarding the second goal mentioned above, it is easy to point out to a group of faculty that all of our undergraduate classes would be easier, and more fun, to teach if our undergraduate students entered the university with a sophisticated understanding of what science is about as well as with an understanding of some of the major organizing ideas of science. This intellectual sophistication can only come from their having had excellent teachers in primary and secondary schools, so we can only make things better for ourselves and our students if we pay close attention to the quality of teachers that we are producing. If we can convince our faculty of this idea then all we need to do is demonstrate how this can be done with only moderate efforts from some of the faculty in these departments. This feasibility demonstration is some of what we hope our PhysTEC work will do for our own faculty. Our particular PhysTEC project will not be very different from other such sites but an understanding of the details of our particular implementation will require some background information on UC Davis in general, on our current efforts to increase the number of science teachers graduating from UCD, and on our introductory physics courses.

UC Davis has close to 25,000 undergraduate students and about 7500 graduate students making up a relatively ethnically diverse population with a large contingent in the sciences. As a quick example of the ethnic diversity, in a recent 10-year span our introductory physics course for bioscience majors was made up of about 37% of students identifying themselves as White/Caucasian, about 16% were students of Chinese descent, and the other (almost) half made up of many different ethnicities. The largest three other groups, at about 5% apiece, include students identifying themselves as of Mexican, Filipino, or Vietnamese descent. UC Davis began as an agricultural school in the early 1900's and remains a strong school in the sciences. The students in Science, Technology, Engineering, and Mathematics disciplines at UC Davis are distributed among four colleges: College of Agricultural and Environmental Sciences, College of Engineering, College of Biological Sciences, and in the Mathematics and Physical Science Division of the College of Letters and Science.

The PhysTEC site currently being organized at UC Davis is planned as an extension of our already successful Math and Science Teacher (MAST) program at Davis. The MAST program is our campus' version of the California Teach program which was begun in 2005 with a goal of producing an extra 1000 math and science teachers per year. Our current MAST program consists of a series of three seminar classes that explore the foundations of learning and, in addition, offer supervised field experiences in either elementary, middle, or high school classrooms. These experiences include progressively more responsible opportunities for teaching K-12 students and give vitally important time for our students to explore their interest in teaching careers and to complete prerequisites for teaching credential programs. Academic advising and recruiting are also essential elements of the MAST program. Our advising encourages students to keep career options open through appropriate choices of requirements and sequences of courses, and it also identifies alternate pathways to teaching careers for late-deciding students. We recruit prospective teachers from among prospective and current students on campus and through local community colleges. In addition, we are especially proud that over a dozen faculty, representing all the undergraduate colleges and the School of Education, advise our students and the program. This widespread interest and participation by the faculty is having a noticeable effect on the culture of our campus and gives us hope of achieving our broad goal of changing the general faculty and administrative culture toward producing teachers involvement in research into teaching. Enrollment in MAST has grown from 22 students in 2005-06 to a current level of over 400 students per year. In the past two academic years, twenty-one students have completed or enrolled in credential programs, twelve of them at UC Davis. Despite the broad success enjoyed by the program, only one or two physics majors have participated in an average year.

In an attempt to specifically encourage more physics students to think about teaching as a career, a significant part of the PhysTEC program at UC Davis will involve the building up of a larger "Learning Assistants" (LA) program within MAST in collaboration with the Department of Physics. The LAs will work in the discussion/lab sections of our introductory physics classes alongside the TAs and/or instructors in the class. This year we are modifying our introductory courses for engineers and physical science majors (the "calculus-based course") so it is not currently the best class in which to place our LAs. So, in this first year of our PhysTEC implementation, we will only have LAs in our introductory physics series of courses for bioscience majors (our "algebra-based course"). The introductory series for bioscience majors is a radically reformed, large-enrollment, one-year, introductory physics series that makes student interaction in small groups the central instructional component. This series was fully implemented in 1996 and enrolls over 1500 students each quarter who are taught by ten faculty/instructors and 25 graduate teaching assistants (TAs). Each of the three courses employs a general course design scheme called Collaborative Learning through Active Sense-making in Physics (CLASP). The series of introductory physics courses for bioscience majors at UC Davis is Physics 7A, 7B, and 7C.

The goal of a CLASP course is to have students continually striving to make sense, for themselves, of fundamental physics concepts and widely-applicable analytical approaches to problems that will be useful to them in their careers. All aspects of the course are designed to further this goal. Toward this end, the courses are organized around a set of about two dozen models that physicists use to describe the major features of how the world works. Of these models, it is probably fair to say that about a half dozen of them are the most important overarching models. These models, and this organization of ideas, are prominent in all of the work that the students do.

A regular offering of a Physics 7 course at UC Davis includes a lecture which meets once a week for about 80 minutes (during which there is usually a 20 minute quiz) and a discussion/laboratory (DL) that meets 140 minutes twice a week and is run either by an instructor or by a TA. In the DLs, the students are mostly involved in intellectually intensive discussions (in small groups of about five students) concerned with either i) making sense of the physical models themselves or ii) using the models to make sense of various important physical situations. The discussions in DL are what places a CLASP class in the category of "active-learning" classes and these discussions are as student-centered as we have been able to make them. The students are given activity sheets that ask them about models and applications of models to simple physical situations, complex physical situations, and computer simulations. The discussions are facilitated by the instructor/TA who, ideally, uses some form of Socratic questioning to help each group of students figure things out for themselves whenever they get stuck. Our intent is that the pace of these small group discussions is completely controlled by the students and that the discussions are carried out primarily in the student's voice even when an instructor is present. We provide instructors/TAs with guides for each activity, and some of these guides remind the instructor that they are supposed to be a "guide on the side" not a "sage on the stage".

CLASP courses differ from many reformed courses in that our students carry out their small-group discussions at blackboards and put (almost) all of their work on those blackboards as shown in Figure 1. This allows the instructor/TA to immediately determine the progress of each of the 6 small groups in the classroom.After a reasonable number of the small groups (half of them or more) have come to their conclusions about the activities, the instructor stops the small group discussions and leads a whole class discussion on the activity. Ideally, this whole class discussion is also carried out in the voice of the students (i.e. student-student discussions of the ideas). The whole class discussion at the end of an activity serves many instructional purposes. The whole class discussion attempts to leave each student, at a minimum, with a basic understanding of what ideas needed to be used in the activity, how they needed to be used, where these ideas fit into the field of physics, and how the ideas relate to other activities that they have done. The activity discussion format also gives our students a (somewhat) realistic view of how science proceeds. For instance, a whole class discussion may result in some groups advocating for one way of thinking about things and other groups advocating for another way (this is actually not uncommon when 5 or 6 groups work on their activities relatively independently) and then the discussion can bring out differing assumptions, differing viewpoints, and (of course) genuine conceptual misunderstandings. The whole class discussion also gives the students a chance to practice developing proper scientific discussions. We may even motivate the students to develop these skills by reminding them that they are practicing the argument skills that they will use on exams. This practice at generating proper scientific arguments in support of their conclusions should

Figure 1 - Students presenting work at blackboard in CLASP laboratory.

help their confidence on our exams but also their confidence in their other classes. Finally, although we have these many goals for whole-class discussions, we have found that facilitating good whole class discussions is perhaps the most difficult job for a teacher in a CLASP class.

Our initial plan for our new LAs is to have them work as assistant TAs during small-group discussion time in a CLASP course. The instructor/TA will be in charge of the DL but the LA will roam around the classroom and carry out Socratic dialogues as necessary with the individual small groups in the same way that the TA does. Because it is hard for a single TA to carefully monitor and help out 6 separate group discussions, it seems likely that the LAs will be found to be valuable in the DL setting. In addition, senior LAs will periodically be given the chance to take more control over a DL and essentially act as the instructor under the eye of the actual instructor/TA. Each LA will also participate in a one hour per week seminar on the pedagogy of the course including discussions of how people learn, how to facilitate small group discussions, how to facilitate whole class discussions, and specific issues that introductory physics students have. Later this year, we will hire our first Teacher In Residence (experienced high school teacher) to help mentor these LAs. In the long run, we hope to double or triple the number of our undergraduate students who receive physics teaching credentials, and to begin to make progress on the broader and longer term goals mentioned in the first paragraph.

David Webb earned Physics degrees from UC Berkeley ('77) and Univ. of Maryland ('83) and did postdoctoral work at Stanford. He has been a faculty member in the Dept. of Physics at UC Davis since 1987 and is currently doing research in Physics Education.

Preparing urban students to teach in the urban classroom: Chicago State University's PhysTEC Program

Mel S. Sabella and Andrea Gay Van Duzor,Chicago State University

Chicago State University is positioning itself to be a leader in preparing science teachers for the urban instructional environment by incorporating innovative, research-based instructional materials in its courses and by providing intellectual and financial support to students who choose to pursue certification in science. This past year, CSU was one of five institutions to receive funding from the American Physical Society's *PhysTEC Program* to recruit students into teaching and provide a model instructional program for students interested in becoming physics teachers. Students chosen as PhysTEC fellows at CSU will have the opportunity to act as Learning Assistants in our introductory physics courses with Physics Education Research (PER) based curricula and engage in an action research project with an inservice high school physics teacher in the Teacher Immersion Institute. The intent of the PhysTEC program at CSU is to recruit more physics students into teaching and to support them in their academic and early professional careers.

CSU has several science education programs that address the critical need to provide high quality science education to the students in our community. The PhyTEC project aligns with and builds on CSU's existing programs including the Illinois Board of Higher Education (IBHE) Science Van Program for the professional development of inservice teachers, the National Science Foundation (NSF) Robert Noyce Scholarship Program for the recruitment and support of preservice science teachers, and the NSF Course, Curriculum, and Laboratory Improvement (CCLI) Project for the integration of PER curricula and pedagogy in the introductory physics course sequence. Although these four projects address quality science education from different perspectives, each shares a common set of core resources and tools that foster the creation of a science education community in which the public schools, the university, and the science education research community act as stake holders and collaborators.

Our programs in science education specifically target the students we serve at CSU, many of whom will go back to the communities in which they grew up. CSU is an urban institution serving approximate 7000 undergraduate and graduate students on the South Side of Chicago. Demographically, 85% of the undergraduate students identify as Black, 7% Hispanic, 3% White.[1] About 50% of students at CSU have at least once child and most students live within 5 miles of campus and attended high school in the area.[2] CSU serves a vital role for the community on the southside of Chicago and the programs in Science Education specifically focus on providing access to high quality science education in the inner city high school. In order to achieve this goal, CSU has implemented several programs with the objective of providing high quality science education through collaboration with high school science teachers, university students preparing to be science teachers, and university faculty. A discussion of how the current science education programs at CSU will align with and enrich the new PhysTEC program at CSU follows.

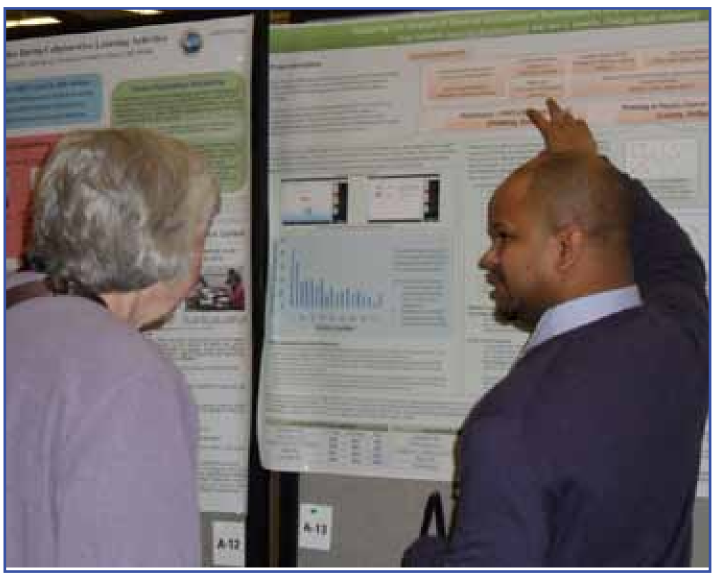
The Science Van Programs in Biology, Chemistry, and Physics provide teachers with two courses in which they can critically reflect on their craft, the Science Van Course and the Pedagogical Content Knowledge (PCK) Course. The Physics Van Course is a two-week summer course in which inservice teachers engage in physics education research driven, inquiry-based activities that they can then take into their own high school classrooms.[3] Most activities are accompanied by pre- and post- tests that help teachers elicit students' initial ideas and gauge improvement after utilizing the Van Activities. While many activities use technology-based tools such as Vernier and Pasco Probeware, other activities use low-tech equipment such as bricks and floor tile. Because many schools in the Chicago Public School (CPS) System did not have the specific tools needed to support these activities, sets of equipment were purchased through the IBHE grant funds. This equipment is then lent to the participating schools so that they are able to conduct the activities with their students at their schools. A retired physics teacher from CPS, who is currently funded by CPS, delivers equipment to the schools and may assist the teacher with the activity if requested, although the teacher always leads the class. The newly developed Physics PCK Course is an intensive four-week summer course in which teachers actively reflect on the intersection between physics concepts and pedagogical practices in the classroom.

Inservice Teachers in CSU's summer 2009 Pedagogical Content Knowledge Course. Approximately twenty teachers participated in the month-long program.

The Physics Van, the Chemistry Van, and the Biology Van program has been serving CPS teachers and students for many years and has allowed the Science Education Programs at CSU to build strong professional relationships with many teachers in Chicago. This network of educators, with a wealth of collective and individual experience, has and continues to play an essential role in CSU's evolving preservice teacher programs. The collective knowledge and experience of the practicing teachers with whom we work plays three major roles in our education programs. Namely, the teachers provide guidance in the development of our programs, serve as mentors to our preservice teachers during observation hours and student teaching, and provide induction year support for our students.

Students at Chicago State can pursue certification in science as undergraduates enrolled in our secondary education options in the different science disciplines. Students who already have bachelor degrees in related fields can pursue initial certification through the Master of Arts in Teaching Degree or through a certification only program. CSU's Robert Noyce Teacher Scholarship Program and our new PhysTEC Program were developed to serve the specific needs of the preservice teacher. Both these programs provide intellectual and financial support to students during their academic and early professional careers to help recruit and retain teacher candidates.

Students at CSU engage in PER-based activities in the introductory physics course. The revisions to the introductory physics courses at CSU are a result of three National Science Foundation Course, Curriculum, and Laboratory Improvement Grants that focus on the needs of students at the urban institution.



Sean Gallardo presents his research in Physics Education at the 2010 AAPT conference in Washington DC. Sean is preparing to be a high school physics teacher and was part of CSU's first cohort of Noyce Scholars. In addition to presenting at two national AAPT conferences, Sean has also presented his work at the 2010 Gordon Research Conference on Physics Research and Education.

Central to the recruitment of students into science teaching at a school like CSU, is a focus on the professional nature of teaching. The purpose of this focus is twofold: it serves to change student perceptions about teaching and it prepares students to become teachers who value continued professional development and value the science education research literature. African American non-education majors can view teaching as a career that is underpaid and undervalued and often believe that teaching is only viable for students with altruistic tendencies seeking intrinsic rewards.[4] The Noyce and PhysTEC programs at CSU place the professional nature of teaching front and center by involving students in education research projects and paid internships at Chicago area museums, such as the Museum of Science and Industry and the Adler Planetarium. Students regularly attend local and national conferences on science and physics education as well as the Noyce Seminar Series on Science Education at CSU. Furthermore, they are enrolled in a weekly journal reading class to discuss science education and science education research papers. Through PhysTEC funding we are implementing two new components to the teacher education program at CSU that build and reinforce this idea of professionalism in science teaching and also emphasize the challenging nature of teaching.

Because the teacher education program at CSU is small, it is important to incorporate specific program components that are sustainable, can build capacity, and can draw students who may not have initially considered teaching. The CSU PhysTEC project is creating two components designed to address the specific needs of the smaller teacher preparation program. These two components are the collaborations between CSU and two-year colleges in the area and the development of a Teacher Immersion Institute (TII).

Because the population of students who choose to enter the CSU secondary science teacher education program is small, CSU will work closely with the two-year colleges in the area that already have strong collaborative relationships with the Physics Program at CSU. CSU has been working with the physics faculty at Harold Washington College (HWC) and Olive Harvey College (OHC), two of the City Colleges of Chicago on implementing research-based instructional materials in the introductory courses. Each of these schools shares a common vision on modern instructional approaches and is committed to providing the best possible learning environment for its students. HWC and OHC have pilot tested a number of Physics Education Research (PER) based lessons designed to actively engage students in the scientific process and promote scientific dialogue through inquiry-based activities as a result of a multi-year CCLI project. By working closely with our two-year college partners we are able to broaden the pool of potential preservice teachers and further strengthen the links between the two-year colleges and CSU. Like CSU students, the students at the two-year colleges will be invited to apply to be PhysTEC Fellows (PTFs). As PTF's, students will act as Learning Assistants (LAs) in the introductory physics courses at the two-year colleges to help them make an informed decision about whether teaching is right for them.[5]

CSU students who are accepted as PTF's will act as LAs in the CSU introductory physics course sequence and the physics course for preservice elementary teachers. CSU PTF's will also be part of the new Teacher Immersion Institute (TII). The TII will be a two credit course taught by two of the practicing teachers with whom we regularly work with in our Science Van Program or PCK courses. The TII is designed to provide an early teaching experience for students with an interest in possibly entering this field. CSU Level 1 PTFs will enroll in the TII as part of their semester activities. In the TII, the teachers will lead the PTFs in a semester long action research project with support from CSU science education faculty. In an action research project, teachers reflect about their instruction, implement new strategies to improve teaching and learning, and assess the effectiveness of the new strategies through analysis of student work, with the ultimate goal of improving practice through this iterative process. Often, action research is done as a collaborative effort between colleagues at a particular school.[6] The TII action research project will provide opportunities for our preservice teachers to assess student understanding of a specific topic, design a lesson that is guided by research, implement the activity with high school students, and assess the effectiveness of the activity. PTFs will be expected to work with the teachers on all aspects of the project establishing a mentor-student relationship that we hope will last well beyond the semester. By creating and supporting these relationships as part of PhysTEC, we anticipate creating long term support structures for our preservice teachers that will aid them during the difficult induction years. Encouraging new teachers to become a part of discourse communities centered on modern pedagogies and reflective teaching can provide support for teachers who take positions in schools with possibly negative or limiting educational philosophies.[7] The creation of the TII will further strengthen the professional relationship and collaboration between the teachers in CPS and CSU. Teachers will have an opportunity during the TII to work on a project in which they are interested with support from students and faculty at CSU as well as earn tuition exemption vouchers to further their own professional development. When the instructional materials are implemented by the teacher in their classrooms, the PTFs will act as Learning Assistants in the high school classroom, providing an early teaching experience grounded in thoughtful reflection about student learning.

The TII will also play an important role in recruitment. Because of the caliber of practicing teachers with whom we work and due to the careful development of science activities and practical applications in the classroom, we expect that this will be a very exciting piece of our PhysTEC Program. Practicing teachers who are leading the TII's will begin to be an integral part of the teacher education program at CSU, and we hope that this will allow our cooperating teachers to feel an increased level of ownership in the teacher education program at CSU. Teachers who participate will learn more about the diverse programs for preservice teachers at CSU as well as CSU's efforts at reforming undergraduate science education. They will hopefully promote the diverse CSU science programs to their own students. Teachers have always been one of CSU's most profitable avenues for recruitment but they need to be given access to correct, current information about the school and the opportunities at CSU in science. We expect that this collaboration will increase the number of students entering CSU as freshman in both the science teacher-education major options or the options that lead to industry careers and graduate programs.

Although teachers do not command the same salaries as doctors and engineers, it is important that our preservice teachers begin to see that teaching is as challenging as these fields and should be given the same respect. At CSU, science teaching is consistently promoted as a professional career that requires continued intellectual engagement and professional development and that provides opportunities for advancement. We believe that the synergy between our inservice programs, such as the Science Van, and our undergraduate programs that support teacher candidates such as the Noyce Scholar and PhysTEC programs and the implementation of PER curricula in the introductory physics courses will enable the science education program to continue to grow and help promote the professional nature of teaching. Aspects of the CSU approach to science education and teacher development may prove fruitful for other urban universities with relatively small science education programs. More information on CSU's programs in science education can be found at: http://webs.csu.edu/~scienceed/.

Mel Sabella is an associate professor of physics at CSU whose research focuses on improving STEM education for underrepresented students.

Andrea Gay Van Duzor is an assistant professor of chemistry at CSU whose research and programmatic interests focus on fostering connections between chemical theory and practice for students and teachers.

Sabella and Van Duzor draw upon diverse but complementary backgrounds to lead the CSU PhysTEC Project.

Endnotes

1. Illinois Board of Higher Education. (2007). Institutional profile: Chicago State University. Retrieved April 4, 2008, from http://www.ibhe.org/InstitutionProfiles/ILinstProfile.aspx?id=001694
2. CSU Office of Institutional Research and Academic Evaluation. (2007). CSU student demographics. Chicago.
3. Sabella, M. (2007). Providing support to inner-city students

and teachers through the physics van inservice institute. *The Physics Teacher,* **45(2)**, 80-84.

4. Shipp, V. H. (1999). Factors influencing the career choices of African American collegians: Implications for minority teacher recruitment. *The Journal of Negro Education*, **68(3)**, 343-351.
5. For more information on the LA Program see http://laprogram.colorado.edu/.
6. Etkina, E., et al. (2009). Using action research to improve learning and formative assessment to conduct research. *Phys. Rev. Special Topics – Phys. Ed. Research.*, **5** (010109)
7. Putnam, RT and Borko, H (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher*. **(29)** 1 4-15.

Browsing the Journals

Carl Mungan <mungan@usna.edu>

- Many people (myself included) are interested in the physics of potato guns. Mark Denny has a very accessible analysis of how the muzzle speed and mechanical efficiency depend on the barrel length in the February 2011 issue of *The Physics Teacher* (http://scitation.aip.org/tpt/). I also enjoyed thinking about the "Direction of Friction" for a cylinder rolling without slipping up and down an incline in Paul Hewitt's January 2011 *Figuring Physics* column. Finally, if you teach thermodynamics, you may wish to consider Todd Timberlake's suggested coin-flipping activities on page 516 of the November 2010 issue.

- The February 2011 issue of the *American Journal of Physics* (http://scitation.aip.org/ajp/) has an article beginning on page 193 that compares theory and experiment for some extensions of the familiar demonstration of dropping a magnet down a conducting pipe: What happens if you drop two magnets? How does the magnetic braking force depend on the distance between the magnet and the pipe wall? In the January 2011 issue, the article "Listening to student conversations during clicker questions" gave me some interesting new ideas to help me improve my use of student response systems in introductory physics.

- I enjoyed the various tidbits in the End Results section of the January 2011 issue of *Physics Education*. Also, the old chestnut of whether one should walk or run in the rain to minimize how wet one gets is discussed on page 355 of the March 2011 issue of the *European Journal of Physics*. Both journals can be accessed at http://iopscience.iop.org/journals.

- The 1 January 2011 issue of the *Journal of Chemical Education* (http://pubs.acs.org/toc/jceda8/88/1) discusses the issue of dimensional analysis involving transcendental functions (such as sine or logarithm) on page 67.

- I was intrigued by the discussion of how a fly can walk upside down on a ceiling without falling off in the online version of *Physics World* at http://physicsworld.com/cws/article/indepth/44454. Apparently the secret involves an emulsion of two different fluids secreted by a fly's feet.

- APS recently highlighted an article in *Physical Review Letters* about a state-of-the-art determination of the Avogadro constant at http://physics.aps.org/synopsis-for/10.1103/*PhysRevLett*.106.030801. I find it to be an interesting exercise to brainstorm with students various ideas for how one might determine the values of such constants.

Web Watch

Carl Mungan <mungan@usna.edu>

- The Australian Broadcasting Corporation has a great online gateway to science materials including a news service, audio and videos, quizzes and games, teaching resources, science careers, and more at http://www.abc.net.au/science/.

- A nice set of computer animations of processes in physics arranged topically can be accessed at http://www.physics-animations.com/.

- The Perimeter Institute in Canada has posted videos of a panoply of their past public lectures at http://www.perimeterinstitute.ca/en/Outreach/Public_Lectures/View_Past_Public_Lectures/.

- This past December, Fox News reported that the U.S. Navy achieved a 33 MJ railgun firing, http://www.foxnews.com/scitech/2010/12/10/navy-railgun-shoots-bullets-electromagnet/, launching a projectile at faster than Mach 7.

- An insightful essay about mathematics education that has many analogs to physics education is at http://www.fordham.edu/academics/programs_at_fordham_/mathematics_departme/what_math/.

- I hereby retract inclusion of the term "physics education research" in my summer list of teaching phrases (http://www.aps.org/units/fed/newsletters/summer2010/mungan.cfm). Sciencegeekgirl (http://blog.sciencegeekgirl.com/2010/07/09/the-real-meaning-of-common-teaching-phrases/) correctly points out that it's a research not a teaching phrase and that my definition was a bit edgy. My apologies!

- Occasionally I get stumped over the full name of an abbreviated science or engineering journal title. A useful lookup list is online at http://scieng.library.ubc.ca/coden/.

- • A useful resource for faculty in the sciences is the National Academy of Sciences book "Adviser, Teacher, Role Model, Friend" at http://www.nap.edu/openbook.php?record_id=5789.

- A useful set of multimedia prelecture modules for introductory physics to accompany a new text under development called "Smart-Physics" is currently accessible at:Mechanics: https://online-s.physics.uiuc.edu/courses/phys211/gtm/No_Login/page.html
  E&M: https://online-s.physics.uiuc.edu/courses/phys212/gtm/No_Login/page.html

- Check out the "Just-in-Time Teaching" (JiTT) materials at http://jittdl.physics.iupui.edu/jitt/.

- Have you ever been to a Gordon Research Conference? Take a look at the list of meetings and locations at http://www.grc.org/home.aspx.

- The U.S. government has an authorized portal to federal agencies and information about science at http://www.science.gov/.

Executive Committee of the Forum on Education

Chair
Lawrence Woolf
(04/10-04/11)
General Atomics

Chair-Elect
(and Chair of the Program Committee)
Chandralekha Singh
(04/10-04/11)
University of Pittsburgh

Vice Chair
(and Chair of the Nominating Committee)
Renee Diehl
(04/10-04/11)
Penn State University

Past Chair
(and Chair of the Fellowship Committee)
Peter Collings
(04/10-04/11)
Swarthmore College

Secretary/Treasurer
(and Website Administrator)
Bruce Mason
(04/08-04/11)
University of Oklahoma

Forum Councilor
Gay Stewart
(01/09-12/12)
University of Arkansas

General Member-at-Large
John Thompson
(04/08-04/11)
University of Maine

General Member-at-Large:
Laird Kramer
(04/09-04/12)
Florida International University

General Member-at-Large
Alice Churukian
(04/10-04/13)
University of North Carolina, Chapel Hill

APS/AAPT Member
Stamatis Vokos
(04/08-04/11)
Seattle Pacific University

APS/AAPT Member
Amber Stuver
(04/09-04/12)
California Institute of Technology

APS/AAPT Member
Richard Peterson
(04/10-04/13)
Bethel University

Non-voting Members
Chair, Committee on Education
Noah D. Finkelstein
Univ of Colorado - Boulder

APS Liaison
Ted Hodapp
APS Director of Education & Diversity

AAPT Representative
David Cook, AAPT Past President
Lawrence University

AIP Representative
Jack Hehn, AIP Director of Education

(Newsletter Editors, if not already voting members, are non-voting members of the Executive Committee)

Newsletter Editor, Spring 2011
Paul J. Dolan, Jr., Northeastern Illinois University
Deadline: February 1, 2011

Newsletter Editor, Summer 2011
Nic Rady, University of North Texas
Deadline June 1, 2011