Forum on Education
American Physical Society

Spring 2013 Newsletter

Paul J. Dolan Jr., Editor

In this issue:

From the Chair

Renee Dieh

I would like to welcome the newly-elected members of the Forum on Education Executive Committee, who will start their terms in March. Randy Knight will take over the vice chair position from Michael Fauerbach, who will move up to Chair-Elect. Heather Lewandowski and Geoff Potvin will become members-at-large, replacing Alice Churukian and Dick Peterson. I'd like to thank Alice and Dick for their able and generous service during their terms as members-at-large. I also congratulate Gay Stewart on her re-election to the post of Forum Councilor. The Forum Councilor is the official liaison between the FEd executive committee and the APS Council, and in this capacity, Gay keeps the communication lines open and facilitates the operations of the FEd within APS. I would also like to extend a huge thank you to Chandralekha Singh, who has been a tremendous mentor to me in my year as the chair of the FEd. I will be replacing Chandralekha as past chair in March, and Paul Cottle will step into the chair position. Paul is more passionate about pre-college physics education than anyone I have met, and we can expect some fires to be lit during the next year.

I also congratulate Gary Gladding, Mats Selen and Tim Stelzer at the University of Illinois, Urbana-Champaign for winning the 2013 APS Excellence in Physics Education Award. They will be speaking about their award-winning activities at the APS April meeting. Four APS members were elected to APS fellowship by the FEd this year. They are David Cook, Paul Cottle, Paul DeYoung and David Meltzer. And finally, four programs were chosen for the 2013 Awards for Improving Undergraduate Physics Education. These are Colorado School of Mines, Kettering University, MIT and University of Wisconsin at LaCrosse. All of the awardees will be honored for their achievements during the awards session at the APS April meeting.

This year, for the first time, the FEd has two major APS awards to offer. The new one is the Jonathan and Barbara Wolff-Reichert Award for Excellence in Advanced Laboratory Instruction. Information for this award and for the Excellence in Physics Education award can be found on the APS website. The deadline for nominations for both is July 1, 2013. Please think now about making a nomination. The nomination process is not complicated, but it does take some time to prepare a good nomination package.

An overview of the FEd programming for the March and April meetings was provided in the Fall 2012 newsletter, and the full program can be found on the APS meeting website. As program chair, Paul Cottle has assembled an exciting program covering all aspects of physics education.

We have had three fantastic newsletter editors during the past year – Nic Rady, Beth Lindsey, and Paul Dolan, who is editing this edition. We will be moving to a somewhat different model for the production of newsletters, which is to have an editor-in-chief who is responsible for the production of all newsletters. We believe this will strengthen the newsletters and allow more creative possibilities such as themed issues. Our first editor-in-chief is Beth Lindsey, who begins her duties with the Summer 2013 newsletter.

As my year as Chair winds down, I thank everyone who has made the year interesting, fun and memorable. I especially want to express my appreciation to Scott Franklin, our Secretary-Treasurer, who performs the invisible administrative work that keeps our organization alive and thriving.

Renee Diehl is Professor of Physics and Associate Department Head for Equity and Diversity in the Physics Department of Penn State University. She is Chair of the APS Forum on Education and carries out research in the area of surface physics, with an emphasis on surfaces having complex structures and weak interactions. She also leads a GK-12 Program called CarbonEARTH that seeks to improve STEM literacy and communication at the K-12 and graduate levels.

From the Editor – What Are the Best Conferences You Have Attended?

Paul J. Dolan, Jr., Northeastern Illinois University

If you are like me, you did not receive much 'formal' training as an educator when you were in graduate school. I was fortunate at Dartmouth, in that the TAs were quite well supervised, guided, and assisted (as needed), and I had a great advisor with whom I co-taught for a year. However, I know that many who are now physics faculty may not have had such a fortunate experience.

So, where do we now get that needed boost to our educational skills, and also that enervation to keep us going and add new skills? I find this at various professional meetings – and 'various' is perhaps the key term here – much as we may try, no one meeting will fulfill all one's needs.

Certainly for research, one would rely on APS meetings, whether it be the March or April Meeting, or one of the many Division Meetings that occur throughout the year. Not only can one report on and learn about one's research area, and of course attend FEd sessions, but one can learn about new topics, and find useful information to bring back to the classroom to supplement upper level, and perhaps even lower level, classes.

Depending on one's research area, one may attend meetings of one of the many member societies of the AIP, or perhaps something more interdisciplinary, such as meetings of AAAS.

Often one needs more, pedagogically –I have long attended my local AAPT section meetings, but in the past few years have become a regular participant in the Summer &/or Winter National AAPT meetings. The regular interaction (and the ongoing discussions that ensue throughout the year) can be quite invigorating, especially as one find colleagues who have similar teaching challenges. In fact, in a round-about way, it was through attendance at AAPT that I became actively involved with the FEd.

Sometimes one needs more than just the physics point of view – for example, I teach in a middle school pre-service program. While it is the physics course that I teach, knowing more about how the other disciplines are taught, and about the overall educational picture, is useful. For this, one can attend NSTA (National Science Teachers Association) meetings, and in particular sessions sponsored by the college affiliate organization of NSTA, the SCST (Society for College Science Teachers). One gets to learn new (to us) educational techniques, but ones that have been proven in other sciences; one gets to meet new colleagues across other disciplines. Attending the SCST sessions also keeps one sane at a National NSTA Conference – these meetings dwarf most APS or AAPT meetings, and as a first-time attendee, can be even more intimidating than being a graduate student at an APS meeting. Actually, NSTA really NEEDS more physicists & more college professors to attend – I have found that we are sorely underrepresented – which does not bode well for the students of the thousands of elementary, middle, and high school science teachers who do attend these meetings. Fewer physics participants also means fewer physics sessions being offered! At least, each NSTA meeting does typically include a session run by the local AAPT section; for example, recent AAPT President David Sokoloff led a fascinating session at the 2011 NSTA meeting in Seattle.

What then does one do when one needs help with specific courses or specific topic areas that one teaches? Perhaps there is a special gathering, a Gordon Conference, Topical Conference, or some other meeting that is pertinent to the subject, possibly co-located with an AAPT or APS meeting. One such meeting with which I have recently been involved was the 2012 Conference on Laboratory Instruction "Beyond the First Year" (aka BFY), sponsored by ALPhA and AAPT; BFY took place last summer in Philadelphia, immediately preceding the Summer AAPT meeting. ALPhA is the organization that was formed among those of us who teach 'Advanced' physics labs, and BFY is the second (large) Topical Conference that has been organized by ALPhA. It is different from other meetings, in that a large portion of the meeting is spent not in sessions, but in workshops, some run by academics and some by vendors; each session of a workshop is limited to a small number of participants (typically 2 – 4), so that one can really get a 'hands on experience' with the experimental topic of that workshop, and the equipment – and yes, vendors & participants BRING their equipment to the meeting (or find someone local from whom to borrow it); it really IS a hands-on experience. Even the poster sessions are likely to be 'poster plus equipment' (not picture or sketch of equipment). Among the really neat workshops I took, and will be implementing in my classes, were ones on the Arduino and related programmable controllers, and one on microfluidics, which has some interesting interdisciplinary applications. If you missed all the fun, the proceedings are on the ComPADRE site.

One of the spin-offs of the ALPhA conferences is the Immersion program (see details below), where one gets to spend not just an hour, but 2 – 3 days, learning all about a particular experiment, and becoming ready to implement the experiment with one's own students – the great learning experience of being back in grad school, but without the hanging sword of a thesis or a grade. Another spin off is mini-sessions at local AAPT or APS section meetings – see for example the letter below from Joss Ives.

These Advanced Lab Conferences seem to be falling into a three-year cycle, so we hope to have the next conference in Summer 2015, in Maryland. (And we expect that it will once again be a sold-out meeting.)

Of course, if you aren't the Advanced Lab instructor at your institution, then perhaps this would not be the meeting for you – but there are so many options available, among the meetings of APS and its affiliates, the other science & science education societies, and special events such as Gordon Conferences. Find the ones that are right for you.

Paul J. Dolan, Jr. teaches General Education, Pre-Service and Advanced Lab courses in Physics at Northeastern Illinois University in Chicago. He spends considerable time at local, state, national, and occasionally international, science education and physics meetings. In the interest of full disclosure, the editor is a member of the Board of the SCST, and is President-Elect of ALPhA; he would be thrilled to see any fellow FEd members at an SCST or ALPhA event.

Forum on Education invited and focus sessions – March 2013 Meeting

Teaching Physics and Other STEM Subjects in an Urban Environment

(B9, Monday, 8:00 am, Chair - **Mel Sabella**, ***Chicago State University***)

- Away from the ivory tower: Real challenges teaching high school physics in an urban environment /**Richard Steinberg**, ***City College of New York***
- Universities Reaching Outwards: Science Education Partnerships with Urban School Systems/**Cody Sandifer,** ***Towson University***
- Meeting Urban Science Students Where They Are: Perspectives from Two Physics Teachers and Four Schools/ **Rosalind Echols**, ***The Science Leadership Academy, Philadelphia PA***
- Engineering Education in K-12 Schools/**Anne Spence**, ***UMBC Mechanical Engineering***
- Preparing teachers for ambitious *and* culturally responsive science teaching /**Gale Seiler**, ***McGill University***

Broadening Participation in Physics and Other STEM Fields

(G9, Tuesday, 11:15 am, Chair - **Paul Cottle**, ***Florida State University***)

- Broadening participation in Natural Sciences and Mathematics at the University of Maryland Baltimore County/**Philip Rous**, ***University of Maryland Baltimore County***
- APS Initiatives for Broadening Participation/T**heodore Hodapp**, ***American Physical Society***
- Drawing minority students into the physics community/**Paul Gueye**, ***Hampton University/National Society of Black Physicists***
- Drawing Women In: Engaging in Science and Engineering Disciplines/**Senta Greene**, ***Vanderbilt University***
- How Undergraduate Women Choose STEM Careers/ **Roxanne Hughes**, ***National High Magnetic Field Laboratory***

Landmark Reports in Education

(N11, Wednesday, 11:15 am, Chair - **Daniel Crowe**, ***Loudon County Public Schools Academy of Science***)

- Linking National and International Educational Assessments: NAEP and TIMSS/**Taslima Rahman**, ***U.S. Department of Education***
- Linking NAEP to TIMSS Using Statistical Moderation/**Gary Phillips**, ***American Institutes for Research***
- The NRC Study of Undergraduate Physics Education: The role, status and outlook for physics education research/**Paula Heron**, ***University of Washington***
- A Future for Undergraduate Physics Education?/**Donald Langenberg**, Retired
- Disciplined Based Educational Research – What is it? What has it done? Where is it going?/**Kenneth Heller**, ***School of Physics & Astronomy, University of Minnesota***

Integration of Research and Teaching Excellence: Cottrell Scholars

(Z3, Friday 11:15 am, Chair - **Richard Wiener**, ***Research Corporation***)

- Cottrell Scholars Collaborative – Integrating Research and Teaching/**Jairo Sinova**, ***Texas A&M University***
- Optics for Biophysics: An Interdisciplinary course in Optics for Physicists and Life Science Students/**Jennifer Ross**, ***University of Massachusetts Amherst***
- Stimulating Creativity by Integrating Research and Teaching Across the Academic Disciplines/**Richard Taylor**, ***University of Oregon***
- Integrated Concentration in Science (iCons): Undergraduate Education Through Interdisciplinary, Team-Based, Real-World Problem Solving1/**Mark Tuominen**, ***University of Massachusetts Amherst***
- Living the good life: pursuing excellence as a scientist and as a teacher1/ **Erica Carlson**, ***Dept. of Physics, Purdue University***

Focus Session: Building a Thriving Undergraduate Physics Program

(B38, Monday, 11:15 am, Chair - **Ted Hodapp**, ***American Physical Society***)

- Keynote talk: From Near Extinction to Academic Excellence: The University of Wisconsin-La Crosse Physics Program/**Gubbi Sudhakaran**, ***University of Wisconsin-La Crosse***

Forum on Education invited sessions – April 2013 Meeting

Excellence in Physics Education Award Session: smartPhysics

(C7, Saturday, 1:30 pm, Chair - **Paul Cottle**, ***Florida State University***)

- Excellence in Physics Education Award Talk: Initiating and Sustaining Reform in Introductory Physics Instruction: The Illinois Experience/**Gary Gladding**, ***University of Illinois***
- Transforming the lecture experience at the University of Illinois/**Tim Stelze**r, ***University of Illinois***
- Pedagogy meets Technology: Optimizing Labs in Large Enrollment Introductory Courses/ **Mats Selen**, ***University of Illinois***

Transforming Teaching and Learning in Upper Division Physics

(G7, Sunday, 8:30 am, Chair - **Benjamin Zwickl**, ***University of Colorado - Boulder***)

- Using a Research-based Approach to Transform Upper-division Laboratory Courses/**Heather Lewandowsk**i, ***University of Colorado / JILA***
- Using a Research-based Approach to Transform Upper-division Courses in Classical and Quantum Mechanics and E&M/**Steven Pollock**, ***University of Colorado, Boulder***
- Physics Education Research at the Upper Division at the University of Maine, **John Thompson**, ***University of Maine***

AAPT: Learning Assistant Programs as Tools for Course Transformation and Recruitment of Future Physics Teachers

(J7, Sunday, 1:30 pm, Chair - **Monica Plisch**, ***American Physical Society***)

- Learning Assistant Alliance for Promoting and Sustaining Transformation of Physics Education1 /**Valerie Otero**, ***University of Colorado Boulder***
- Building an undergraduate physics program with Learning Assistants1 /*Edward Price*, ***California State University San Marcos***
- Physics Undergraduate TA Programs in Research Universities: A Low-Cost Sustainable Model/**Robert Thorne, *Cornell University***

AAPT: Colorado State University's Little Shop of Physics

(Q7, Monday 10:45 am, Chair - **Paul Williams**, ***Austin (TX) Community College***)

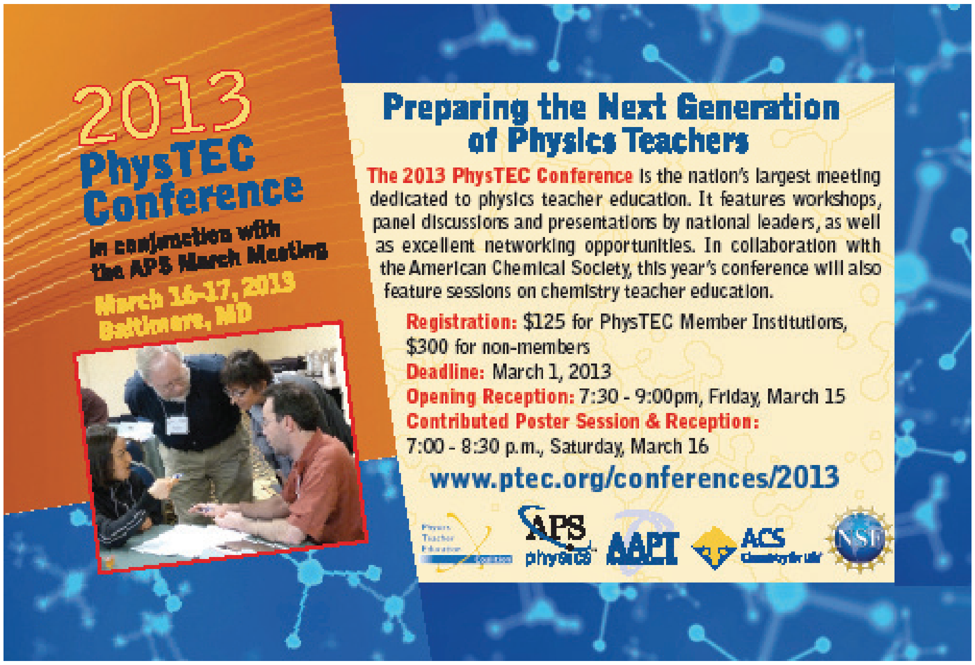
- The Little Shop of Physics: Lessons from Informal Science Education for the College Classroom1/ **Brian Jones**, ***Colorado State University***

Educational Outreach by the High Energy Physics Community

(Y7, Tuesday 1:30 pm, Chair - **Thomas Jordan**, ***University of Florida***)

- Particle Physics Outreach for Secondary Education/S**pencer Pasero**, ***Fermilab***
- Impact of Outreach on Physics Enrollment in Idaho/**Steven Shropshire**, ***Idaho State University***
- Quarknet/**Mitchell Wayne**, ***University of Notre Dame***

Upcoming APS & AAPT Meetings and Workshops



APS March Meeting
March 18 - 22, 2013
Baltimore, MD.

APS April Meeting
April 13 - 16, 2013
Denver, CO

AAPT Summer Meeting
July 13 - 17, 2013
Portland, OR

Theme: "Going Green with Portland"

If you are interested in STEM Education in general, you may want to attend:

- **Joint NSTA/SCST Conference**, April 11 - 14, 2013, San Antonio, TX
- **NSTA Stem Forum & Expo**, May 15 - 18, 2013, St. Louis, MO

New Jonathan Reichert and Barbara Wolff-Reichert Award for Excellence in Advanced Laboratory Instruction

This new APS Award has been endowed by Jonathan Reichert and Barbara Wolff-Reichert This award is to recognize and honor outstanding achievement in teaching, sustaining (for at least four years), and enhancing an advanced undergraduate laboratory course or courses. The course(s) should provide a selection of experiments in a range of the various interest areas of physics, for example atomic physics, electronics and optics.

The award consists of $5,000 plus travel expenses (up to $2,000) to attend an APS meeting at which the award is presented, and a certificate citing the achievement of the honoree. The honoree will be invited to present a lecture at that meeting. The award will be offered annually.

The award will be given to an individual or a team of individuals who have taught, developed, and sustained an excellent advanced undergraduate physics laboratory course or courses for at least four years. Some or all of this activity should have occurred within the five years prior to the nomination. The course(s) will lead upper-division students to experience a broad selection of experiments in the various interest areas of physics. This may include the development of experiment(s) reflecting current research.

Nominations are sought that confirm the fundamental role of the advanced laboratory course(s) in a physics department's curriculum, and which clearly show its impact on students and their subsequent careers in physics or applied physics. A successful nomination may also present evidence of the dissemination of the laboratory work to the broader physics community. Evidence of broad scope, excellence, and dissemination may include faculty/staff publications and workshops, student awards and publications, and other demonstrated student outcomes (as in preparation for undergraduate research, future employment, and acceptance and performance in graduate programs).

Full details of the award and nomination procedures can be found on the APS website at: http://www.aps.org/programs/honors/awards/lab.cfm.

ALPhA Immersions for Summer 2013

Speaking of excellence in Advanced Labs, with what lab experience do you need more help, or about which experiment would you like to learn more, from an expert/

In the summer of 2013, ALPhA (with support from NSF and AAPT) is offering a series of faculty development opportunities for instructors of laboratory courses for students beyond the first year of instruction. These 'Immersions' give faculty and instructional staff 2-3 days to learn, with expert colleagues on hand, a single new instructional physics experiment well enough to confidently teach it to students.

Faculty who teach 'beyond the first year' undergraduate laboratory courses should consider attendance at an Immersion this summer. The Immersion program has proven to be highly popular in past years, and we have been able to extend and expand the offerings with further NSF support. There is also financial support available for faculty from minority serving institutions.

For more information, please go to www.advlab.org/immersions

The 2013 Immersion locations and experiments are:

June 4-6 Harvey Mudd College (CA)

- Quantum Mechanics Experiments with Single Photons and Entangled Photons

June 17-19 Pacific University (OR)

- Teaching with the Magneto-Optical Trap

June 17-19 CSU - Chico (CA)

- Arduinos in the Advanced Lab

June 24-26 Miami University (OH)

- Quantized Conductance and the Arduino Platform for Advanced Labs
- Laser Induced Fluorescence in Iodine Molecules: Molecular Spectroscopy

June 26-28 Univ. of Florida (FL)

- Optical Trapping for Biological Physics
- Chaotic Pendulum

June 26-28 Bethel University (MN)

- Imaging Shock Waves in Compressible Flows
- External Cavity Diode Lasers & Spectroscopy
- Plasmonics and Surface-Enhanced Spectroscopy

July 22-24 Buffalo State (NY)

- Pulsed NMR for Protons and Fluorine
- Fourier Methods
- Noise Fundamentals
- Earth's Field NMR

July 24-26 Univ. of Minnesota (MN)

- FPGA Exercises in the Advanced Lab

August 6-8 Colgate University (NY)

- Experiments on Photon Quantum Mechanics

August 7-9 Caltech (CA)

- Spectroscopy of Hydrogen-Like (Rb) Atoms
- Vacuum Techniques / Thin-Film Deposition
- Low-Noise Signal Detection with Lock-Ins
- Hanle Effect

APS Award for Improving Undergraduate Physics Education

College Park, MD – The Committee on Education (COE) of the American Physical Society announces the recipients of the 2012 Award for Improving Undergraduate Physics Education. The award recognizes physics departments and/or undergraduate-serving programs in physics that support best practices in education at the undergraduate level.

Colorado School of Mines
The Department of Physics at The Colorado School of Mines has substantially transformed itself over the last decade, using an iterative model of innovation, implementation, and assessment. Their dedicated and aggressive approach has transformed all levels of their curriculum, from introductory classes for non-majors to senior level courses and seminars. Over the past decade the number of majors has more than doubled, from 114 students in 2000-2001 to 258 students in 2011-2012, significantly outpacing the overall growth of the student body. They are now one of the top five largest physics departments in the country, graduating on average 56 seniors per year since 2006.

Kettering University
Kettering University's Physics Department is a distinctive program, with co-op experiences integrated to promote graduates being placed in industry. Kettering has demonstrated excellence by tripling the number of majors over the last ten years as well as by focusing on the assessment of particular elements of the program including course outcomes and evaluation of co-op experiences.

Massachusetts Institute of Technology (MIT)
MIT has engineered an impressive transformation of its undergraduate physics curriculum, which currently produces the largest number of bachelor's degrees in physics annually of any university in the United States. The Department has more than doubled the number of majors since 2001, accompanied by a focus on diversity that has resulted in a department in which more than a third of graduating seniors are women. These changes have been accomplished through a focused commitment to creating a program that is flexible, welcoming and respectful of all students, with advising, mentoring and other programs to support students at all levels. The Department has been a consistent innovator in physics education with an emphasis on quality, including the innovative Technology Enabled Active Learning (TEAL) approach to teaching introductory physics to most MIT freshmen. This dual focus on outstanding educational practices and a student-focused departmental culture has resulted in an exceptionally strong undergraduate physics program.

University of Wisconsin at LaCrosse
COE recognizes the University of Wisconsin at LaCrosse Physics Department for revitalizing their physics program through widespread student-centric reforms. These reforms have included implementing a revised curriculum at all levels using physics-education research supported methods, increasing undergraduate participation in research, creating a supportive department community through seminars and student organizations, and developing a thriving physics teacher training program. The results of these efforts have been a significant increase in the number of majors, bringing this undergraduate-only program from the brink of elimination to one of the largest physics departments in Wisconsin, national recognition of many of the department programs, and quantifiable success of the students graduating from the program.

APS Award for Excellence in Physics Education

This award recognizes and honors a team or group of individuals (such as a collaboration), or exceptionally a single individual, who have exhibited a sustained commitment to excellence in physics education. The award may be a given for, but not necessarily restricted to, such accomplishments as: outreach programs; a specific program or project that has had a major ongoing influence on physics education at the national level; outstanding teacher enhancement or teacher preparation programs over a number of years; long-lasting professional service related to physics education that has had a demonstrated positive impact.

The Forum on Education is pleased to announce the 2013 Recipient of the Excellence in Physics Education Award given to Gary Gladding, Mats Selen, and Timothy Stelzer from University of Illinois, Urbana-Champaign.

The award citation reads:
"For the creative application of physics education research results with components of modern technology to create a new pedagogy for an introductory physics curriculum that substantially changes the roles of the instructors and students and, as measured through research, provides significant and nationally recognized learning benefits."

APS Members Recognized by AAPT for Excellence in Physics Education

The following major awards were presented at the 2013 AAPT Winter Meeting in New Orleans, LA. Learn more about the Winter Meeting and view the plenary talks at www.aapt.org/Conferences/wm2013/.

The John David Jackson Award for Excellence in Graduate Physics Education is presented to physicists and physics educators who, *like John David Jackson after whom the award is named*, have made outstanding contributions to curriculum development, mentorship, or classroom teaching in graduate physics education. The 2013 award was presented to David Pines, Center for Advanced Study, University of Illinois at Urbana-Champaign, Urbana-Champaign, IL.

The **Oersted Medal** recognizes those who have had an outstanding, widespread, and lasting impact on the teaching of physics. The 2013 award was presented to Edward (Joe) Redish, University of Maryland, College Park, MD.

Established in 1953 and renamed in recognition of one of the AAPT founders, Homer L. Dodge in 2012, the **Homer L. Dodge Citation for Distinguished Service** to AAPT is presented to members in recognition of their exceptional contributions to the association at the national, sectional, or local level. Awards were presented to Stanley Micklavzina, Sarah (Sam) McKagan and A. James (Jim) Mallmann.

Information on all AAPT awards may be found at http://www.aapt.org/programs/awards/.

Call for Nominations for APS Awards

Call for Nominations: APS Fellowship
Application deadline: April 1, 2013.
APS members are eligible for nomination and election to Fellowship. Each FEd nomination is evaluated by the FEd Fellowship committee. Please consider nominating outstanding candidates. Full details are at
http://www.aps.org/programs/honors/fellowships/nominations.cfm

Call for Nominations: Excellence in Physics Education Award
Application deadline: July 1, 2013.
This award recognizes and honors a team or group of individuals (such as a collaboration), or exceptionally a single individual, who have exhibited a sustained commitment to excellence in physics education. Please consider nominating outstanding candidates. Full details are at http://www.aps.org/programs/honors/awards/education.cfm

The APS Award for Improving Undergraduate Physics Education recognizes best practices in undergraduate physics education. This award was initiated in 2011 by COE in order to recognize physics departments and/or undergraduate-serving programs in physics that support best practices in education at the undergraduate level. Programs are recognized for 3 years, acknowledged on the APS website, awarded a plaque, announced in *APS News*, and recognized at an APS national meeting. These awards are intended to acknowledge commitment to inclusive, high-quality physics education for undergraduate students, and to catalyze departments and programs to make significant improvements. The annual deadline for departments to apply for the award is July 15. Full details are at:
http://www.aps.org/programs//education/undergrad/faculty/award.cfm

Please see information elsewhere in the Newsletter on the new Reichert Award for Excellence in Advanced Laboratory Instruction.

New APS Fellows Nominated from the Forum on Education

This year there are four new APS fellows, as nominated from the FEd. Their "citations" are below, and brief bios of each new Fellow follows.

David M. Cook , Lawrence University
Citation: For the prominent roles he has played in developing and disseminating outstanding computational elements for undergraduate physics courses, in building an exemplary undergraduate physics program, and in executive leadership of the American Association of Physics Teachers.

Paul Cottle, Florida State University
Citation: For the impact of his efforts to improve university physics education, especially for precollege teachers, and his advocacy for effective precollege science education standards and policy in Florida and nationally

Paul DeYoung, Hope College
Citation: For his strong and sustained leadership of facilitating research opportunities to enhance undergraduate education

David E. Meltzer , Arizona State University
Citation: For his tireless advocacy for the quality of professional preparation of K-12 teachers and for the depth and breadth of his scholarly contributions to research in physics education and the community of physics education researchers

About our new APS Fellows

David M. Cook grew up in Troy, NY, and received B.S. (1959) and Ph.D. (1965) degrees in physics from Rensselaer and Harvard. He then joined the Department of Physics at Lawrence University, where he received the Lawrence excellence in teaching award in 1990. During his 43 years on the Lawrence faculty, he taught nearly every course offered by his department and supervised a multitude of student projects. Between 1988 and 2008 (with support from the NSF, the W. M. Keck Foundation, and Lawrence University), Professor Cook directed an ongoing curricular development project that has created a departmental environment in which physics majors become expert at using state-of-the-art computing resources intelligently and independently. In February 2000, he received an NSF grant to support the assembling of the extensive locally developed instructional materials into a customizable textbook titled *Computation and Problem Solving in Undergraduate Physics*; the text was completed in January 2003, and continues to be used at several colleges around the country. Just before his retirement in June 2008, Professor Cook was elected Vice-President of the AAPT, serving four years in the presidential chain. In that capacity, he served on several AAPT Advisory Committees and as AAPT representative to the AIP Governing Board, the APS Council, the APS/FEd Nominating Committee, and the APS/FEd Executive Committee. In January 2013, he will embark on a three-year term as chair of the AAPT Meetings Committee.

Paul Cottle earned his Ph.D. in Physics from Yale in 1986 and joined the faculty of Florida State University in the same year. He has published more the 100 refereed papers in experimental nuclear physics, and in 1987 was awarded the Presidential Young Investigator Award by the National Science Foundation. Cottle has been involved in teacher education and other K-12 issues for twenty years. He was a member of the committee that wrote Florida's science standards in 2007-2008, and is presently serving on the chair line of the APS Forum on Education and as Chair of the society's Committee on Education. He was awarded the George B. Pegram Award by the Southeastern Section of the APS in 2002.

Paul DeYoung graduated from Hope College, completed his doctorate at the University of Notre Dame in 1982, and subsequently conducted research at the Nuclear Structure Laboratory, SUNY-Stony Brook, before returning to Hope to teach. He is currently the Kenneth G. Herrick Professor of Physics at Hope, where he co-leads the college's "nuclear group". His research has received continuous support since 1985, from agencies including the National Science Foundation, Research Corporation and the Michigan Space Grant Consortium, and has resulted in more than 80 journal articles and more than 80 presentations at professional conferences. In February 2011, the college's division for the natural and applied sciences recognized him for with that year's "James N. Boelkins Natural and Applied Sciences Division Research Award". He loves teaching students about physics through involvement in original research.

David E. Meltzer received a Ph.D. in theoretical condensed matter physics from SUNY Stony Brook in 1985, then went on to complete six years of post-doctoral work at the University of Tennessee and the University of Florida. In 1991 he joined the faculty at Southeastern Louisiana University in Hammond and turned his focus to research on the learning and teaching of physics. Since 1992 his primary work has been in physics education research and physics curriculum development, and he has been Principal Investigator on nine projects funded by the National Science Foundation. He joined the faculty at Iowa State University in 1998 and from 1998 to 2005 he was director of the Iowa State University Physics Education Research Group. He later taught at the University of Washington in Seattle and joined the faculty at Arizona State University in 2008 as an Associate Professor. He has taught more than two dozen different university courses on physics, science, and science education, and has also regularly taught middle-school science classes since 2007. He has published 30 papers in refereed journals and proceedings, edited seven books, and given about 100 invited presentations in five countries. He is a consultant to the American Physical Society and the Physics Teacher Education Coalition (PhysTEC), and Senior Consultant to the National Task Force on Teacher Education in Physics. He is also a competitor in Masters Olympic-style weightlifting.

Interested in more than just Physics Education?

About the Society for College Science Teachers

Brian R. Shmaefsky, Lone Star College
President, SCST

SCST (Society for College Science Teachers) is a multidisciplinary college science teaching organization that promotes the best teaching practices in all science fields. Our meetings are times to share field-tested general teaching principles applicable to any science. We also look at ways to encourage students to see how the different science disciplines inter-relate and rely upon each other for the furthering of knowledge. Many of our members also conduct research in higher education to better understand the way undergraduates best learn science. Members publish in the *Journal for College Science Teaching* and present cutting-edge sessions at the SCST annual conference and regional meetings. Our special SCST/NSTA symposium sessions at the annual conference also highlight the overlap and interdependency of the disciplines. Our Facebook site and listserv are other avenues of sharing member ideas and promoting collaborative efforts to improve college science teaching. Check us out at www.scst.org.

Note added: the Editor is a member of NSTA and SCST.

Some Reasons for Lack of Physics Achievement in Inner City Schools

Stewart E. Brekke

The environment in inner city schools can be devastating to young physics students, especially those of color; what appears to be bad teaching or lack of achievement is really an indicator of the amount of destruction the inner city environment can work on bright capable children. Very often the low achievement of these children is a direct result of years of intimidation, exposure to violence and the fear that pervades their lives. The cumulative impact of this environmental situation has repeatedly destroyed their sense of safety and security. Many of these children have witnessed killings and other crimes and have been intimidated in ways far beyond what most white people living in the suburbs can imagine.

For example, one day just before physics class, the students were talking to each other about “where they (the gangs) dump the bodies.” Apparently, every so often behind a store dead bodies would be found by the students who lived in the neighborhood. One student described a body of a naked woman who had her nose cut off found there recently. Another student was describing “who he has to know on the bus” every day to get to school in order not to be hurt on his way to the school. In one of my physics classes, a boy was doing B work and therefore, I had noticed him. However, he started to become absent more and more frequently and later dropped out. Apparently, his house was being robbed when everyone left for work and school. He had to stay home to guard the house rather than go to school.

In physics I had a bright young Negro girl who was murdered by random gunfire in the neighborhood after school. The bullet also killed the baby in her womb. Her boyfriend thereby became despondent and committed suicide. One bullet essentially killed three people. Another young black excellent physics student went for a sandwich after school and was shot in the head and died. I had just been able to place him into an upward bound program at a local university. Many physics teachers teach another subject besides physics. I had a boy in general science whom I was planning to get into my physics class and one day after school he was killed by a bullet by someone shooting up the neighborhood. Over the years I had four students murdered from classes I was teaching. One teacher who had been teaching longer than I had sixteen students murdered during his tenure. On two occasions the students came to school in the morning only to find a dead body of someone in the neighborhood on the school track facility. Apparently, that is where gang executions took place. Once I was called out of my physics classroom at the end of the school day to find one of my physics students with her head bleeding. Apparently, she was hit against one of the lockers by a boy in school. I asked a good physics student in my class to build a rocket to use for a Newton’s Law demonstration. I had to drive him home with the kit because he feared someone might take it from him. He came back to school the next day late with the built rocket and it was hidden in a paper bag. I failed a senior football player because he did not do enough work in physics class. When he found out he was failing, he left the room in the middle of class. At the end of the day, when I went to my car, I found the front fender damaged–the police could do nothing because I had not seen the student do the damage.

Another factor affecting school achievement is the constant disruptions of a few students that substantially affect the learning process. In one school at which I taught, we took a survey of about 500 students and almost 40 percent of the students stated that their classes were routinely disrupted. The same survey determined that many of the students felt that their neighborhood was unsafe. Moreover, problem children disrupt the learning environment all through elementary and high school. As a direct result of this situation many minority children get to high school unable to read at grade level and are also very weak in fractions, decimals and long division. Subjects which lead to good jobs such as Chemistry and Physics build on elementary mathematics and good reading skills and are unattainable because of this repeated devastation. It takes just one disruptive student to destroy the learning that is supposed to go on in the classroom.

It is easy to blame the teachers and students for underachieving students in the inner city. However, the environment certainly affects the performance of the physics students. The hope that schools offer young bright inner city students is slowly dashed over the years due to the constant negative effects of the inner city environment out of school and in school. The teachers, the vast majority of whom are very dedicated, are wrongly being blamed for what is a massive social problem.

Enhancing Your Local Section Meetings

Joss Ives, University of the Fraser Valley (British Columbia, Canada)

This past October, a special session on Upper-year Lab Instruction was held at the Annual Meeting of the Northwest Section of the APS. With the excitement of the 2012 Conference on Laboratory Instruction Beyond the First Year of College (BFY) still fresh in my mind, I approached the section meeting organizers with the idea of putting on a session to serve the upper-division laboratory instruction community in a regional setting. To my delight, they supported the idea and a very successful session resulted.

Last minute cancellations took the invited speaker count from five down to three, but the talks we did have were excellent, and those in attendance indicated to me that they thoroughly enjoyed the session. First, Nancy Forde described a senior undergraduate lab course in Biological Physics at Simon Fraser University which teaches the students biophysical techniques as well as basic molecular and cell biology. Next, Georg Rieger discussed an advanced lab course at the University of British Columbia which places heavy emphasis on communication skills and has been organized to recreate, on a smaller scale, the experience of a graduate student in a research group. The final talk came from Erik Sanchez where he outlined his Advanced Experimental Class which includes in its offerings labs involving Plasmonics, thin film deposition and scanning probe microscopy. After the talks there was a scheduled discussion period in which all the speakers and session attendees participated.

The Chicago Section of the AAPT plans to follow Joss' lead at our Fall 2013 meeting. ALPhA, the organizer of last summer's BFY (Beyond the First Year) Lab Conference, hopes to that others will have special Advanced Lab sessions at their local section meetings. Feel free to contact a member of the ALPhA board if you need advice, or would like to make a presentation or workshop at a local APS or AAPT section meeting (www.advlab.org).

An intermediate-level physics laboratory: A system of two coupled oscillators with low-cost accelerometers

Mary Lamont and Minjoon Kouh
Physics Department, Drew University, Madison, NJ

Wiimote is a wireless controller for the Nintendo Wii game system. This device can measure acceleration along three orthogonal axes and broadcast the data via Bluetooth, which can be captured and recorded by free software like GlovePIE (http://www.glovepie.org). Recently, there have been a number of reports on the innovative usage of Wiimotes in physics laboratory and demonstration projects, such as vector decomposition on an inclined plane, harmonic and circular motions, collision, and other motion-tracking experiments [1,2,3].

Using commonly available equipments (springs, airtrack, and aircarts) and Wiimotes (Figure 1), we have designed an intermediate-level mechanics experiment about a system of two coupled oscillators. This experiment complements standard theoretical coverage of this important topic, and provides an opportunity to incorporate a lesson on data analysis and scientific-computing software.

As covered in many mechanics textbooks (such as [4]), a system of two coupled oscillators can be described by a set of coupled differential equations, and has two normal modes, commonly referred to as the symmetric and antisymmetric modes. The symmetric mode occurs when both masses are displaced equally from their equilibrium positions in the same direction. The antisymmetric mode occurs when the masses are displaced in the opposite directions from the equilibrium positions. In general, the masses will oscillate as a combination of the two modes. The frequencies of the normal modes are determined by the spring constants and the masses.

Sample data from our setup are shown in Figure 2 for the symmetric and antisymmetric modes, as well as the mixed modes, over a few seconds. We have performed the discrete Fourier analysis on the acceleration data, using the FFT function in Matlab [5,6]. As expected, the Fourier transformation of the pure mode reveals a single peak, and that of a mixed mode reveals two peaks at the expected frequencies (in our case, 0.3 and 0.6 Hz).

As further explorations, we have (a) varied the starting positions of the two masses, and analyzed the relative amplitudes of the two normal modes, which depend on the initial conditions, and (b) analyzed the mass-dependence of the frequencies, by putting extra weights on the aircarts. In both cases, there was a good agreement between the theory and the experimental data. For details, please see the extended version of this report [7].

By incorporating a low-cost wireless accelerometer and scientific-computing software, we have designed an intermediate-level mechanics experiment, suitable for typical sophomore or junior physics students in college, allowing them to study this important topic in quantitative details, to deepen the understanding of the theoretical concepts about normal modes and Fourier analysis, and to learn and use computational tools. With its $40 price, 100-Hz sampling rate, and within-5% accuracy, this relatively new sensor package opens up many possibilities for innovative lab experiments beyond the first year of physics curriculum.

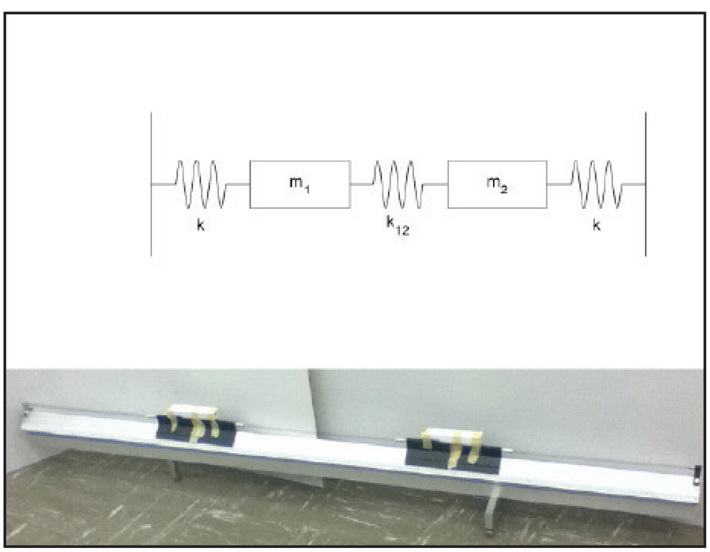


Figure 1. Experimental setup. Two aircarts per Wiimote were necessary to provide enough lift on the airtrack.

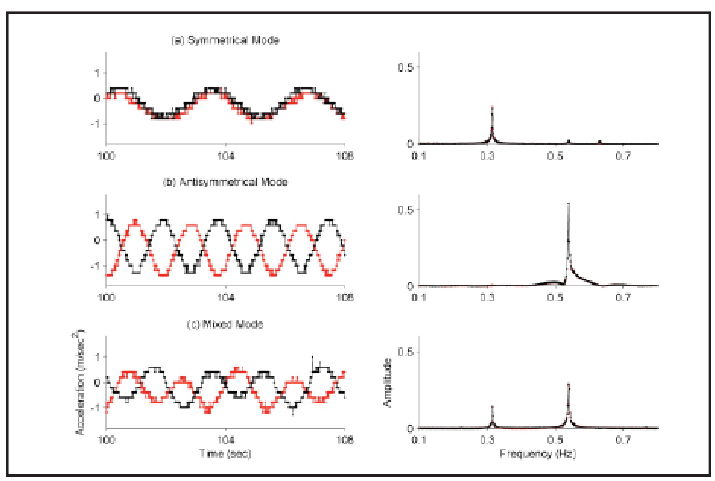


Figure 2. Sample trials with different initial positions of two aircarts. The accelerometer data from two Wiimotes (left) and their FFT analyses (right) are shown.

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Einstein on Faster-Than-Light (FTL) particles?

Robert Ehrlich, George Mason University

In one of his famous 1905 papers on relativity Einstein said that "Velocities greater than that of light have … no possibility of existence." This statement was made after he noted that the energy needed to accelerate an electron to $v = c$ would be infinite, so his proscription against $v > c$ particles was specifically in reference to objects that start out with sub-light speeds. It is unclear what Einstein might have thought about $v > c$ particles (tachyons) that had superluminal speeds from the very moment of their creation in subatomic particle collisions – an idea suggested by Bilaniuk, Deshpande, and Sudarshan in 1962. Such particles would obey the equations of special relativity and hence have an imaginary rest mass or a negative value of m^2. Of course all searches for these hypothetical particles have proven negative, and there have also been many false reports over the years – the latest being the famous OPERA experiment at CERN in 2011. The initial OPERA result was shown to be due to several errors, including a loose cable. These false reports over the years have probably made most physicists very skeptical of the whole idea of tachyons, although there continues to be a small group who believe that one or more of the neutrinos may indeed be tachyons, with a negative m^2 so close to zero, that it would have so far escaped detection. The author happens to be among this group, and he believes that there exists a number of experimental indications (though certainly no clear proof yet) that one neutrino is a tachyon – results he has published in a number of papers, including: http://arxiv.org/abs/1204.0484

In an effort to overcome what he considers the "tardycentrism," i.e., a misguided unwillingness to seriously consider the evidence for tachyonic neutrinos, the author has recently created a humorous video of a cartoon Einstein giving his views on the subject. Of course, it is not possible to know what Einstein, if he were alive today, might make of the possibility of tachyons existing. Nevertheless, given Einstein's fondness for unconventional thinking and entertaining ideas out of the mainstream, it is quite possible he would share the views of Richard Feynman, who when asked by a graduate student several decades ago whether he thought tachyons really existed, replied "Of course." The author's 16 minute long video entitled "Einstein on Faster-than-Light Particles?" can be found on YouTube, and it should be understandable to viewers having only a very modest amount of basic physics. See: https://www.youtube.com/watch?v=l9aLyfFnfOU

For those readers interested in the mechanics of creating such videos, the following is worth noting. The author is relatively unskilled at computer animation, but once he created a detailed script, he was able to put the project out for bid, with the whole thing costing under $2300 – although some bids were for many times that figure. There were over 30 people bidding to do the voice over, and around 10 animation companies bidding to create the video itself – most outside the U.S. He awarded the project to an India-based company (AFX Animation) with whom he has worked on a variety of media projects in the past, and was very pleased with the end result. Of course, following the 2011 "Phantom of the OPERA", now may not be the greatest time to stimulate interest in the notion that neutrinos may indeed be tachyons, but perhaps the video might prove to be of interest to students who find very appealing the notion that there are still many undecided extremely fundamental questions in physics that do have empirical answers.

Service Learning in Introductory Astronomy and Physics

Michael P. Orleski, Ph.D. – Misericordia University, Dallas, PA

Introduction

Service Learning is an instructional technique where students enrolled in a course use the course's content in a community service project. The students write a reflection piece after each service activity to analyze how they used the course material when performing the service activity. The analysis done in the reflection piece(s) is a key part of the process. Performing the service and creating the reflection piece(s) are incorporated into each student's grade for the course.

Service Learning at Misericordia University

The Sisters of Mercy founded Misericordia University in 1924. Service is one of its four guiding principles, called charisms. To help support this mission, Misericordia has a support system for faculty who want to incorporate Service Learning into a course. The Service Learning office will assist in finding and contacting an organization to schedule a service project and can also help to design the service project if the faculty member does not already have a service plan in mind. To aid faculty in designing their Service Learning project, Misericordia has a faculty guide[2] that is available on the university website.

Misericordia has a minimum of ten hours, in addition to the reflection, that students must fulfill in the course of the project. The students need to keep a log of the time spent since the project may encompass several weeks or months. Any work supporting the service project may be counted in the total hours with the exception of travel time. Travel is often necessary because the project must serve a group outside the university community. The Service Learning office prefers to have the entire class involved in the service project as opposed to something more akin to an extra credit project where the students decide whether or not to participate.

At the conclusion of the course the students fill out two surveys from the Service Learning Office. The surveys gauge the students' opinions on how successful the service and the course were as well as their attitudes regarding performing service to the public in the future. At the end of the semester the students receive a certificate stating the number of hours they spent over the course of the service project. They also receive a service leadership transcript detailing all of their service learning work when they graduate from the university.

Service Learning in Introductory Astronomy

The author has incorporated Service Learning into an introductory Astronomy course. The students have hosted observation sessions for local elementary schools. The attendees get to observe the Moon near to first quarter and whichever bright planets are visible. They also have the prominent constellations indicated in the sky with a green laser pointer. The astronomy students are required to research their assigned celestial object(s) so the students can talk to the viewing audience as they rotate to each viewing station. The observations have been held on Misericordia's campus so the audience consists of the elementary students, their parents and siblings and their teachers. The Astronomy students must be prepared to speak appropriately to the different age groups in the audience. For example when speaking to a younger audience the astronomy students must describe their target using simpler language, as compared to older audience members who can understand more complex descriptions. All members of the audience, regardless of age, are encouraged to participate in all aspects of the observation.

International Observe the Moon Night[3] presents an opportunity to host an observing session with only one observed object. The students have only the Moon to research in preparation for the event. Depending upon the scheduling of *IOMN*, to date near the first quarter moon in September or October, this may be the first observation of the semester. The crater activity described below also fits well with a Moon-themed event.

Since Service Learning has a minimum time commitment from the students of ten hours and the success of observations depends on good weather, alternative activities must be prepared. The students prepared presentations explaining the Zodiac constellations and the planets as an alternate activity. They also prepared an activity[4] that illustrates how impact craters form. The activity starts with a pan containing layers of flour, cocoa, and other colored powders. Participants then drop or toss various sized objects into the powders in the pan, creating craters complete with ejected material. Characteristics of the craters such as depth and how wide the ejected material is spread can be observed and discussed. The colored powders serve as an indication of how deep into the layers of powder the impacting object penetrated. Varying the shape of the impacting object and its entry angle can change the shape of the crater.

Presentations created for the general public are another possibility. For example, the Chemistry Club hosts an annual Halloween show for the public. Some of the astronomy students created a shorter presentation on the Zodiac constellations that they presented before the Chemistry event.

Service Learning in Introductory Physics

Lynn Aldrich, Ed.D.[5] has incorporated Service Learning into algebra-based introductory physics courses. The primary organization is Habitat for Humanity, which builds houses for underprivileged families. Students work with the organization for one day. For the reflection activity the students explain, at an appropriate level, the physics they used in the work they performed. Another organization that is utilized is Rails to Trails. This group converts unused rail lines into walking and biking trails and maintains those trails. Again the students perform some type of physical work and explain the physics involved in that work. Most students will spend about seven hours with Habitat for Humanity and three hours with Rails to Trails to make up their ten hour requirement. Additional options include working with Community Supported Agriculture (CSA) doing gardening or working with the local Council on Economic Opportunity (CEO) packing Thanksgiving boxes for the less fortunate. Since the students must be able to write about the physics they used in the work they performed, they must perform some form of manual work. The students are required to write two to three pages of analysis for each service activity. Occupational Therapy students form a large portion of the students in this course, so Dr. Aldrich tries to have the students focus on the different types of levers they used during their work in at least one of the reflection pieces. Levers are a key concept those students must understand for their chosen career.

Conclusion

Service to the community is a founding principle of Misericordia University. To support that mission, the University embraces Service Learning. Service Learning puts course content to use in service projects for the general public. Students then analyze the experience via reflection activities. The Physics Department has incorporated Service Learning into an introductory physics course and an introductory astronomy course. The physics students engage in manual work with a number of organizations and reflect on their use of physics in written reflection pieces. The astronomy students host astronomy observation sessions for local school students. For their reflection activity, they write about how teaching others about astronomy has affected their own learning in the course.

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Preparing Physics Graduate Students for Careers in Industry

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Consider the tale of 2 physics PhD students recently hired into industry. Bob has experienced the traditional graduate student program and is highly skilled and knowledgeable in a narrow branch of physics. Alice has a similar background but has also developed a broader base of experience relevant to the needs of industry. Both are told they will be leading critical development programs. Bob is panicked because he is thrown into a new situation with no sense of how to succeed, Alice has essentially led all aspects of her graduate program and has a broad base of relevant experiences and is confident she will be successful. For one new hire, it was the best of times, for the other, the worst of times.

Most physics graduate students will not have academic careers. Yet, it may be difficult for physics professors to prepare their students for careers in industry since most professors have not experienced professional life outside of academia. While most professors would no doubt like to better prepare their students for industrial careers, the lack of knowledge about this career path as well as lack of time and resources to prepare and teach a class in this area are significant barriers to providing a solution to this problem. In this note, I will describe the basic attributes and skills that are useful for industrial careers from my perspective, and will propose ways in which this education can be accomplished with minimal cost in time or resources. I base this on my 30 years of experience in industry in many roles including physicist, materials scientist, engineer, technical project leader, program manager, and engineering manager.

A new PhD physicist entering industry will be expected to at least be a technical leader, and will also likely be asked to manage some or all aspects of a small R&D program, or some significant part of a larger development program. So they will be responsible for the success of a program. They may also be asked to manage the schedule, budget, technical progress, and the work of others, including scientist, engineer, or technician co-workers, and outside collaborators and vendors. This means the new hire will need to do whatever is necessary to ensure success. In a broader context, a PhD will be asked to successfully negotiate transitions from basic research to early stage development, or early stage development to initial production, areas fraught with challenges. The latter transition is known as the competitive "Valley of Death" (Ref. 1) to those with a business or entrepreneurial orientation, while those in large Department of Defense or NASA programs may refer to these issues in terms of Technology Readiness Levels (Ref. 2), or TRLs.

So how can PhD level graduate students learn the necessary skills to be successful in this environment at minimal cost to physics departments? I propose two solutions, one relevant to course work and the other to the research effort, both based on my own experience as a graduate student of more than 30 years ago, where courses were almost exclusively devoted to derivations, mathematical manipulations, and standard end of chapter problems. Students should be also able to apply their knowledge to new situations, a key requirement for industrial physicists. Courses should include real world examples of the applications of the basic physics principles; for example, problems from a related engineering course would be useful to show real world uses. They should be asked to construct conceptual models of the physics, should be able to discuss the physics and applications, and should be able to draw/pictorialize the basic physics. When there are physical parameters (e.g. refractive index, extinction coefficient, permeability, permittivity), students should learn values for typical materials and the typical ranges as well as have a conceptual understanding of them. Preferably, students should also be introduced to computational methods/software packages used in industry. I know that almost none of these occurred in my graduate education. These changes to the graduate curriculum will allow students to more easily navigate the transition between basic physics and the engineering applications of their physics, as well as communicate the basic conceptual physics with fellow scientists, engineers, technicians, program managers, upper management, and customers. It would also, I think, make courses more relevant and interesting for many students.

The second solution involves small but important changes to the later years of a graduate research program. These changes should also improve the training of graduate students if they choose the academic route, so are applicable to all graduate research students. In many ways, professors, who are research program leaders, are much like program managers in industry: they write proposals, interact with their sponsors, give presentations, lead the research effort, and are generally responsible for the success of their programs. The major differences are that the efforts are mostly aimed at basic research in academia, whereas they are focused on solving a well defined technical problem or developing a product in industry, with specific cost and schedule constraints. Nevertheless, the process by which a successful project is managed is fundamentally similar.

First, later stage graduate students should be involved in all aspects of proposal writing, preferably leading the effort with guidance from the professor. The student should take the lead in finding and understanding the request for proposals as well as writing the technical proposal, including background information and the rationale and expectations for the research effort. They should note the expertise and research done by other groups in their research area and should consider the rationale of why a funding agency should fund them instead of other competing groups; in other words, they should do a "competitive analysis." They should also help develop the budget and also provide a schedule for the work to be done. While academic work is often open ended, with schedules not a standard part of proposals, a schedule should still be generated using the best available knowledge. For example, if an experiment can't be done until some equipment is purchased, the schedule would show some time to investigate and determine the best piece of equipment, and include the expected delivery time, time to set up and debug the equipment, and the time to get some results. More generally, students can use commercial software, such as the industry standard Microsoft Project, to develop a Gantt chart (Ref. 3). At the same time, students can determine how rapidly the funds will be spent, and can develop a chart that shows the expected cumulative spending vs. time.

Second, when a proposal has been funded and the work started, the student should be given a high level of responsibility for all aspects of their specific research program, including working with others and procuring needed materials, equipment, and expertise, again with guidance, as needed, from the professor, post-docs, senior staff, or more advanced graduate students. The student should be given monthly updates of costs incurred for their part of the grant, so the student can track the actual spending vs. the amount planned in the proposal, and discuss the impact of any difference with the professor. The student should also track the progress of the work in a monthly basis and show progress on an updated home-made chart or on a more official Gantt chart. In this way, the student is acting as a program manager for the part of the effort that is their own, and is gaining valuable program management experience in a low stress, relatively simple environment. In addition, they are learning the critically important work attributes of being proactive and taking responsibility for all aspects of their program. An added benefit in using a schedule is that it can also be used as the basis for discussions between student and professor about progress towards the PhD degree in a quantitative manner

Near the end of the research effort, students should be asked to consider the technological applications of their research. It is likely that some aspect of what they have done has either short term or long term technological applications. They should consider these applications and determine challenges that need to be overcome before they can be transformed into useful technologies, preferably providing some ideas as to how to overcome these challenges. They should also consider other commercial products or patents already existing in this area, describe their characteristics and note the companies that make these products. Further, students could evaluate potential regulatory, environmental, safety, political, and social impacts of possible applications of their research. By doing this students will be learning about the challenges of crossing the "Valley of Death" or equivalently, greatly increasing the TRL. Note that this also could help meet the broader impacts aspects of NSF proposals in that a standard part of each research program will be to have the lead graduate student evaluate the broader impacts of their research and preferably include these analyses in their thesis.

In most industrial careers, the scientist has significant interaction with others: technicians, fellow scientists, engineers, managers, directors, and customers. It is important to develop interpersonal skills that allow good oral communication, including listening, and the ability to work well with others, to motivate them, and work as a team. Writing skills are equally important as scientists will asked to write proposals, technical reports, and project related reports as well as generate presentation materials for themselves and others. The teaching and education outreach skills that many graduate students develop to communicate complex scientific ideas to students and the public are truly transferable to industry, since they will be communicating complex scientific ideas to their managers and directors to try to get funding, as well as educating their technicians and engineers so that they understand the reasons for the work being done so they can better support the technology development.

Other skills or habits are also needed to succeed in industry. Some years ago, I generated a 15 point guide for success in industry, based on my experience. All can be practiced throughout graduate school. They are listed below:

1. Be responsive – return phone calls and emails promptly. When asked to do something, do it on time – be sure to ask when it should be done. Document requests and responses in writing.
2. Become the world expert in your particular area.
3. Continually expand the depth and breadth of your knowledge and skills.
4. Utilize all information resources available - books, science magazines, web sites, search engines, search services, colleagues, patents, trade magazines, catalogs, sales reps, conferences.
5. Get involved with or develop projects that have a high probability of contributing to the company's success
6. Understand and be aware of project constraints such as your personnel and company capabilities, competitor's strengths, and customer needs.
7. Innovate continuously. Always push your envelope as well as the science and technology envelope. Stay uncomfortable with what your skills and knowledge are.
8. Document your work in a manner that can be easily understood by a co-worker a year from now. Use spreadsheets, tables and charts to convey your results in a concise, visual, and easy-to-understand manner.
9. Make sure that you learn something useful from any tests or experiments that you perform. These results should form the basis for future tests.
10. Learn from your mistakes. Don't repeat them.
11. Don't believe everything you are told, even if it is company lore or told to you by an expert. Be skeptical.
12. Enjoy your work.

13. Treat everyone you work with (above and below you) with respect. Thank them for their work. Acknowledge their contributions whenever possible. Keep them informed as to what you are doing and why you are doing it.
14. Have a sense of humor.
15. Develop a unique and necessary skill and knowledge set that complements those of your co-workers and greatly increases the value of your project/team. Be indispensible.

The graduate student that has these experiences will be adept at applying their knowledge to new applied problems, can generate proposals, lead and manage programs, provide strategic planning to their employers by evaluating competitive strengths as well as evaluating challenges. They will also have the skills and habits to work well and responsibly with others and become valuable contributors to their company's success.

This is a quick overview of how relatively small changes can be made to the graduate physics curriculum so that for all graduate students beginning industrial careers, it can be the best of times.

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Lawrence Woolf is a former Chair of the FEd.

Section on Teacher Preparation

Teacher Preparation Section

John Stewart, University of Arkansas

This edition of the Teacher Preparation Section features articles from three PhysTEC sites. Cody Sandifer and Ronald Hermann will describe the PhysTEC program at Towson University. This is the second PhysTEC program at Towson; the first focused on elementary education while this project focuses on secondary education. The article describes some of the challenges encountered by the program. Towson is also an UTeach replication site and some of the issues of merging PhysTEC and UTeach are touched upon.

John Simonetti will describe the PhysTEC program at Virginia Tech. This program features a novel use of physics outreach formalized within the course sequence of the program and the extension of graduate teaching assistantships to PhysTEC graduates to allow the completion of a one-year post-baccalaureate licensure program.

Edward Price describes the PhysTEC program at California State University San Marcos and its role in supporting a recently instituted physics degree program. This article contains a detailed description of the implementation and modification of a Learning Assistant (LA) program and the positive impacts of the LA program both on the department and on the learning assistants.

PhysTEC will hold its yearly conference in Baltimore immediately preceding the March meeting. This conference gathers together individuals committed to improving the number of highly qualified physics teachers. This year's meeting will be held in collaboration with the American Chemical Society and will also discuss ways to improve the number of highly qualified chemistry teachers. This is my favorite conference of the year.

This year's conference theme is "Preparing the Next Generation of Physics Teachers". Further information is at http://www.ptec.org/conferences/2013/.

Towson University PhysTEC Project

Dr. Cody Sandifer and Dr. Ronald Hermann
Towson University

The Physics Teacher Education Coalition (PhysTEC) project, founded in 2001, is a nationwide project that has funded 26 universities to improve and promote the education of future physics teachers. At these sites, physics faculty, education faculty, and a full-time teacher in residence (TIR) work together to improve secondary physics education programs.

From 2004-2008, Towson University (TU) was an elementary education-focused PhysTEC site, and received an American Association of Physics Teachers Presidential Citation Award for Teacher Preparation for its elementary education efforts. In 2010, Towson University rejoined the national PhysTEC project to focus on the retention, recruitment, and mentoring of physics secondary education majors.

The purpose of this article is to summarize the project goals, activities, successes, and ongoing challenges from Towson's 2010-2013 secondary education PhysTEC project.

Project Personnel

The directors of the current TU PhysTEC project are Dr. Ronald Hermann and Dr. Cody Sandifer, both of whom are faculty in Towson's Department of Physics, Astronomy & Geosciences (PAGS). The project has the full support of Dr. David Schaefer, our department chair. Dr. Hermann is a former high school science teacher from Harford County, Maryland, who graduated from Morgan State University and joined Towson as a secondary education faculty member in 2009; Dr. Sandifer, a science educator who has his roots in San Diego State University's joint doctoral program (with UC San Diego), co-directed the original TU elementary PhysTEC project and has focused on K-16 science curricula and inquiry-based teaching methods since coming to Towson in 2001.

Towson's 2010-2012 PhysTEC TIR was Mr. Jim Selway, who had been a high school physics teacher in Baltimore County for 35 years. Mr. Selway continues to work with the PAGS department as a volunteer to sustain his previous TIR accomplishments. The current 2012-2013 TIR is Mrs. Lisa Rainey, who was a former high school science teacher and community college administrator.

University and Department Background

Towson University (TU), a member of the state university system of Maryland, began as a Teacher's College, and the tradition of developing qualified teachers continues as TU graduates the highest number of education majors in the state. Currently 2,382 undergraduate and 1,698 graduate students are enrolled in teacher education programs at TU.

TU is one of the few academic institutions nationwide to have a significant number of education faculty housed in its science content departments. For example, the PAGS department contains six science education faculty members, with one specializing in high school education and the rest specializing in elementary or middle school education.

The PAGS physics program has four concentrations to choose from: general, applied, astrophysics, and secondary education. These concentrations have historically emphasized undergraduate research experiences, a high degree of faculty-student interaction, and a comprehensive curriculum. Most faculty in the department are active in research.

In addition to their general education requirements, secondary physics education students complete 34 credits of physics courses, 23 to 24 credits of non-physics science and math courses, 32 credits of non-science education courses, and 15 credits of science education courses.

Starting in 2000, the PAGS department concentrated on increasing the number of its physics majors – which is critically important to secondary education efforts because secondary education majors are drawn from the larger pool of physics majors. From 2000 to 2012, PAGS grew its number of physics majors from 34 to 114 through the implementation of admissions targeting, scholarship programs, improved advising, the creation of a first-year seminar, and grouped on-campus housing of majors. However, despite the increase in physics majors, the enrollment numbers of physics secondary education majors (prior to PhysTEC) remained disappointingly low. In total, only two undergraduate students graduated from TU with a physics secondary education degree between 2002 and 2009.

Project Goals

The 2010-2013 TU PhysTEC project goals fall into two categories: physics program goals and physics secondary education program goals.

Physics Program Goals

- Refine, enhance, and expand the amount of active learning pedagogy in introductory and upper division physics courses
- Provide professional development and mentoring for full- and part-time physics faculty new to active learning instruction
- Increase the extent to which physics majors engage in ongoing discussions regarding secondary teaching as a possible career option
- Provide early teaching experiences for physics majors to get them interested in secondary teaching as a possible career option

Physics Secondary Education Program Goals

- Clarify, reorganize, and disseminate the description and requirements of the secondary physics education program to help with recruitment of secondary education majors
- Modify the secondary science teaching methods course such that secondary education majors increase their depth and breadth of physics-specific pedagogical content knowledge
- Create organizations and activities that will help secondary physics education develop feelings of belonging to an educational community
- Provide education-based internships to help declared secondary physics education students maintain an interest in teaching as a career
- Work with the College of Education, its Center for Professional Practice, and neighboring school districts to select appropriate mentor teachers and provide orientation workshops to ensure that active learning approaches are valued and implemented in the student teaching semesters
- Increase the amount of financial support offered to secondary physics education majors
- Maintain communication with and provide mentoring for recent secondary physics education graduates

Project Activities and Successes

The national PhysTEC organization has identified key components of successful teacher education programs, including: recruitment, resident master teachers (TIRs), course transformation, early teaching experiences, learning assistants, and induction & mentoring.[1]The activities and successes described below are a summary of Towson's PhysTEC efforts from 2010-2012, as categorized by these key components. Similar activities can be found at other PhysTEC sites, although some activities (as noted) are unique to Towson and represent TU's contribution to the evolution and advancement of the national project.

Recruitment. In alignment with nationally advocated PhysTEC recruitment activities, the PAGS department displays teaching posters in its hallways, holds informational meetings for physics majors interested in education, and has intense one-on-one advising sessions with incoming, newly-declared, and continuing secondary education majors. One recruitment practice that potentially sets Towson apart from other PhysTEC sites is ongoing communication between TU PhysTEC TIRs and local high school teachers (via email, classroom visits, Physics Olympiad meetings, etc.); these discussions and presentations focus on encouraging high school physics students – especially those who show promise as teachers – to consider (a) teaching as a profession and (b) joining the secondary education program at TU.

Prior to 2010, the greatest number of physics secondary education majors in the PAGS department (across all levels, including MAT students) was three, which occurred in 2008-2009. Historically, a more typical number has been either one physics secondary education major across the entire department, or none at all. In stark contrast, as of November 2012, we now have thirteen secondary physics education majors, including four MAT students. Thanks to PhysTEC, this is a substantial and welcome increase in the number of future physics teachers at Towson.

Resident teachers. Full-time TIRs are the only project team members who dedicate 100% of their working hours to PhysTEC, so the role that they play in the project is critical. At TU, our TIRs perform a multitude of important tasks, including mentoring recent secondary education graduates, meeting with college and high school physics students interested in education, and helping learning assistants to integrate active learning exercises and inquiry-based questioning techniques into lecture and lab courses.

TIR activities, unique to the TU program, include offering professional development workshops to Baltimore County teachers, teaching a new third-semester early teaching course (desccribed below), and working with two-year colleges and TU administrators to ensure that the transfer of two-year students into the secondary physics education program goes smoothly.

The greatest success of our hard-working TIRs has been the creation of an energetic teaching community of undergraduate learning assistants and physics faculty who have increasingly gained an interest in reform- and research-based physics pedagogies. Our TIRs are now the "go-to" project members, for example, when a faculty member hopes to integrate an interactive demonstration into lecture. Personal contact between the TIRs and secondary education students has also played a key role in increasing and retaining the number of secondary education majors in the department.

Course transformation and learning assistants. As a result of PhysTEC funding, the PAGS department has been able to double the number of undergraduate physics learning assistants (LAs) that are hired each semester. From 2010-2012, seventeentwenty-six undergraduates served as physics LAs, often for multiple semesters. Ten different full- and part-time physics faculty utilized these LAs. LAs spend their time in the project doing one thing: supporting the improvement and redesign of physics courses. They do this by serving as tutors, offering test review sessions, helping with instructional planning, and either leading or assisting with student-centered learning activities in lecture and lab. As part of their paid duties, LAs also attend Teaching and Learning seminars and meet regularly with TIRs and course instructors.

One particularly important success is that LAs have come to realize that experiences with active-learning pedagogical methods will serve them well in any teaching career, whether they end up as a high school teacher, graduate teaching assistant, university faculty member, or parent.

1 There are eleven key components in total; the others are not addressed here.

Induction and mentoring. Mentoring is an ongoing activity that begins in our undergraduate program and continues into the first few years of high school teaching. Dr. Hermann officially advises and mentors all secondary education majors in the department, with additional informal advising/mentoring being provided by the TIRs. Upon graduation, the responsibility for university-based mentoring officially shifts to the TIRs, though Dr. Hermann still maintains correspondence with alumni.

Induction is a separate concept that represents the integration of the future teacher into the greater physics teaching community. One goal is to help the future teacher develop an "I am a teacher" (as opposed to an "I am a student") mindset. At TU, we have had success with helping future teachers feel connected with practicing teachers and the teaching profession by having them present at local and national educational conferences (e.g., Maryland Association of Science Teachers, National Science Teachers Association). Additionally, a preservice physics teacher – with the help of Dr. Hermann - has resurrected and is now the president of TU's local National Science Teachers Association chapter.

Early teaching experiences. Prior to TU becoming a secondary PhysTEC site, PAGS faculty and the Dean investigated the nationally recognized UTeach project and adapted selected UTeach activities for local use. Consequently, TU has offered versions of UTeach's STEP 1 and STEP 2 courses for the past four years; in these one-credit, low-stakes courses, first- and second-year STEM majors are placed in informal teaching contexts (e.g., science museums, nature centers) and elementary and middle school classrooms to give them an opportunity to develop an interest in teaching. Since the TU STEP courses were put into place, twelve physics majors have enrolled in STEP 1 or STEP 2.

TU has extended the STEP sequence even further by creating a new STEP 3 course for secondary physics education majors (only). This course, which is taught by a TIR, places secondary majors into high school classrooms as participant observers to give them additional pre-student teaching experience. Student evaluations of the STEP 3 course have been extremely positive.

Other early teaching experiences at TU include the aforementioned learning assistant program and various informal outreach activities in the department and college.

Ongoing Challenges

No project is perfect, and our PhysTEC project is no exception. Not everything has gone as planned, and not all problems have been solved. The following is a truncated list of ongoing challenges that are related to Towson's secondary physics education improvement efforts.

Identifying effective recruiting strategies has been difficult, as most students in the teaching concentration are not influenced by one specific strategy.

Other PhysTEC sites use learning assistant programs and early teaching coursework to recruit students into the secondary education major, but this approach has not been successful at TU. While we have found LA and early teaching programs to be extremely beneficial in a variety of different ways, these activities have not motivated undecided physics majors to switch into the secondary teaching concentration.

Increasing the number of future high school teachers in the university pipeline should not come at the expense of teacher quality, and we are struggling with how to implement evaluation and feedback mechanisms so that only those students who should become high school teachers (in terms of interpersonal and instructional skill, etc.) actually do so.

As of Fall 2012, TU has become a UTeach replication site, so the path to sustaining our PhysTEC successes will partly rest on the degree to which Towson's UTeach project will maintain and duplicate our PhysTEC project activities. The extent to which this might occur is currently unclear, since UTeach is a general project focused on secondary STEM education (not just secondary physics education), and the UTeach model for resident teachers is very different from the PhysTEC model in terms of expected duties and responsibilities.

Final Thoughts

Towson University's participation in the secondary education-focused national PhysTEC project has been a rewarding three-year experience that has resulted in an increase the number of physics secondary education majors, new avenues of communication between physics and education faculty (even within the PAGS department), and improved faculty and learning assistant attitudes toward active learning instructional methods. Those of you who are interested in improving your own secondary education programs should feel free to contact the TU PhysTEC directors or members of the national PhysTEC project for details and support. Our aim is to share what we have learned over the past few years, which means offering advice on what NOT to do as well as brainstorming secondary education activities that might be appropriate for your own institutional context.

Dr. Cody Sandifer is a member of the Towson University Department of Physics, Astronomy, and Geosciences and was the co-director of Towson University's original PhysTEC site.

Dr. Ronald Hermann is a member of the Towson University Department of Physics, Astronomy, and Geosciences and a former high school teacher.

The PhysTEC Program at Virginia Tech

John Simonetti, Department of Physics, Virginia Tech

The Physics Teacher Education Program (PhysTEC) is now in its second year here at Virginia Tech. PhysTEC, as you may know, is a project led by the American Physical Society and the American Association of Physics Teachers, with the aims of improving the education of future high school physics teachers and physical science teachers, and increasing the number of credentialed physics teachers drawn specifically from the ranks of college and university physics majors. Secondary goals include the improvement of undergraduate physics teaching by incorporating modern research-based methods of instruction and improving the general atmosphere surrounding the educational mission with physics departments. To advance this last goal, PhysTEC also aims to raise the level of regard among physics faculty for teaching physics as a career option for undergraduate physics majors. As you should be aware, the nation suffers from a severe lack of highly qualified physics teachers at the secondary level. With the dramatic scientific and technological issues facing our nation and the world, the future health of our civilization depends upon the quality of education, and particularly science education, at the pre-college level.

Virginia Polytechnic Institute and State University is a land grant university, founded in 1872. It is a research university with eight colleges and a graduate school, with approximately 29,000 full-time students on campus (about 24,000 undergraduates). The university is most well-known for its College of Engineering. Virginia Tech is located in southwestern Virginia, about a 4 hour drive from Washington, D.C., and the heavily populated northern Virginia area; many of our students come from northern Virginia. The university is located in the New River Valley, a rural area between the Blue Ridge and Alleghany Mountains. Blacksburg, the surrounding town, is very much a college town.

The Physics Department has approximately 200 majors. In addition to educating the majors, the department teaches a two-semester calculus-based introductory physics sequence to all engineering students – a total of about 2000 per semester. A non-calculus introductory sequence is also presented to approximately 900 life-sciences majors per semester. Graduate Teaching Assistants (GTAs), taken from the ranks of our physics graduate students, run laboratory and recitation sections for these introductory sequences.

PhysTEC at Virginia Tech has many features common to other PhysTEC sites, but also some unique innovations. Like most PhysTEC sites, we have a Teacher in Residence (TIR) and a Learning Assistant (LA) program. In our program, we collaborate closely with the School of Education, use a SCALE-UP approach to teach introductory physics to our physics majors, not a traditional lecture, have some unusual pre-service teaching experiences for our PhysTEC students, and offer our PhysTEC students a Graduate Teaching Assistantship to cover their expenses while completing their Masters of Education at Virginia Tech.

Our current TIR is Alma Robinson. She has been with us since the beginning of the program. While it is unusual for the TIR to serve for more than one year at a PhysTEC site, there was a change in PhysTEC leadership at our site and the PhysTEC administration thought it best to allow our TIR to continue for another year, adding some additional continuity to the program. Alma has been an integral part of the success of our program because of her boundless energy and her enthusiasm for the program and for education in general. She graduated from our undergraduate physics program and completed a Masters in Education here at Virginia Tech before we became a PhysTEC site. After teaching physics at a high school in northern Virginia for a number years, she became our first TIR. Alma has a thorough knowledge of the Virginia Tech program, knows the faculty involved, and the specific academic programs here for physics majors and graduate education students. She also has a preexisting connection with high school physics teachers in the area through her experience here as a student teacher. In addition, she was a GTA in our department as a graduate education student, and had the job of working with teachers in the area to schedule outreach visits to those schools by our physics majors outreach team (more on this program later). The potential lesson for other PhysTEC sites: while it is often useful to have new blood in a program, don't shy away from using a TIR that was a successful graduate of your program, either as a physics major, or education student, or both. Such a person can be quite an asset.

This year we started an undergraduate Physics Learning Assistant program, with the intent of interesting more students in teaching, improving the delivery of physics instruction to both physics majors and engineering students, and assisting the LAs in their own understanding of physics (as faculty know – and as we tell all our students – you only really learn physics when you teach it). We were already on track to use undergraduates as Learning Assistants before our selection as a PhysTEC site. LAs are similar to GTAs, but are undergraduate students (who may be paid, or may receive academic credit for their LA work). Before we became a PhysTEC site, we used some undergraduate physics majors as teaching assistants in the labs associated with introductory astronomy. These students were high-level physics majors, interested in teaching, who had a background in astronomy or had taken the introductory course and labs earlier. Our newly initiated Physics LA Program has 12 participants, who serve as LAs in introductory astronomy lab sections, introductory physics lab sections, introductory physics lectures for engineers, and the SCALE-UP introductory physics section for freshman physics majors. All LAs must take our new Physics Teaching and Learning course, taught by the TIR. The LAs take this course concurrently with their first semester as an LA. They receive credit for taking the course, and as is common within the College of Science, our undergraduate LAs receive academic credit for their work as an LA. We hope the LA program will improve the performance of physics majors in upper level courses, convincing the faculty of the value of LAs, spreading the use of LAs to upper-division courses, and enhancing the teaching mission of the department.

The SCALE-UP approach to instruction was initiated in the Physics Department at North Carolina State University and has been adapted at many colleges and universities, including MIT. SCALE-UP, in general, refers to courses which use interactive group work, in classrooms specifically designed for the purpose. Often the classrooms, as in our case, use round tables of a specific size, with 9 seats; students at these tables often work in groups of 3, with a computer available to each of group. Whiteboards hang on all the walls of the classroom. The specific activities undertaken by the groups emphasize learning by doing, as opposed to learning by lectures. The instructor is more a facilitator of discussion, and a coach as he or she walks about the room. Groups may interact as they share results or ideas. In our setting we also use a GTA and two LAs for the SCALE-UP section, which contains about 40 freshman physics majors. This section is taught by the Department Chair, who is one of the Co-PIs on the PhysTEC project.

Perhaps one of the uncommon aspects of our PhysTEC program is the constructive combination of the PhysTEC program and a separate, independently initiated Virginia Tech program called the First Year Experience (FYE). The FYE program aims to provide freshman and transfer students with specific skills to increase their chances of success in their undergraduate studies: skills in problem solving, inquiry, and integration of information. In addition, FYE courses address career planning. Faculty can obtain university money to design courses that address these goals. I obtained FYE money to design and run an FYE course for physics majors. The course is a two-semester sequence (1 credit per semester) which is run in the SCALE-UP room, with the assistance of a GTA who is one of the PhysTEC Masters of Education (MAED) students. In addition to addressing the FYE goals, we often have the students teach their fellow group members, and we stress the importance of this activity. The FYE platform gives us a chance to introduce the LA program and teaching – teaching peers, and a teaching career.

We support all our MAED PhysTEC students using Graduate Teaching Assistantships in the Physics Department. These students have obtained their B.S. or B.A. in physics from our department, and so are quite familiar with our undergraduate labs and courses. This also means the MAED students obtain their graduate degrees, and licensure, while being entirely supported financially. Alma Robinson was one of the first students to be supported in this model before we became a PhysTEC site. This year we have five MAED PhysTEC students who obtained their undergraduate physics degrees from our department; all are supported as GTAs.

The student I work with in the FYE course was our co-valedictorian a few years back, went to graduate school in astronomy, and returned after a year to pursue teaching as a career. He has not followed the standard PhysTEC track, since most of our PhysTEC students start their MAED program in their senior undergraduate year; thus the PhysTEC physics major-MAED sequence is a five-year program. Usually these students take some education courses in the summer after obtaining their physics degree. Thus, support combined with an accelerated program help to make our full program attractive to potential teachers among our undergraduate majors.

Perhaps the most interesting aspect of our program is the set of pre-service experiences we provide for our undergraduate PhysTEC students: a multi-level outreach program and a robotics program. The outreach program consists of two possible courses. All physics majors are welcome to enroll in the first course, Physics Outreach. In Physics Outreach students meet weekly with the GTA, usually an MAED student, where they learn how to run physics demonstrations and lead discussions about the physical principles involved in a secondary school setting. Teams of these students visit the local and regional middle and high schools, where they lead class meetings with the students in science classes. Alma Robinson was the GTA for this course when she was an MAED student. Many of our PhysTEC MAED students tell us they were first turned on to teaching through Physics Outreach. The second level of the outreach program is the Enhanced Physics Outreach course. PhysTEC students in this course must put in a greater effort, and receive a larger payback, through working more closely with the instructor (our TIR) and the local science teachers to develop detailed lesson plans for demonstration-based physics lessons in the middle school and high school science classrooms. They carry out these plans on visits to the schools. While Physics Outreach has been going on for years now, Enhanced Physics Outreach is a new addition, born of our PhysTEC program.

Our most unique program unit is our robotics program pre-service experience. The School of Education has partnered with the College of Engineering to provide a capstone course in the design and building of a robot in collaboration with the surrounding Montgomery County Public Schools. With the initiation of the PhysTEC collaboration between the School of Education and the Physics Department, our undergraduate PhysTEC students are now welcomed into the robotics program course. The physics majors are not engineers, but they quickly learn the design process, and given their strong background in physical principles, make significant contributions to the effort. The high school students meet with the engineering and physics students during the spring semester, in late afternoons and on Saturdays, in a building at the Virginia Tech Corporate Research Center. The purpose is to design and build an entry for the national FIRST robotics program. The college students acts as coaches and mentors in the design process, the construction of the robot, the testing, and finally the entry of the completed robot in regional and, hopefully, national competitions. This past spring, there were two PhysTEC physics majors in the robotics program. The design purpose of the robot was revealed nationally early in the Spring semester: the robot had to autonomously shoot basketballs into a basket, and also do so under the remote control of a student. While the resulting Montgomery County robot did fairly well in the regional competitions in Richmond, VA, and Raleigh, NC, the team did not win a spot in the national competition in St. Louis. However, the physics students were particularly proud of the fact that their two subteams (Drivetrain and Bumper) won subteam awards at the Raleigh competition, while the subteams lead by engineering students did not. The result of the robotics program that impressed me the most was related by one of our School of Education collaborators. The parents of our two PhysTEC students in the robotics program told her they were initially uneasy that their children were pursuing a career as secondary school teachers. When the parents saw their children with the high school students at the competition, saw how their children interacted with the high school students, saw how much their children had grown through this experience, and saw how the high school students looked up to their children as mentors, the parents became completely supportive of their children's choice to become high school physics teachers.

The author, acting as a "coach," in the SCALE-UP room.

John Simonetti received his B.S. in physics from SUNY at Stony Brook in 1978, and received his M.S. and Ph.D. in Astronomy and Space Sciences from Cornell University in 1982 and 1985. After he did postdoctoral work at the National Radio Astronomy Observatory, he became a faculty member of the Department of Physics at Virginia Tech, where he is currently the Associate Chair.

The CSUSM Learning Assistants Program

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San Diego County, where California State University San Marcos (CSUSM) is located, has a high concentration of technology-based firms, and projections for regional and state growth show a strong need for workers with degrees in all STEM disciplines [1]. Consistent with these needs, in 2007, the CSUSM Physics Department began offering a B.S. in Applied Physics, its first physics bachelorsbachelor's degree program [2]. As a regional university, CSUSM is connected to and dependent on the state of local K-12 STEM education. The recent National Task Force on Teacher Education in Physics noted the connection between STEM careers, high school physics, and high school physics teachers: "An effective precollege physics education is indispensable in preparing U.S. students for global competition." Quality high school physics depends, in turn, on qualified physics teachers [3]. Yet, California, like much of the nation, faces a shortage of qualified physics teachers, and high school mathematics and science teachers generally. Over the next 10 years, projections indicate a need for in excess of 30,000 new mathematics and science teachers [4]. For all these reasons – self-interest, regional economic needs, and the current and future health of the field - helping prepare high school physics teachers is an important goal for the CSUSM Physics Department, consistent with American Physical Society (APS) and American Association of Physics Teachers (AAPT) goals and priorities [5]. We have been able to pursue this goal while simultaneously building a new physics degree program; indeed, the two efforts support each other, with a Learning Assistants (LA) Program based on the University of Colorado (CU Boulder) model [6, 7] playing a central role.

In an LA Program, undergraduate Learning Assistants (LAs) assist faculty in class, meet regularly with the course instructor, and participate in a weekly seminar on teaching and learning, which provides guidance on effective instruction and an opportunity to reflect on their experiences in the classroom. The LA program promotes course transformation, improved student learning, and teacher recruitment. Starting a physics program from scratch offered the opportunity to incorporate recent innovations in physics education when developing courses. Because most CSUSM students come from the local area, the health of the Department is coupled with the vitality and strength of local high school physics education. Thus, the LA program goals (course transformation, improved student learning, and teacher recruitment) align with our efforts to launch a new and thriving undergraduate program.

Program Overview

What does the LA program look like at CSUSM? It shares many core features with the University of Colorado model, including the participation of LAs in structured class activities (in contrast to office hours, tutoring, or grading), an ongoing pedagogy seminar for the LAs, an emphasis on teacher recruiting, and coordination between the STEM faculty and the School of Education. CSUSM is a very different institution from CU Boulder, and our LA program reflects this. At CSUSM, the LA program has included math and science (primarily chemistry and physics) courses since its inception. In contrast, the CU Boulder LA Program began in physics and later expanded to other STEM departments. In 2005, the California State University (CSU) system started a Mathematics and Science Teacher Initiative (MSTI) in response to statewide needs for more qualified mathematics and science teachers [8]. The CSUSM LA Program was established in 2008 with support from MSTI, and so included math and science, not just physics. Broadening the program also had the practical benefit of roughly doubling the program's size: during the first semester there were 4 LAs in physics courses, 3 in math, and 1 in chemistry. This helped achieve an economy of scale in program management; for instance, leading the pedagogy seminar requires about the same effort with 4 or 8 LAs. It also resulted in a pedagogy seminar (and indeed, entire program) that was more vibrant. The program had to find ways to work with part-time instructors, or adjuncts, who teach many courses at CSUSM. These faculty often teach many courses and have limited time to develop new materials. Modest curriculum development stipends are offered to encourage faculty to transform their courses to more effectively utilize LAs. Faculty are required to document their materials and share with other instructors to promote shared practices.

At CSUSM the LA program is co-directed by faculty from the Department of Physics (Dr. Edward Price), and the School of Education (Dr. Brian R. Lawler). College of Science and Mathematics faculty work with the LAs in their courses and School of Education faculty lead the teaching and learning seminar. The CSUSM LA program is described at <http://www.csusm.edu/laprogram/>. Since 2008, the CSUSM LA program has placed over 130 LAs in 11 STEM gateway courses (see Figure 1), including 50 LAs in physics courses. The program has grown with campus enrollment, increased participation from faculty, continued support from the CSU MSTI Program, and recent additional support from PhysTEC. In 2011, CSUSM received funding for a targeted PhysTEC project. As a PhysTEC site, CSUSM has increased the number of LAs in physics courses, expanded the LA program to a nearby community college, and created a group for local high school physics teachers.

CSUSM offers two calculus-based introductory physics sequences, one taken primarily by biology majors (PHYS 205 and 206), and the other taken by physical science, math, and computer science majors (PHYS 201, 202, and 203). LAs are placed in both sequences. The courses for biology majors meet twice weekly for a total of six hours, with students working actively in groups, then explaining their work to their peers in a whole class discussion [9].

The instructor lectures for a total of about 75 minutes per week, mainly to help students organize their ideas about the phenomena encountered in their group activities. In this setting, LAs help facilitate group work, and respond to student questions. Given the course's non-traditional format, the LAs, as former students, are an important source of continuity and help students who are new to the course to transition effectively.

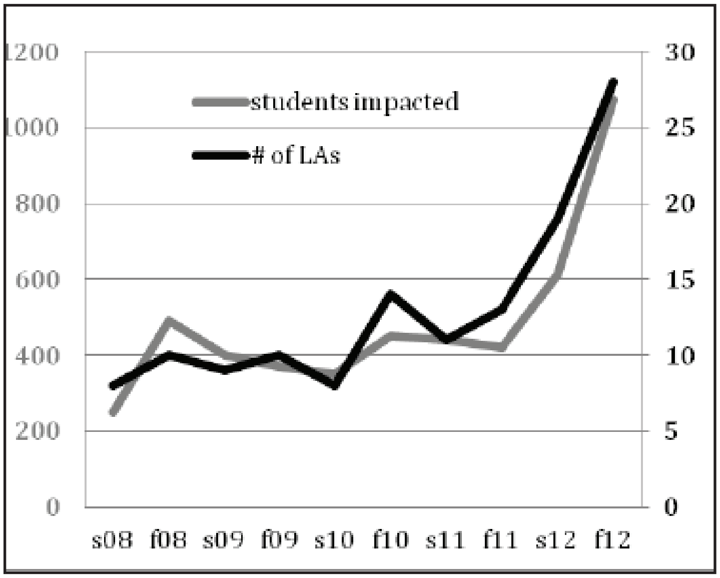

Figure 1. LAs are placed in introductory physics, pre-calc, calc I and II, and general chemistry. The left axis shows the number of students impacted and the right axis the number of learning assistants.

PHYS 201, 202, and 203 have a more traditional format of lecture and laboratory. In lecture, LAs help facilitate Peer Instruction [10]; the labs are project based, and LAs work help students with the design, building, and analysis of their projects.

Teacher recruiting and Impacts on LAs

Participation as an LA has many benefits for the students. The opportunity to explore teaching in a structured program leads many LAs to consider careers in teaching. LAs also benefit from the opportunity to review or better learn the course material, practice communication and presentation skills, and interact closely with a faculty member. At the end of each semester, we ask LAs to comment on their experience. These remarks suggest a well-developed understanding of teaching and learning. "Good teaching guides a student through the thought processes to acquire new knowledge." "[Good teaching was] providing the material in a manner so that the students needed to think, and also ask[ing] 'good' questions to aid them. The questioning part was hard at first because I was so used to math being watched then practiced." LAs experience gratification when working with students. For instance, one student reported, "The first time I made sense to a student and saw their face light up with understanding… In a small world it made me feel big -like I know something." Finally, LAs appreciate that teaching is an intellectually challenging activity: "One of the challenges I faced was coming up with the best questions to ask students when helping them solve problems. As it turns out, I had to do this on a case by case basis. What might be the best question to ask one student may not necessarily be the best question to ask another student…"

At CU Boulder, Otero et al. found that "approximately 12% of LAs are actually recruited to K-12 teaching careers [7]." At CSUSM, approximately 10% of math LAs have entered the single subject math credential program. It is too soon to know if a similar pattern will develop in physics. CSUSM's first Bachelors of Science in Applied Physics was awarded in 2009, and many of the 50 LAs in physics courses have been majors in other fields. However, a number of current Applied Physics majors have expressed interest in teaching.

Supporting and sustaining course transformation

There are many research-based physics curricula that promote active engagement and student learning. However, implementing these approaches can be difficult for many reasons, including large class sizes, the inertia of past practices, lack of experience with non-traditional techniques, time constraints, student expectations, and departmental expectations. The CSUSM LA program helps address some of these issues by providing additional manpower (the LAs) and a curriculum development stipend if faculty are making their courses more interactive. By providing faculty with additional resources, the LA program catalyzes and sustains curricular changes. At CU Boulder, Otero, et al. found that the LA program "improved student understanding of science content, and engaged a broad range of science faculty in course transformation…" Not only did STEM departments find improved student achievement as a result of the LA program, but, "faculty members report increased attention to what and how students learn [6]." We see similar outcomes at CSUSM.

Two examples illustrate how the LA program has supported and sustained course transformation. In one case, a new instructor began teaching PHYS 206 with LAs. While open to the course format and pedagogy, this instructor's teaching experience was exclusively with the lecture format. However, the LAs and instructor established trust, and the LAs would often provide suggestions, give feedback, and help the instructor "stay true" to the course format. The instructor went on to become very confident and comfortable with the course format. While other factors were also important, the continuity and support provided by the LAs contributed to this outcome.

Another instructor (in a different course) had introduced some in-class activities, such as having students work in groups to analyze demonstrations. After finding these difficult to implement, the instructor requested an LA. The LA helped facilitate group work, presented demonstrations, and acted as an intermediary between the instructors and the student. At the end of the semester, the instructor wrote, "All of the procedures introduced to improve the student participation in the learning process could be employed without the LA but only at very greatly reduced scope, possibly rendering them a waste of time." This instructor was also interested in implementing clickers (a class response system where students can vote and the instructor can show the results), but had technical concerns. The LA learned to use the system and the instructor was able to focus on pedagogical issues rather than technical ones.

At CSUSM, a Learning Assistants Program has helped us launch and grow a new physics degree at a time when other programs are being closed due to low enrollment [11]. The B.S. in Applied Physics at CSUSM has grown from 11 majors in 2008 to over 80 in 2012. The LA Program goals of course transformation, improved student learning, and teacher recruiting are also important goals for our growing program. In particular, through teacher recruiting and preparation we can strengthen local K-12 STEM education. In the long run, this will benefit our Department, our region, and the physics community.

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Browsing the Journals

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- Geoff Dougherty recommends the Fulbright faculty exchange program on page 947 of the November 2012 issue of the *American Journal of Physics* (http://scitation.aip.org/ajp/). Do stars twinkle when viewed from Mars? Find out at the end of the article on page 980 of the same issue. I also appreciated the detailed book review of Mark Levi's (nb: not Mark Live's) book *Why Cats Land on Their Feet*on page 1112 of the December 2012 issue of *AJP*, together with an online link to a further list of comments on the book. I was amused by the explanation of why bubbles sink in stout beer glasses on page 88 of the February 2013 issue. (It has to do with the tilt of the sides of the glass relative to the vertical, but I think it's just an excuse to go out drinking.) Jeroen Spandaw shows that the principle of least action can be tricky to apply correctly on page 144 of the same issue: one needs to start with boundary values (two different fixed values of y) rather than initial conditions (values of y_0 and v_0).

- Rod Cross's measurements of the viscoelastic properties of Silly Putty on page 527 of the December 2012 issue of *The Physics Teacher* (http://scitation.aip.org/tpt/) motivated me to summarize the analysis in more detail at http://usna.edu/Users/physics/mungan/Scholarship/SillyPutty.pdf. I was also intrigued by Göran Grimvall's brief discussion on page 530 of the same issue about presenting an unlabeled graph and several possible captions to students and asking them to figure out which is the only correct match. Finally, the article by Hester and Burris on page 534 shows that it is possible to derive the rocket thrust equation from Newton's second law if one is careful about choice of system, and Craig Bohren discusses cooling rates of humans in air and in water on page 560. In the January 2013 issue, you might be interested in the analysis of Baumgartner's supersonic balloon jump on page 14, the surprising longitudinal momentum imparted to air flow in the near-field of a sinusoidally driven loudspeaker on page 16, the question of whether a thin or a thick fuse connected in parallel across the same potential difference would burn out first on page 38, a lovely brief derivation for maximum range of a projectile fired off a tabletop on page 52 (I recommend having your students unpack some of the missing intermediate steps), and a wonderful Physics Challenge Problem on page 56 involving two Carnot refrigerators running in a tent.

- Two identical balloons are filled, one with air and the other with helium, with their ends held pinched closed and then released together from rest. Which balloon will deflate most quickly? Which balloon will fly higher? How will they sound different as the gases escape? The key is the difference in their average molecular masses, as you can read about on pages 782 and 783 of the November 2012 issue of *Physics Education*. The journal can be accessed at http://iopscience.iop.org/journals.

- *Nature* has reviewed the year 2012 in science at www.nature.com/news/specials/2012/. In particular, don't miss the interactive guide through key numbers and a summary of the year in review for science.

- Usually I don't reference myself, but just for fun, you might read what the Chief of Naval Research said in *Wired* magazine about laser weapons at http://www.wired.com/dangerroom/2012/10/lasers/ and then read my related brief remarks in the local Annapolis newspaper at http://www.capitalgazette.com/news/naval_academy/with-lasers-on-their-way-naval-academy-preps-mids/article_c43720cc-c6c2-5b61-b7cf-1d633f6ddf3d.html.

Web Watch

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- Change the Equation is a business group dedicated to improving STEM learning at http://changetheequation.org/.
- Frank Potter has some good links for grade school and college level physical science on his page at http://www.sciencegems.com/; although I would caution that he is not formally affiliated with any educational institution.
- Point your students to some profiles of working scientists and engineers on the science360 network at http://science360.gov/series/Profiles+of+Scientists+and+Engineers/711d5cab-8416-40f7-9297-099c1f37a9bd.
- Kyle Forinash has an interactive online textbook on the Physics of Sound for nonscience majors at http://homepages.ius.edu/kforinas/S/Introduction.html.
- If you are a Mac user, as I am, you may like the list of science resources (mostly chemistry, but with some physics overlap) starting at http://www.macinchem.org/.
- A variation on the Prisoner's Dilemma is at http://s3.boskent.com/prisoners-dilemma/fixed.html where the computer can essentially force your average score to be fixed, to rise, or to fall. If anyone sees you, tell them you're not playing a game, you're doing operations research….
- Teaching intermediate mechanics? The old (1960) but great film on Frames of Reference is online at http://archive.org/details/frames_of_reference.
- NIH has an Office of Science Education (mostly life sciences, but still worth a browse) with a website at http://science.education.nih.gov/home2.nsf/feature/.
- Engineering Pathway is a collaboration of academia and industry linking to a variety of resources supporting technical education. Start at http://engineeringpathway.org/engpath/ep/hEd/.
- The Institute of Physics has a site devoted to Teaching Advanced Physics at http://tap.iop.org/. (By "advanced" they mean topics in first-year university physics.)
- At http://serc.carleton.edu/sp/library/guided_discovery/index.html you will find a discussion of Guided Discovery Problems. Then, in the left menu you will find links to all kinds of other pedagogical resources.
- If you were to dig a hole straight though the center of the earth starting anywhere, where would you end up? Find out at http://www.livephysics.com/simulations/mechanics-sim/dig-hole-earth/.
- Check out UBC's Physics Teaching for the 21st Century at http://c21.phas.ubc.ca/.
- NASA has been trying for a long time to perfect solar sailing in space. Next year it will try to deploy a sail over 1000 square meters in size according to http://www.huffingtonpost.com/2013/01/31/nasa-solar-sail-largest-ever-launch-2014_n_2592545.html?utm_hp_ref=science.
- SPS has a site devoted to Careers Using Physics, including job resources and college & graduate school admissions at http://www.spsnational.org/cup/resources.html.
- The briefly titled website http://why-sci.com/ is a collection of snippets written by scientists to explain current research topics to the general public.
- Sites with photos and descriptions of physics demos are often helpful to instructors teaching a new course. University of Florida's page is at http://www.phys.ufl.edu/demo/.

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