

Forum on Education

American Physical Society

Spring 2016 Newsletter

Beth Lindsey, Editor

In This Issue:

Changing the Culture of Physics Education, <i>Randy Knight</i>	1
From the Editor, <i>Beth A. Lindsey</i>	3
Forum on Education Election Results, <i>John Stewart</i>	3
FED Invited Sessions at the APS March and April 2016 Meetings, <i>Tim Stelzer</i>	4
New APS Fellows Nominated from the Forum on Education	6
2016 Excellence in Physics Education Award Recipient	6
Award for Improving Undergraduate Physics Education Awardees	7
2016 Jonathan F. Reichert and Barbara Wolff-Reichert Award for Excellence in Advanced Laboratory Instruction	8
Directors's Corner, <i>Theodore Hodapp</i>	8
New Editor for the American Journal of Physics Sought, <i>David Jackson</i>	9
The Unique Perspective of a Minority Student in a Physics Class Versus Chief Justice Roberts <i>Chandralekha Singh</i>	11
The 2015 Conference on Laboratory Instruction Beyond the First Year of College <i>Elizabeth George</i>	12
An Overview of the AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum <i>Joseph F. Kozminski</i>	14
AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum: Implications for Assessment, <i>Benjamin Zwickl</i>	15
Exposing and Assessing the Hidden Agenda of Laboratory Instruction <i>Natasha Holmes and MacKenzie Stetzer</i>	17
Teacher Preparation Section	
<i>Alma Robinson</i>	18
Mentoring Future Physics Teachers at the University of Wisconsin – La Crosse, <i>Jennifer L. Docktor</i>	19
Transitioning to Teaching through Mentorship, <i>Elizabeth Rosendale</i>	20
Brigham Young University’s Physics Teaching: Mentoring Physics Teachers, <i>Duane Merrell</i>	21
Browsing the Journals, <i>Carl Mungan</i>	22
Web Watch, <i>Carl Mungan</i>	23
Executive Committee of the FED	24

Disclaimer—The articles and opinion pieces found in this issue of the APS Forum on Education Newsletter are not peer refereed and represent solely the views of the authors and not necessarily the views of the APS.

Changing the Culture of Physics Education

From the Chair, Randy Knight

Physics departments in the U.S. awarded 7500 bachelor's degrees in 2014, a full 100% increase over the nadir of physics degrees in 1999. This is news to celebrate; physics is still relevant to today's students! Congratulations to all of you who worked to increase the number of graduates from your department.

At the same time, each year sees only 350-400 openings for tenure-track physics faculty, a number that is unlikely to change much anytime soon. Which is to say that only 1 in 20 of today's physics majors is destined to one day be a physics professor. (Actually, less than 1 in 20 because a not insignificant number of faculty slots are filled by candidates who received their undergraduate degree abroad.) PhD-granting departments average about 20 majors per year, and, on average, only one of those graduates will ever be a physics professor. Most bachelor's-only programs will graduate several classes before producing even one major who will go on to be a professor.

This is a problem. It's also an opportunity. Let's start with the problem.

As everyone recognizes, the physics curriculum, both undergraduate and graduate, has been essentially frozen for the past 60 years, since quantum mechanics became a core subject. It's a curriculum focused on preparing undergraduates for graduate school and graduate students to pursue pure research in academia or national labs. But it's not just the ossified curriculum that's the problem; it's also the culture of physics.

We in academia have a culture that places a premium on fostering younger versions of ourselves and denigrating – often subtly although sometimes quite blatantly – other career paths. We've probably all seen colleagues trying to steer top students away from high school physics teaching and toward graduate school. The quite clear message to students is that physics teaching is a lesser career best left to those who can't "cut it" in grad school. And when was the last time you or any of your colleagues actively guided a top student toward an industrial career or suggested that physics was a great entry into medicine or programming or interdisciplinary fields such as energy or climate?

Take a careful look at your department web site. What messages – tacit or explicit – is it sending to majors and potential majors about the range of careers that physicists can and do follow? Department web sites are the number one way that high school students gather educational and career information, and their number one question is "What could I do with a degree in physics?" State-of-the-art research is wonderful and will remain the core of physics, but is your web site unintentionally suggesting that this is the only career path for physicists?

The rather arrogant signals we send about what it means to be a physicist, and who has the ability to be a physicist, don't go unnoticed by majors and potential majors. This narrow rather than expansive view of what physicists are and do is almost certainly a contributing factor to the still serious lack of women and minorities in physics.

Surely we can do better. And we must do better to meet the educational and career needs of those other 19 students (or 29 or 39 if the upward trend in physics majors continues) in our classes and labs. This is where the opportunities lie. We can make our degree requirements more flexible and offer more courses that will prepare students for non-academic careers. Computational physics, optics, condensed matter physics, biophysics, acoustics, energy, physics pedagogy, and a host of more-applied-but-still-physics topics come to mind. We can inform students early and often of the range of careers open to physicists. (And, conversely, refrain from unduly promoting graduate school as the only serious option.) We can welcome and embrace diversity. We can actively promote and support high school physics teaching as a desirable career – which, ultimately, is in our own self-interest in terms of generating a stream of qualified and enthusiastic freshmen.

In other words, we can change the culture of physics education to match the realities of physics in the 21st century.

J-TUPP

All of which is to encourage you to read and act on the report of the Joint Task Force on Undergraduate Physics Programs when it is released later this spring. J-TUPP, a joint effort of APS and AAPT, was charged with answering the question: *What skills and knowledge should the next generation of undergraduate physics degree holders possess to be well prepared for a diverse set of careers?* Their report will "provide guidance for physicists considering revising the undergraduate curriculum to improve the education of a diverse student population."

The 2003 SPIN-UP report was instrumental in increasing the number of physics majors by providing insight into what makes an undergraduate program thrive. I'm hoping that the J-TUPP report will be equally influential in terms of helping departments change both their curriculum and their culture to better meet the needs of today's physics students. We want to continue attracting the best and brightest, but with a clear message that physics opens doors to an entire universe of career possibilities.

Randy Knight is Chair of the Forum on Education. He is Professor Emeritus at California Polytechnic State University, San Luis Obispo, and author of the introductory textbooks Physics for Scientists and Engineers: A Strategic Approach and (with co-authors Brian Jones and Stuart Field) College Physics.

From the Editor

Beth A. Lindsey, Penn State Greater Allegheny

This issue of the Forum on Education newsletter focuses on laboratory instruction. Laboratory instruction is a perennial hot topic for physics educators, and the 2015 summer AAPT conference was bookended by two meetings that focused on this topic. The first of these was the Conference on Laboratory Instruction Beyond the First Year of College (“BFY II”), which was organized by the Advanced Laboratory Physics Association (ALPhA) and supported in part by a monetary contribution from the FED. During three days preceding the summer AAPT meeting, approximately 150 instructors came together to share effective lab curricula, teaching methods, and experiments in small-group workshops, plenary and breakout sessions, and contributed poster sessions. The second meeting was the 2015 Physics Education Research Conference on the day following the AAPT. Each year, the PERC has a theme, and this year the theme focused on a “Critical examination of laboratory-centered instruction and experimental research in physics education.”

Elizabeth George, chair of this past summer’s gives a summary of that conference. Two of the presenters at BFY II, Joseph Kozminsky and Benjamin Zwickl, present articles on the AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum and how to assess them. Finally, Natasha Holmes and MacKenzie Stetzer consider open questions for physics education researchers to tackle within the instructional laboratory environment.

This issue of the FED newsletter marks the end of my three-year term as Editor-in-Chief. After this newsletter appears, I will be stepping down to pursue other projects. However, I leave the newsletter in the capable hands of Richard Steinberg, who will be taking over the role of editor. I expect he will bring a fresh perspective and new ideas to these pages, and I wish him the very best. I hope he finds the job of being FED newsletter editor as interesting and stimulating as I have.

Forum on Education Election Results

John Stewart, Vice Chair APS Forum on Education, West Virginia University

The Forum on Education (FEd) congratulates the successful candidates in the most recent election. Lawrence (Larry) Cain of Davidson University was elected FED Vice Chair. He will serve a four year term becoming Chair-Elect, Chair, and Past Chair. His first responsibility will be organizing next year’s elections. Nominations for candidates may be sent to Larry at lacain@davidson.edu. Toni Sauncy of Texas Lutheran University was elected as APS/AAPT Member-at-Large and Luz Martinez-Miranda of the University of Maryland – College Park as Member-at-Large. All newly elected FED officers will begin their term of office immediately after the APS April Meeting in Salt Lake City.

I would also like to thank the other candidates: Mel Sabella, Andrew Gavrin, Eric Brewe, Michael Wittmann, and David Klumpar. Being nominated is an honor that should be recognized by their departments and universities. The slate of candidates was exceptionally strong and I hope many will be elected to leadership roles in the future.

The strong slate of candidates was the result of the careful work of the nominating committee: Ken Heller, Carl Mungan, Wendy Adams, Scott Franklin, and Ramon Lopez. Janelle Bailey represented the American Association of Physics Teachers through the nomination process. This committee has completed its work and a new committee will be convened next year.

Each candidate provided a statement of their goals for their term

of office. These were provided with the election emails sent to FED members and are reprinted below.

Larry Cain: The Forum on Education has involved its members in a wide variety of activities at all stages of education, from elementary through graduate school and beyond. The challenge we face is to keep this involvement strong and broad. From improving instruction at all levels, to teacher preparation, to increasing diversity, to education outreach, and to education issues at the federal, state and local levels, the problems and opportunities are great and the FED must be a bridge between all of them. However, as the membership in APS has grown, the membership of the FED has been decreasing. We need to encourage more APS members to be concerned about all aspects of physics education and to join the Forum as we serve the diverse membership of the APS.

We must encourage graduate students, and undergraduates, to be more aware of the issues facing physics education so they can participate in the programs that the Forum supports. This is particularly relevant to two areas: the preparation of new teachers, particularly women and underrepresented minorities, and the support of education in their states and local areas regardless of what careers they pursue.

I will work with the Executive Committee and the membership to maintain and sustain current programs and to form new initiatives, particularly working with the new GPER to promote improved

physics education and the FOEP to promote outreach and engagement of the public.

Toni Sauncy: I have been an advocate for physics in and out of the classroom throughout my career, with a focus on engaging undergraduate students in the study of physics as early as possible through research training, science outreach for the general public, and most recently in physics career development. Over the past several years, I have come to understand that the undergraduate physics experience plays an essential role in not only the formation of physicists, but in the making of many other careers. Whether students are studying physics to be physicists, or studying physics to be something else, the value of physics as a way of thinking has proven to be invaluable, making our efforts to be effective educators more impactful. As the number of undergraduate physics degrees awarded each year continues to grow, the value of successful education in physics at the undergraduate level will grow. Physics departments have the opportunity to produce well qualified, highly effective thinkers and problem solvers who will join the STEM workforce in a variety of careers.

My goals for the Forum on Education should I be elected would include working with my colleagues to see that APS FED communications and sessions include a broad range of topical coverage aimed at the full undergraduate physics education experience, inclusive of the large percentage of students who will not attend physics and astronomy graduate school. We must realize that curricular and extracurricular education programs must include those

undergraduate physics students who may not follow the same academic path as their faculty mentors. This includes advocacy for including undergraduate research training as a priority for funding agencies. I hope that my experience in a broad range of the undergraduate physics experience will be beneficial and add to the overall FED mission.

Luz Martinez-Miranda: Physics is a very important and fundamental field. Many of the advances we see are strongly based on Physics knowledge. These include advances in Materials, Electrical Engineering, Biophysics, and other related fields. Physics is important because of the contributions to basic knowledge. We need to have a population of Physics-trained people that will contribute to basic knowledge, and will further advance the field. I am interested in serving in the Forum on Education because I have an interest in early Physics education, especially in the K-8 level, since I feel that we lose a great number of the potential scientists at this age. By middle school, many students have lost interest in physics specifically and science in general. Students that may be interested in engineering cannot see the relation of this field to physics. My experience in bringing demonstrations or mini-talks to students in middle school (level 6 – 8) has shown me that the more related these are to what the students are learning in school the more interest is generated. I am also interested in increasing the population of underrepresented groups in Physics at all levels, and have been even before I was called to serve in the Committee on Minorities in Physics.

FED Invited Sessions at the APS March and April 2016 Meetings

Tim Stelzer, University of Illinois

Sponsoring invited sessions on physics education at the March and April Meetings is perhaps the Forum's most visible activity. It is an opportunity to reach out to the larger physics community. We have some very interesting sessions lined up for this year's meetings, so please show your support by attending if you plan to be in Baltimore or Salt Lake City.

APS March 2016 Meeting in Baltimore Integration of Research and Teaching Excellence: Cottrell Scholars

Tuesday, March 15 at 11:15

- From Particle Physics to Education: The Role of Tinkering, Mats Selen, University of Illinois
- Excellence and Diversity in Physics, and the Quest for Other Worlds, Keivan Stassun, Vanderbilt University
- Undergraduate research: A win-win for both students and faculty, Thomas Solomon, Bucknell University
- Interdisciplinary Biophysics Major with a Comprehensive Research-Based Capstone, Rae Anderson, University of San Diego
- Untypical Undergraduate Research: Player Motion Analysis in Sports, Dinah Loerke, Denver University

Reichert-Award Session

Tuesday, March 15 at 14:30

- Advanced Instructional Labs: Why Bother?, Van Bistrow recipient of 2016 Reichert Award, University of Chicago
- Investigating Student Ownership of Projects in Upper-Division Physics Laboratory Courses, Jacob Stanley, University of Colorado, Boulder
- 8 Years of ALPhA's Impacts / 45 Years of Developing Experimentalists with Few Resources: A Talk in Two Parts, Lowell McCann, University of Wisconsin, River Falls
- Student-Driven Engagement: An Interdisciplinary-Team Research-Learning Renewable Energy Laboratory Experience for Undergraduates, Mark Tuominen, University of Massachusetts-Amherst
- Open-Ended Projects in Undergraduate Optics and Lasers Courses, Chad Hoyt, Bethel University

Impacts and Experiences with Hybrid and Online Courses

Wednesday, March 16 at 11:15

- Apples vs. Oranges: Comparison of Student Performance in a MOOC vs. a Brick-and-Mortar Class, Michael Dubson, University of Colorado, Boulder

- Fully Online Introductory Physics with a Bona Fide Lab, Michael Schatz, Georgia Institute of Technology
- A Blended Pedagogy for Expert Problem Solving, David Pritchard, MIT
- Online activities to optimize in person learning, Tim Stelzer, University of Illinois
- Lessons from two decades of hybrid and online physics courses at Michigan State University, Gerd Kortemeyer, Michigan State University

TA Professional Development: Excellent TA's making Excellent Researchers

Co-sponsored by the Division of Biological Physics

Thursday, March 17 at 14:30

- Using the TA to Prepare Students for Research and Employment, Kenneth Heller, University of Minnesota - Minneapolis
- Mobilizing the Forgotten Army: Improving Undergraduate Math and Science Education through Professional Development of Graduate Teaching Assistants, Jordan Gerton, University of Utah
- TA Professional Development: A Graduate Student's Perspective, Emily Alicea-Munoz, Georgia Institute of Technology
- A Joint Pedagogy Course for Learning Assistants and Teaching Assistants, Joshua Von Korff, Georgia State University

APS April 2015 Meeting in Salt Lake City Excellence in Physics Education Award Session

Saturday, April 16 at 15:30

- SCALE-UP, Student Centered Active Learning Environment with Upside-down Pedagogies, Robert Beichner, North Carolina State University
- Online Interactive Video Vignettes (IVVs), Priscilla Laws, Dickinson College
- Introductory labs; what they don't, should, and can teach (and why), Carl Wieman, Stanford University

Preparing and supporting university physics educators

Sunday, April 17 at 15:30

- Research-Based Assessment Affordances and Constraints: Perceptions of Physics Faculty, Eleanor Sayre, Kansas State University
- Perceived Affordances and Constraints Regarding Instructors' Use of Peer Instruction: Implications for Promoting Instructional Change, Chandra Turpen, University of Maryland
- Characterizing Pedagogical Practices of University Physics Students in Informal Learning Environments — Katie Hinko, University of Colorado, Boulder

Report from the Joint Task Force on Undergraduate Physics Programs

Saturday, April 16 at 13:30

- How the task force was formed, how it reached its conclusions, members of the task force, overview of report, and major findings, Paula Heron, University of Washington

- How does (or should) private sector employment influence educational practice. Results of national surveys, reports from other organizations, recommendations for skills and knowledge to prepare students for diverse careers, Theodore Hodapp, American Physical Society
- Motivation for report, implementation of findings, supporting structures in departments, dissemination, and next steps, Lawrence Woolf, General Atomics - Aeronautical Systems, Inc

Supporting and understanding physics identity development

Co-sponsored by GPER

Sunday, April 17 at 8:30

- Becoming Physics People: Development of Integrated Physics Identity through the Learning Assistant Experience — Eleanor Close, Texas State University-San Marcos
- Identity Development in Upper-Level Physics Students: Transitions In and Out of Physics — Paul Irving, Michigan State University
- The Role of Recognition and Interest in Physics Identity Development — Robynne Lock, Texas A&M University

Engaging the Public Through a Variety of Collaborations and Initiatives

Co-sponsored by AAPT

Monday, April 18 at 10:45

- St. Albans Under the Stars: Connecting the Community with the Universe, Gerceida Jones, New York University
- Rural Outreach in Maine: A Research-Driven Professional Development Teacher Community
- — Michael Wittmann, University of Maine
- TBD — Emina Stojkovic, Northeastern Illinois University

Building an inclusive STEM Community: The ACCESS Network

Co-sponsored by GPER

Tuesday, April 19 at 10:45

- CU Prime Diversity Workshops: Creating Spaces for Growth Amongst Organizers, Simone Hyater Adams, University of Colorado, Boulder
- Promoting Student Ownership of University Science Programs: Towards Building a more Equitable Scientific Educational Experience, Anna Zaniewski, Arizona State University
- Using Mindfulness and Metacognition to Support and Retain First Generation and Deaf and Hard of Hearing Students, Corey Ptak, Rochester Institute of Technology

New APS Fellows Nominated from the Forum on Education

This year there are two new APS fellows, as nominated from the FEd. Their “citations” are below.

Daniel Claes, University of Nebraska - Lincoln

Citation: For outstanding contributions to education initiatives associated with elementary particle physics, in particular to underserved remote rural communities.

Peter Shaffer, University of Washington

Citation: For contributions to the field of physics education research and to the development of research-based instructional materials that have led to improved learning in physics by undergraduates and K-12 teachers.

2016 Excellence in Physics Education Award Recipient



The Excellence in Physics Education 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 selection committee emphasizes that making the final decision was not an easy task. However, the committee recognized that the work of this year's awardee continues to have a broad impact on the physics community, not only on students. Thus, the Forum on Education is pleased to announce that in 2016, the Excellence in Physics Education Award recognizes Robert John (“Bob”) Beichner from the North Carolina State University. The citation reads,

“For leadership in research and dissemination of SCALE-UP teaching tools, providing an effective approach to learning phys-

ics with attention to conceptual understanding and participation of all students; and for editorial leadership in the establishment of PRST-PER, allowing broad dissemination of research-based educational practices.”

Background:

Bob Beichner received BS degrees in Physics and Mathematics from Penn State in 1977. He has a 1979 MS from Illinois and a 1989 PhD from SUNY, Buffalo. He started at NC State in 1992 and directs the Physics Education R & D Group. He invented the popular Video-Based Lab pedagogy and his team developed a widely-used series of conceptual assessments. In 1995 he originated SCALE-UP (Student Centered Active Learning Environment with Upside-down Pedagogies), now in use at more than 250 institutions. He was the founding editor of Physical Review Special Topics-Physics Education Research. He is a member of NC State's Academy of Outstanding Teachers. He received the Ohaus Award for Innovation from the National Science Teachers Association. He was named the 2009 North Carolina Professor of the Year by the Carnegie Foundation for the Advancement of Teaching and received the 2010 UNC Board of Governors Award. Beichner was named the 2010 National Undergraduate Science Teacher of the Year by the Society of College Science Teachers and the National Science Teachers Association. In 2011 he was awarded the McGraw Prize. He is a Fellow of AAPT, AAAS, and APS.

Award for Improving Undergraduate Physics Education Awardees

The American Physical Society's (APS) Committee on Education (COE) seeks to recognize physics departments and /or undergraduate-serving programs in physics (hereafter "programs") that support best practices in education at the undergraduate level. 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. In contrast to the Excellence in Physics Education Award, this award recognizes multiple institutions, and seeks to focus specifically on undergraduate programs.

In 2016, there were two awardees:

California State University, Long Beach

The Department of Physics and Astronomy at California State University Long Beach has been engaged in a decade-long campaign to strengthen its programs. Total production of undergraduate physics degrees has increased from 3 in 2007 to 25 in 2014 and an estimated 35 in the 2015 academic year. 30% of degrees are awarded to under-represented minorities (URMs), and they have no achievement gaps in graduation rates between URM and majority students, nor between men and women. Implementing many of the recommendations of the SPIN-UP report, such as innovative curricula and SCALE-UP classrooms, has improved their undergraduate curriculum with a measurable increase in the graduation rates of students taking introductory physics. In addition, adopting the Colorado Learning Assistant model has allowed the department to use their upper-division students to improve their lower-division courses while also providing valuable training for their majors. Students who complete the LA training course have significantly elevated graduation rates. In summary, the Department of Physics and Astronomy at CSULB has made significant, research-based and quantitatively assessed improvements throughout their program and achieved a transformative increase in the number of physics degrees awarded at the University, particularly to URM students, along with improved educa-

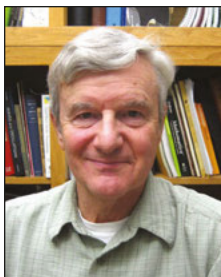
tion of not only their majors but all STEM students.

Western Washington University

Western Washington University (WWU) is a regional comprehensive university with about 15,000 students located in Bellingham, WA. The Department of Physics & Astronomy at WWU is dedicated to strong undergraduate education with emphasis on student-centered teaching practices and an exceptional research experience. The 14 faculty members serve over 5000 students annually, including about 120 physics majors, a significantly increased the number of majors from Spring 2002. The success in growing the major is attributed to the establishment of strong community within the department, that welcomes students and engages them in close collaboration with faculty not only in coursework, but also in meaningful research, teaching, and outreach experiences. Each year, the department awards 20 or more B.S. degrees in Physics, ranking nationally in the top 1% among physics departments exclusively offering baccalaureate degrees. Faculty professional development emphasizing research-based teaching has led to demonstrable increases in student learning, measured, for instance, in above average gains on standardized tests in core disciplines of physics. WWU Physics majors work closely with faculty on original research in the fields of Astronomy, Condensed Matter Physics, and Physics Education, often supported by external grants and leading to peer-reviewed publications with undergraduate students as co-authors. As some of the statistics show WWU Physics majors graduates are well prepared for graduate education or entrance into STEM professions.

Do you think that your department has a significant impact on undergraduate physics students? If so, consider nominating your department for the COE Award for Improving Undergraduate Physics Education. Applications are due July 15th. More information is available here: <http://www.aps.org/programs/education/undergrad/faculty/award.cfm>

2016 Jonathan F. Reichert and Barbara Wolff-Reichert Award for Excellence in Advanced Laboratory Instruction



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 at US institutions. 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.

This year, the award honors Van D. Bistrow at the University of Chicago.

The citation reads,

“For persistent dedication to the improvement of advanced undergraduate laboratories at the University of Chicago, the consistent support of student success, and for promoting the national discourse on advanced laboratories.”

Background:

Van Bistrow received his B.A. with an emphasis on Philosophy of Science in 1966 from the University of Wisconsin, Madison. Considering a teaching career, he received his Master of Arts in Teaching Physics in 1973 and his M.S. degree in Physics in 1974, both from the University of Chicago. While a graduate student at UChi-

cago, Van was a teaching assistant in its Graduate Lab Course. In 1974 he began working full-time in the instructional labs at UChicago, and in 1997 he was promoted to Director of Instructional Labs. In this capacity he teaches, develops lab exercises, writes lab manuals, trains TAs and is a member of the Physics Department’s Teaching Activities Committee. His first love is working with students, teaching one-on-one. Van’s keen interest in sharing what he has learned has led him to encourage others to do so. He has been an active member of the American Association of Physics Teachers. In that setting he has led workshops on Advanced and Intermediate Instructional Labs, served on and was spokesman for the AAPT Advanced Labs Task Force, charged with identifying ways AAPT could help Advanced Lab developers. He helped with the design of AAPT’s Advanced Labs website, and was co-organizer and presenter at the Conference on Instructional Labs “Beyond the First Year” at the University of Michigan, Ann Arbor. He is a member of the Advanced Labs Physics Association, ALPha, co-presenting an ALPha Immersion on Single-Photon Interference at the University of Chicago, training other Advanced Lab developers to provide this experiment for their students. He is also a member of the Physics Instructional Resource Association (PIRA), an international group of professionals, dedicated to physics education. Van is an accomplished amateur cellist, having played in numerous chamber ensembles and the UChicago Symphony Orchestra for 30 years.

Directors's Corner

Theodore Hodapp

In 2011, the leadership of the Conferences for Undergraduate Women in Physics approached the APS to ask if we could help them achieve their goals for reaching women in physics through their successful model of distributed conferences. I am happy to say that attendance has more than tripled from 400 in 2011 to about 1300 in 2016. The conferences (aps.org/cuwip) remain locally organized and staffed giving many women (especially undergraduates) a chance to feel direct ownership in improving the participation of women in physics. The continued growth of these conferences, with the support of the NSF and Department of Energy has also allowed the APS to get a better handle on how such events impact choices made by women as they pursue physics. Plans are already in motion for 9 sites in 2017 as well as programs copied from this model in Canada and the UK.

Over the past 2 years the APS and American Association of Physics Teachers have been working with a prestigious group of physicists in industry, academia and national labs to provide a review of how the current undergraduate physics curriculum prepares

students for their careers (aps.org/programs/education/undergrad/itupp.cfm). Not surprisingly, current programs predominantly focus on preparation for academic careers (it worked for us, didn’t it?), while the majority of physics undergraduates will likely take a job with the word “Engineer” in the title. The report is due out later this summer, and it will serve as the design document for the next phase of thinking about curricular design and review when APS begins to develop a “best-practices” document for undergraduate programs – an effort spearheaded by the Committee on Education and approved recently by the APS Council. Stay tuned for details, but we expect a 2-year development cycle for this document and the process to update it moving forward.

Also coming shortly is a report from the Ad Hoc Committee on LGBT Issues (C-LGBT). C-LGBT was charged by Kate Kirby (APS CEO) in 2014 to provide recommendations to help the APS create a more inclusive environment for lesbian, gay, bisexual, and transgender (LGBT) physicists. The report will be released on March 1 (the full text will be available on the APS website) and C-

LGBT will hold a session at the March Meeting to discuss the findings and recommendations. The committee undertook one of the most comprehensive studies to date of the climate experienced by LGBT physicists, and the report details specific challenges often

faced by LGBT individuals who study and work in physics. Our hope is that recommendations put forward in this report will help to build a more inclusive physics community where everyone can find a welcoming place to study and practice physics.

New Editor for the American Journal of Physics Sought

David Jackson, AJP Editor

The American Association of Physics Teachers (AAPT) is seeking applications and nominations for a new Editor of the *American Journal of Physics* (AJP). Below is an editorial that first appeared in the November 2015 issue of AJP (*Am. J. Phys.* 83, 909-910). More detailed information about the position of AJP Editor is available at http://ajp.dickinson.edu/Other/New_Editor.html.

Should you be editor of AJP?

It is hard to believe that more than four years have passed since I became editor of this journal. When I was first considering whether or not I should apply for the editorship, I thought long and hard about a number of questions. Ultimately, as I wrote in my first editorial [1], the question I felt was most important was “Why be editor?” And the answer to this question—because AJP is my favorite journal—turned out to be a very good reason for becoming editor of this wonderful journal. If AJP happens to be your favorite journal, then I strongly encourage you to think seriously about whether you should be editor.

Soon after stepping into my new role, I received a number of congratulatory messages. A few of these came from past AJP editors, and these messages gave me a real sense of connection to the journal as well as to those who did the job before me. One of these previous editors gave me a piece of advice that surprised me. He suggested that I do the job for 5–6 years and then think about moving on. At the time, I figured I would remain editor for closer to 10 years, as my most recent predecessors have—and there was a piece of me that thought I would stay on even longer. Indeed, there is a piece of me today that wants to remain editor, and I wonder if in the future I will regret my decision to step down.

Why am I stepping down? As has been stated by numerous previous editors, there is no other journal like AJP; it is truly unique among physics journals. Being editor of this journal has been extremely rewarding, and may very well end up being the most significant achievement of my career. Being editor has also been thoroughly enjoyable, particularly when a new issue arrives in the mail and I am reminded of all the articles I helped prepare for publication. But in addition to being rewarding and enjoyable, being editor of AJP is a big job and it takes a lot of focused energy to keep everything running smoothly. Overall, I think my skill set and personality type have been well suited for this job. That said, I have found it difficult to maintain a sustained focus on other professional activities while being editor, with the result that my to-do

list has been slowly but steadily growing longer. And though I long ago gave up the fantasy that I could ever accomplish everything on this list, there are certain things I do not want to put off too much longer. Thus, I am beginning to feel the urge to move on.

My second term as editor will come to an end on August 31, 2017. At that time I will have been editor for six years, and while this is not the 10+ year tenure I had originally imagined, it does seem like an appropriate time to step down. Although this date is still a long ways off, I felt it was best to announce my decision as early as possible so there is plenty of time to find a replacement and to allow some potential overlap with the new editor to help make the transition as smooth as possible. I can personally attest to the fact that there is a lot to learn, so such an overlap will likely prove useful. While the nominal start date will be September 1, 2017, the new editor may want to ease into the position by working as an associate editor, perhaps as early as the fall of 2016. The details of the transition are flexible and I am happy to work with the new editor to come up with a plan that is agreeable to everyone involved.

So what exactly does it take to be editor of AJP? It is a job that requires a lot of different skills. Anyone with even a passing interest in this position should read the editorials written by some previous editors to see what they had to say on this topic [2-5]. The workload is high, so you need to be efficient and well organized. AJP receives nearly 1,000 new submissions per year, and you need to decide which ones should be sent out for review and which ones should not. Then you need to manage the review process, which often involves several revisions. And finally, you need to decide which of these manuscripts to accept and then help prepare them for publication.

Ultimately, AJP publishes about 20% of the manuscripts received. Unfortunately, this means you will end up having to reject a lot of papers. Many of these rejections are for manuscripts that are clearly outside the scope of the journal. Those decisions are easy. Also easy are decisions on the well-written manuscripts that you know right away will interest many readers. The difficult decisions are those that fall between these extremes: those that are correct but perhaps not very novel or only of limited interest. Like it or not, the heavy workload limits your ability to spend too much time on these decisions, so it can be a challenge to feel 100% confident with every decision. On the positive side, the editor has a lot of power to guide the focus and direction of the journal. But of

course, with such power comes great responsibility. In the end, the final decision of what gets published rests solely on the shoulders of the editor.

A large and growing part of the editor's job is spent helping authors improve their manuscripts. There are a host of issues that can lead to a manuscript being more confusing than necessary: awkward wording, incorrect grammar or punctuation, poor organization, and unclear logic, to name a few. One frequent problem is when authors assume that their audience is as well-versed in the subject as they are. As I often tell my students, one of the most important aspects of writing a paper is to know who your audience is. While AJP is a scholarly journal, it is not a research journal. The readership of AJP is extremely broad, and we are constantly asking authors to supply the complete explanations, technical details, and motivation that is necessary for this broad readership.

While the process of editing manuscripts can be somewhat time consuming, it is also one of the more enjoyable aspects of the job. I have learned a lot of fascinating physics by reading through and editing manuscripts in detail and bringing questions to the attention of the authors. In fact, it is not entirely uncommon to find a significant problem that has eluded the reviewers, and which authors are grateful to have the opportunity to fix. Over the years I have found that most authors are a genuine pleasure to work with and they are truly appreciative of our efforts along these lines.

Besides being efficient and well organized, what other skills are necessary for the AJP editor? You certainly need to be a competent physicist, but you do not need to be an expert in all areas of physics; after all, there is a lot of expertise in the form of reviewers and advisory board members to draw upon. It is more important to have a broad general knowledge of a lot of different areas, and to have a genuine curiosity and interest in learning new physics. It is also important to be acutely aware of your limitations and to be quick to seek advice when necessary. You need to have a lot of college teaching experience, particularly at the advanced undergraduate (or graduate) level, and preferably in many different areas. You should have a reasonable publication record, and enjoy the process

of writing and editing. You should have an eye for detail and a compulsion to get details correct. Perhaps most importantly, you should be quite familiar with AJP and have a clear vision for the journal's role as well as its future. Such a vision will be your guide as you revise the editorial policy and it will help provide some of the emotional strength that is helpful when making difficult decisions.

Robert H. Romer, AJP editor from 1988–2001, said [6] that editing AJP is “one of the most important responsibilities one could aspire to in physics.” I wholeheartedly agree. AJP is the most widely read physics journal in the world, and in my opinion this makes it the most important physics journal in the world. Being AJP editor is certainly demanding, but it is also immensely satisfying. I have no regrets whatsoever about my decision to become editor. And if AJP is your favorite journal, you owe it to yourself to consider becoming editor of this magnificent journal. It is a great feeling to be the editor of AJP; I invite you to try it on for size.

More details about the editor search will be available in the coming months. Those interested should check the AAPT website, <www.aapt.org>, and look for announcements in future issues of AJP.

David P. Jackson, Editor

- [1] D. P. Jackson, “Editorial: Why be editor?,” *Am. J. Phys.* 79(10), 989–990 (2011).
- [2] J. Tobochnik, “Editorial: Search for a new editor,” *Am. J. Phys.* 78(11), 1079–1080 (2010).
- [3] R. H. Romer, “Editorial: Why not be editor?” *Am. J. Phys.* 68(3), 209 (2000).
- [4] J. S. Rigden, “Editorial: The American Journal of Physics and its editor,” *Am. J. Phys.* 55(7), 587 (1987).
- [5] E. F. Taylor, “Editorial: Why not be editor?” *Am. J. Phys.* 45(4), 323 (1977).
- [6] J. S. Rigden, “Announcement: Robert H. Romer, New Editor of American Journal of Physics,” *Am. J. Phys.* 56(5), 394 (1988).

The Unique Perspective of a Minority Student in a Physics Class Versus Chief Justice Roberts

Chandralekha Singh, University of Pittsburgh

On December 9, 2015, Chief Justice Roberts asked the question “What unique perspective does a minority student bring to a physics class?” during the discussion of a case on affirmative action at the university level. It appears that he chose a physics class because he felt that this discipline definitely does not need diverse perspectives. As a female physicist who has been teaching at the University of Pittsburgh for two decades, I feel that the Chief Justice’s question suggests a lack of familiarity with urgent issues in education that must be addressed to maintain US competitiveness.

The question first implies that it is the perspective of the minority student that is the critical feature rather than the presence of the minority student in the physics class. We need to attract minority students to disciplines that need their talents. Currently, 20% of undergraduate and Ph.D. students in physics programs across the US are female, which is significantly lower than the percentage in many European and Asian countries. What is perhaps more alarming is that only about 9% of physics undergraduate and 6% of Ph.D. degrees are awarded to students from underrepresented races and ethnicities. In addition, the minority population is projected to become the majority in the U.S. in a few decades. The students from the minority groups are frequently from economically disadvantaged families, who are often denied the opportunities to get ahead that children from families without economic concerns typically receive. Moreover, there are other barriers due to societal stereotypes and implicit bias that impact the advancement of various underrepresented groups in physics including women and those from underrepresented races and ethnicities. There is an urgent need to engage and increase the participation of these traditionally underrepresented students, whose talents in physics have largely been untapped. These students will be attracted to the beauty of physics if they are supported and encouraged early and often, and have role models.

In response to the Chief Justice’s question, the APS President Sam Aronson released a statement on diversity which notes, “One physics student from a minority community disparaged and feared at the time – the Jews of 19th century Germany – was Albert Einstein, whose unique perspective transformed the world.” One of my colleagues, who was a Ph.D. student of Manhattan Project leader J. Robert Oppenheimer, told me that he had wanted to major in math but the chairman of the math department at the time blatantly told him and others that Jewish students majoring in math would not find decent math related jobs. Therefore, he majored in physics! Although one may feel relieved now that we do not have this level of explicit discrimination against underrepresented groups, it is important to understand that stereotypes and implicit biases persist and can negatively impact the advancement of underrepresented groups.

My two children attended a public high school in which half of the students were African American, Hispanic, or multi-racial, and the other half were white. This school appeared on paper to be “well-integrated” in terms of providing equal education to students with ethnically and racially diverse backgrounds. The reality was different. While my children and many white students took advanced classes in the gifted or honors track, a large number of minority students were in the lowest tier called “main stream.” A major reason for the difference is that some children were privileged and had the resources to succeed. Talented minority students with less-than-optimal resources and less support from various societal stakeholders (including school counsellors) are unlikely to perform as well as privileged children in seemingly “integrated” schools. They are less likely to get into top colleges and live up to their potential unless we give them adequate opportunities and support.

Now let’s go back to the question of the “unique” perspectives of students in a physics class. I wonder if the Chief Justice is assuming that all physics instructors must be a “sage on a stage,” and that students have nothing to contribute to the classroom dynamic. Research in physics education, including my own, shows that teaching by telling does not work for a majority of students; rather the physics instructor must actively engage students in the learning process in order for learning to be meaningful. As the director of a center that focuses on supporting teaching innovation in the nine natural sciences departments at the University of Pittsburgh, I support faculty members who are excited about developing a classroom culture in which students are engaged in discussions with the instructor and their peers.

The Chief Justice may also be assuming that physics is just a collection of facts and equations and discussions of societal and real world issues do not have relevance in physics classes, so there would not be any need for a diversity of perspectives. This assumption is not correct. More than ever, physicists are focusing on the implications of their research to society and these thought processes are impacted by the perspectives of scientists with diverse backgrounds. For example, physicists from third world countries are more likely to be inspired to develop improved stoves, solar cells, water purification systems, or solar-powered lamps.

Moreover, physics as a discipline prepares students for diverse careers and the majority of physics undergraduate majors who do not pursue a higher degree in physics typically find employment in diverse fields such as government, industry, and K-12 education, or they pursue higher degrees in engineering, law, business and medicine. In fact, in the last few decades, a majority of physics Ph.Ds. (approximately 70%) have found employment outside academia. The enriching perspectives that diverse groups of students bring to physics classes shape the thought processes of all students

who go into diverse careers and impact innovation and progress in every walk of life.

We should all focus our effort on providing greater opportunities to students from underrepresented groups. Without figuring out ways to tap the potential of this large number of talented students, we risk losing our competitive edge.

Chandralekha Singh is a professor and founding director of the Discipline-Based Science Education Research Center at the University of Pittsburgh. She served in the chair line of APS Forum on Education from 2009 to 2013. She was the chair of the 2013 conference on graduate education in physics, which especially focused on embracing diversity to sustain thriving physics programs for the 21st century. She remains active in the field of Physics Education Research.

The 2015 Conference on Laboratory Instruction Beyond the First Year of College

Elizabeth George, Wittenberg University

The second Conference on Laboratory Instruction Beyond the First Year of College (“BFY II”) was held on the University of Maryland campus July 22-24, 2015, before the summer 2015 meeting of the AAPT. More than 150 physics laboratory instructors and a dozen commercial laboratory equipment vendors participated in the BFY II conference, which was organized by the Advanced Laboratory Physics Association (ALPhA) [1]. The theme for the conference was “Constructing Great Instructional Lab Experiences.” The conference highlighted a variety of creative and exciting efforts in recent years to rethink and revise the content and structure of the Beyond-First-Year (BFY) laboratory curriculum. Small-group workshops provided participants with hands-on experience with new experiments, equipment, and techniques. Invited talks, panel discussions, breakout sessions, and poster sessions allowed participants to share their new and improved experiments as well as curricular and pedagogical initiatives.

The goal of the BFY II conference was to give participants the opportunity to:

- Learn about, and get hands-on experience with, contemporary or improved *experiments and techniques*, including commercially available equipment appropriate for BFY labs;
- Gain a broader view of the wide variety of *curricula* and *teaching strategies* for the laboratory, and methods for assessing student understanding including assessment of writing;
- Discuss techniques for programmatic *preparation for research and careers*, and for integration of undergraduate research with the instructional laboratory curriculum; and
- **Build the community** of advanced laboratory instructors and support staff.

The conference offered multiple opportunities for participants to engage with each other in each of these areas.

Contemporary or improved experiments and techniques: The heart of the BFY conference is a wide selection of small-group, hands-on, forty-minute workshops. Fifty-two different workshops were available; each participant was scheduled for a dozen of these workshops. Twenty-two of these workshops were offered by par-

ticipating vendors, who showcased experiments using their commercially available equipment and software. Thirty workshops were offered by lab developers and instructors from academic institutions. Workshops represented a broad cross section of physics, including interdisciplinary and applied areas, and ranged from low-cost experiments (using an LED as a single photon detector; quantized conductance in wires) to experiments using research-quality instrumentation (atomic force microscopes; femtosecond lasers). There were also workshops on modern techniques in electronics and computer control (FPGAs, Arduinos, etc.) and on lab techniques such as making low-noise electrical measurements and preparing DNA samples for AFM studies.

New experiments and equipment were also described in two contributed poster sessions that generated lively discussion. In addition, breakout discussion sections were scheduled on a variety of topics, many of which dealt with teaching laboratories in specific areas including electronics, quantum optics, biophysics, and materials science. Finally, a group of master demonstrators from PIRA (The Physics Instructional Resource Association) treated us to a demonstration show illustrating principles relevant to advanced courses.

Curriculum, pedagogy, and assessment: The 2015 BFY conference closely followed the release of the 2014 AAPT Recommendations for the Undergraduate Physics Laboratory [2]. These recommendations stress the vital role of laboratory instruction in developing students’ physics knowledge and experimental skills as well as many transferable skills such as communication, design, and innovation. The conference began with a presentation by two members of the 2014 Undergraduate Laboratory Curriculum Recommendations task force, Joe Kozminski and Ben Zwickl, who talked about the utility of the recommendations for guiding departments in evaluating and updating their lab curricula, and for informing lab assessment. This was followed by a panel of instructors from different types of institutions discussing their institutions’ efforts to implement the recommendations.

Another invited session focused on specific changes that two in-

stitutions are implementing to improve their BFY labs. Anne Cox spoke about redesigning the laboratory curriculum at Eckerd College to include new lab options for upper-level courses such as Mechanics and E&M, and a first-year service-learning lab skills course in which students work in teams to engineer a STEM exhibit. Suzanne Amador Kane talked about an initiative at Haverford College to develop “flipped” prelab video presentations and quizzes to help students better prepare for lab.

In a session on teaching written and visual communication in lab courses, Cary Moskovitz, Director of the Writing in the Disciplines program at Duke University, spoke about the need for instructors to consider the rhetorical context of student writing, arguing that typical lab report assignments often help to reinforce student misunderstandings of scientific communication. Kelly Martin from the School of Communication at the Rochester Institute of Technology gave an overview of visual communication strategies and principles that can be used by instructors to help students create better scientific presentations.

The contributed poster sessions also featured new pedagogical approaches such as structuring peer review of writing, methods of teaching troubleshooting, and flipping (and scrambling) the electronics course. Several of the breakout sessions also dealt with pedagogical issues, including teaching uncertainty and statistical analysis and developing student experimental skills.

Preparation for research and careers: In a plenary session on Innovation, Mentoring, and Career Paths, Duncan Carlsmith spoke about Garage Physics at the University of Wisconsin, an open lab/maker space that provides a model for recruiting and engaging physics majors with other students in innovation and entrepreneurship. Crystal Bailey of the APS spoke on the importance of building opportunities for Physics Innovation and Entrepreneurship education into the curriculum, and argued that the laboratory is a natural place to include such opportunities. Chandra Turpen of the University of Maryland talked about lab instruction as a form of mentoring and the importance of structuring interactions in the laboratory to help students collaborate successfully.

Building the community: An important feature of the conference is that lunches and dinners are provided to participants onsite to allow uninterrupted opportunities for discussion and networking. The final plenary session provided time to share information about other programs and initiatives related to advanced laboratory instruction (check out the ALPhA website, <http://www.advlab.org/>, for more information on these other programs and initiatives).

Outcomes: For the first time, a peer-reviewed proceedings was compiled to serve as the written record of the scholarly work presented at the BFY conference; 27 accepted manuscripts on a variety of topics, ranging from specific experiments to assessment strategies, are available at <http://advlabs.aapt.org/BFY/Proceedings/2015/index.cfm>. Additional information from this conference as well as the 2009 and 2012 conferences on advanced laboratory instruction (including workshop descriptions, contributed posters, abstracts, and breakout session notes) may be found in the AAPT Advanced Labs section of the ComPADRE Digital Library, <http://advlabs.aapt.org/>.

Responses to a post-conference survey showed that participants find the BFY conference to be unique with its multiple emphases on “community, pedagogy, technical ideas, and thinking deeply about the goals of labs and how we assess.” Almost 80% of participants said that they were nearly certain to incorporate information learned at the conference into their own lab courses. Planning for the next conference in the BFY series (location and date to be determined) will begin this summer.

We are grateful for the support of the National Science Foundation (Grant No. DUE-1122993), the American Association of Physics Teachers, and the APS Forum on Education, as well as to the Physics Frontier Center at the Joint Quantum Institute and the University of Maryland Physics Department, who served as hosts. Many commercial equipment vendors also lent their support to the conference, including Active Spectrum, Cold Quanta, Quantum Design, PASCO Scientific, Spectrum Techniques, TeachSpin, MathWorks, Klinger Educational Products, Keithley Instruments, Star Cryoelectronics, Keysight Technologies, and Edmund Optics.

- [1] ALPhA is an association of over 250 individual members dedicated to advanced experimental physics instruction: <http://www.advlab.org/>
- [2] AAPT Recommendations for the Undergraduate Physics Laboratory, https://www.aapt.org/Resources/upload/LabGuidelinesDocument_EBendorsed_nov10.pdf

Elizabeth George is a Professor of Physics and Chair of the Physics Department at Wittenberg University. Her primary research focus is in nuclear beta decay and the weak interaction. She was the chair of the 2015 Conference on Laboratory Instruction Beyond the First Year of College.

An Overview of the AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum

Joseph F. Kozminski, Lewis University

At the 2013 AAPT Summer Meeting, The American Association of Physics Teachers (AAPT) Committee on Laboratories established the Laboratory Goals Subcommittee to review the state of the laboratory curriculum and physics education research on student learning and skill development in the physics laboratory. The subcommittee's charge was to make evidence-based recommendations for the physics laboratory curriculum at the introductory and advanced (i.e. beyond the first year) levels. The subcommittee was comprised of members and friends of the AAPT Committee on Laboratories from a diverse range of institutions: public and private; small, mid-sized, and large institutions; and two-year colleges, primarily undergraduate colleges, and highly research active universities. After more than a year of work, including numerous revisions and public vetting at several forums at national AAPT meetings, this subcommittee produced the *AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum* [1], which was officially endorsed by the AAPT in November 2014.

These recommendations define a minimum set of skills and competencies that students should develop and basic types of experiences students should have at the introductory and advanced levels. The recommendations are general enough that they can be implemented at any institution and within the framework of various physics curricula. The recommendations do not define a particular laboratory curriculum, specific labs that must be run, or specific equipment and instrumentation that a physics program must have. Specific implementation decisions are made locally by each department. Institutions may implement them in stand-alone laboratories, theoretical or computational courses with an integrated laboratory component, or a combination of these.

The recommendations provide scaffolding for skill development from the introductory through the advanced laboratory curriculum. They emphasize the importance of hands-on laboratory experiences and focus on scientific abilities and transferrable 21st century competencies that will prepare students for graduate school, innovation and entrepreneurship, and jobs in industry, technology, teaching, and many other employment sectors. This focus on scientific abilities aligns well with the Next Generation Science Standards [2] and new Advanced Placement Physics standards [3]. While the full scope of the *Recommendations* document is intended for students in the Physics major, many of the learning outcomes at the introductory level are intended to be implemented in both majors' and non-majors' laboratory courses.

The skills, competencies, and experiences laid out in the *Recommendations* are grouped into six focus areas: Constructing Knowledge, Modeling, Designing Experiments, Developing Technical and Practical Skills, Analyzing and Visualizing Data, and Communicating Physics. The ultimate goal of these recommendations

is to provide a framework through which students are able to develop the habits and practices of professional physicists, to think like physicists, and to independently construct knowledge based on personal observation and experimentation.

The subcommittee placed the ability to construct knowledge by “collect[ing], analyz[ing], and interpret[ing] real data from personal observations of the physical world to develop a physical worldview” [1] at the center of the framework. The remaining five focus areas expand on that broad goal:

- By *modeling*, students will be able to “develop abstract representations of real systems studied in the laboratory, understand their limitations and uncertainties, and make predictions using models.” [1]
- By *designing experiments*, students will “develop, engineer, and troubleshoot experiments to test models and hypothesis within specific constraints such as cost, time, safety, and available equipment.” [1]
- By *developing technical and practical laboratory skills*, students will “become proficient using common test equipment in a range of standard laboratory measurements while being cognizant of device limitations.” [1]
- By *analyzing and visualizing data*, students will be able to “analyze and display data using statistical methods and critically interpret the validity and limitations of these data and their uncertainties.” [1]
- By *communicating physics*, students will be able to “present results and ideas with reasoned arguments supported by experimental evidence and utilizing appropriate and authentic written and verbal forms.” [1]

The *Recommendations* are available through the AAPT website [1]. To further disseminate the document, the Committee on Laboratories has been sponsoring one session per national AAPT meeting highlighting one focus area per meeting. The *Recommendations* were also a major theme at the 2015 Conference on Laboratory Instruction beyond the First Year [4] and at the Physics Education Research Conference 2015 [5].

The *Recommendations* will be useful for Physics Departments and Physics faculty looking to review and revise their laboratory curricula and to educate their administrators on the importance of a robust, hands-on laboratory experience. It will also be useful for external program reviewers assessing at the laboratory component of the Physics curriculum. The document is also intended to inform the American Association of Physics Teachers (AAPT) Undergraduate Curriculum Task Force (UCTF) and the American Physical Society (APS) – AAPT Joint Task Force on Undergraduate Physics Programs (J-TUPP). Finally, these recommendations can provide a starting point for numerous potential physics educa-

tion research projects, including development of curricular materials and assessments and provide a common ground for collaboration between laboratory developers and instructors and the physics education research community.

While the implementation of these recommendations will vary based on the local resources available, successful implementation will provide a richer laboratory experience for physics majors and better prepare physics majors for their future endeavours.

The members Laboratory Goals Subcommittee were Joseph Kozminski, Lewis University (Chair); Nancy Beverley, Mercy College; Duane Deardorff, University of North Carolina Chapel Hill; Richard Dietz, University of Northern Colorado; Melissa Eblen-Zayas, Carleton College; Robert Hobbs, Bellevue College; Heather Lewandowski, University of Colorado Boulder; Steve Lindaas, Minnesota State University Moorhead; Ann Reagan, IEC Services; Randy Tagg, University of Colorado Denver; Jeremiah Williams, Wittenberg University; and Benjamin Zwickl, Rochester Institute of Technology.

[1] American Association of Physics Teachers, *AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum* (2014) < https://www.aapt.org/Resources/upload/LabGuidlinesDocument_EBendorsed_nov10.pdf >

[2] NGSS Lead States, *Next Generation Science Standards: For States, By States*, (National Academies Press, Washington D.C., 2012).

[3] CollegeBoard, “AP Physics 1: Algebra Based and AP Physics 2: Algebra Based Curriculum Framework 2014–2015” (2012), <<http://advancesinap.collegeboard.org/mathBandB-science/physics>>

[4] 2015 Conference on Laboratory Instruction Beyond the First Year, <<http://www.compadre.org/advlabs/conferences/2015/>>

[5] Physics Education Research Conference 2015, <<http://www.compadre.org/per/conferences/2015/>>

Joseph Kozminski is a Professor of Physics and Chair of the Physics Department at Lewis University in Romeoville, IL. He was the Chair of the Laboratory Goals Subcommittee, which produced the AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum, is an outgoing member of the AAPT Committee on Laboratories, and is a member of the Executive Committee of the AAPT Undergraduate Curriculum Task Force.

AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum: Implications for Assessment

Benjamin Zwickl, Rochester Institute of Technology

The *AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum* [1] are the first step in an iterative revitalization of the undergraduate lab curriculum. In order to make meaningful progress, the recommendations must be translated into classroom curricula and assessable outcomes. Currently, there are few available assessment tools and limited physics education research aligned with the scientific practices discussed throughout the recommendations. Compared to the extensive resources and research-base for areas such as problem-solving and conceptual understanding, laboratory assessment is still in the early stages. The National Research Council’s 2012 report on Discipline-Based Education Research [2] highlights labs and scientific practices as emerging areas with a significant need for research on characterizing, measuring, and studying the development of expertise across all STEM disciplines. Assessment and research on labs is unique for a few reasons. First, labs typically involve hands-on interaction with lab equipment so cognitive, perceptual, and motor skills are intertwined. Second, labs provide an intersection of theoretical and conceptual understanding with real-world experiences, which often do not satisfy the tidy idealizations of theoretical courses. Finally, laboratory courses prioritize scientific practices (e.g., experimental design or data analysis), rather than an understanding of key disciplinary content (e.g., Newton’s laws).

Developing the needed array of assessments requires the creativ-

ity of our entire community. These assessments need to be rigorous and classroom-relevant, a combination that is best achieved through combined efforts of instructors and education researchers. While talk about more assessments often evokes negative feelings among instructors (e.g., standardized testing or faculty course evaluations), assessments can guide positive long-term improvements in our curriculum. It is impossible to create a one-size-fits-all assessment for labs; rather, our community requires a wide range of tools developed for a range of purposes. What follows is a framework for the diversity of assessment options.

Focus-area: Which of the laboratory recommendations is the assessment aligned with?

Scale: Like any physical measurement, the spatial and temporal scale of a phenomenon and the interacting constituents guides the choice of measurement tool. Quarks are probed with different instruments than living cells. Within educational assessment, there are at least three relevant kinds of scale. (1) Scale of students: Is the assessment intended to assess progress and abilities of individual students, a team, an entire class, or a nationwide cohort of students? (2) Scale of activity: Are we assessing the impact of a single lab activity, a semester-long course, or a 4-year curriculum? (3) Time scale: Is this a one-shot assessment that verifies a benchmark is met, a pre/post measurement of growth during a course, or a lon-

itudinal measurement tracking students throughout several years?

Feedback: Does the assessment provide usable feedback for improving student performance (formative assessments) or for documenting satisfactory completion of an outcome (summative assessment)?

Who benefits? Do the results provide insight to students, instructors, departments, institutions, or education researchers? While it is possible to design an assessment that benefits multiple stakeholders, assessments are typically optimized for a particular audience.

Format: Written or oral? Paper-based or online? Does it involve a hands-on component? Are the questions multiple choice or open-ended?

The assessment “phase space” in this framework is quite large. Not every assessment can accomplish every purpose. Instructors, with their close interaction with students and access to the laboratory classroom, are well-suited to create and administer assessments focused on individual students, including assessments with a hands-on component. For example, technical and practical skills are commonly assessed through a lab practicum. The rigor of physics education research is needed to develop assessments that can be applied across a variety of classes in a consistent way. Ensuring the validity and reliability of widely disseminated assessments requires additional testing and refinement that is typically not needed when instructors assess individual students in their own classes. Additionally, PER researchers will find many fruitful areas of study, particularly around sophisticated practices, such as modeling. Research is needed to characterize student thinking, understand the development of expertise, and develop assessments that can measure students’ development over time.

Although there is a need to develop new assessments, there are examples that are ready to use now. The Concise Data Processing Assessment [3] (focused on data analysis and visualization) and the Colorado Learning Attitudes about Science Survey for Experimental Physics (E-CLASS) [4] (aligned with constructing knowledge) are easy-to-administer tools intended for pre/post use in lab classes. Some curricula, such as the Investigative Science Learning Environment [5] developed at Rutgers, have activities with matched rubrics for several of the scientific practices in the *AAPT Recommendations*. Lab notebooks also document students’ progress throughout an extended activity and can assess a range of scientific practices. Even traditional laboratory reports, sometimes exalted (as the cousin of a PRL) and sometimes maligned (as a fake genre of writing only used in school), can serve as summative

or formative of assessments of students’ ability to communicate technical details of their investigations and report their results.

The need for more and better assessments is a challenge worthy of our dedicated community of instructors and researchers in physics education. These efforts will flourish through collaboration between everyone involved in laboratory instruction and PER. The AAPT Committee on Laboratories is exploring ways to promote the sharing of ideas, curricula, and assessments through conferences, workshops, and online communities.

- [1] Subcommittee of the AAPT Committee on Laboratories - Joseph Kozminski (Chair). *AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum*. (2014). at <https://www.aapt.org/Resources/upload/LabGuidelinesDocument_EBendorsed_nov10.pdf>
- [2] National Research Council. *Discipline-Based Education Research: Understanding and Improving Learning in Undergraduate Science and Engineering*. Washington, DC: The National Academies Press, 2012. doi:10.17226/13362 <http://www.nap.edu/openbook.php?record_id=13362>
- [3] Day, J., & Bonn, D. (2011). Development of the Concise Data Processing Assessment. *Physical Review Special Topics - Physics Education Research*, 7(1), 010114. doi:10.1103/PhysRevSTPER.7.010114, <<https://www.physport.org/assessments/assessment.cfm?I=55&A=CDPA>>
- [4] Zwickl, B. M., Hirokawa, T., Finkelstein, N., & Lewandowski, H. J. (2014). Epistemology and expectations survey about experimental physics: Development and initial results. *Physical Review Special Topics - Physics Education Research*, 10(1), 010120. doi:10.1103/PhysRevSTPER.10.010120 <<http://tinyurl.com/ECLASS-physics>>
- [5] E. Etkina and A. Van Heuvelen, “Investigative Science Learning Environment - A Science Process Approach to Learning Physics,” in *Research-Based Reform of University Physics*, edited by E. F. Redish and P. J. Cooney (American Association of Physics Teachers, College Park, MD, 2007), Reviews in PER Vol. 1, <<http://www.per-central.org/document/Serve-File.cfm?ID=4988>> <<http://www.islephysics.net>>

Benjamin Zwickl is an Assistant Professor of Physics at the Rochester Institute of Technology. He completed his PhD in physics at Yale University, and spent three years at the University of Colorado Boulder as a postdoctoral scholar. His research focuses on how students develop experimental and research skills throughout the undergraduate curriculum, and how they leverage these skills in a variety of professions after graduation.

Exposing and Assessing the Hidden Agenda of Laboratory Instruction

Natasha Holmes, Stanford University, and MacKenzie Stetzer, University of Maine

The 2015 conference season served as an excellent vehicle for a rich discussion of the role of labs in physics education as well as the implications for instructors and physics education researchers. From a dedicated laboratory working group at the 2015 Foundations and Frontiers in Physics Education Research Conference to the Second Conference on Laboratory Instruction Beyond the First Year (BFY II) of College, and the lab-themed 2015 Physics Education Research Conference, a dedicated group of laboratory enthusiasts and education researchers collaboratively focused on learning and teaching in the laboratory. At the heart of all of these conferences was an introduction to and a discussion of the AAPT recommendations for the goals of the undergraduate physics lab curriculum [1], which are described in detail in another article in this newsletter. The document from AAPT focuses on the development of skills in six core areas: modeling, designing experiments, constructing knowledge, technical and practical skills, analyzing and visualizing data, and communicating physics.

While the goals of laboratory instruction have been highly debated for years, the development of conceptual understanding has persisted as a key focus of undergraduate lab courses, particularly at the introductory level. This view often comes from an assumption that students will learn concepts better by seeing the impact of those concepts in the real world. Recent work [2], however, has shown that this is not necessarily the case. One possible reason for this is the extensive set of hidden and implicit goals, concepts, and tasks that are involved in experimentation. In order to make sense of the physical concept in an experiment, one needs to design, set up, and carry out the experiment, take data, make sense of and interpret those data, and engage in any necessary troubleshooting and iterating. The AAPT goals help make this otherwise hidden and implicit curriculum explicit and exposed.

A particular benefit of these laboratory learning goals is that they are not entirely unique to physics. While the list will surely be beneficial for preparing future physicists, competence in these areas will easily transfer to other disciplines and to the extensive set of future career paths open to physics and non-physics majors alike.

Conversations at these conferences, therefore, have centered around whether institutions and instructors are adopting these goals, what difficulties students have in these areas, how to structure labs to achieve these learning goals, and how to develop assessments to ascertain the extent to which these goals are being met. These in-depth conversations between physics instructors, lab coordinators, and physics education researchers are essential, and it is critical that they continue.

While research on physics labs and associated skills has been relatively sparse in comparison to the extensive body of work on student conceptual understanding and problem solving, these

recent conferences also served to highlight some of the emerging research directions in the context of laboratory instruction. At the 2015 PERC, the plenary talks reflected the diversity of this work, including presentations on introductory undergraduate lab courses, undergraduate research experiences, and K-12 adoption of the Next Generation Science Standards. Taken together, the talks highlighted the increased focus on scientific practice goals at all levels.

At the same time, it is clear that more research is needed on, in the broadest sense, what students are (or are not) learning in lab courses, how to improve student learning within the context of these courses, and which structures and pedagogies best support which kinds of learning. While there has been extensive research on student difficulties related to measurement and uncertainty, there are many learning goals articulated in the AAPT guidelines for which student performance (including, for example, specific difficulties) has not yet been investigated (e.g., troubleshooting, understanding of common lab equipment such as oscilloscopes or multimeters, use of lab notebooks, experimental modeling of a measurement system, designing experiments, and identifying research questions). For each of these areas of interest, there are also questions of generalizability. Given the resource-intensive nature of labs, the facilities at every university typically differ. How generalizable, then, are findings from a given pedagogical approach in one context to another context with different experiments or equipment?

We believe that these conferences have set the stage for an increased focus on laboratory instruction within the physics education research landscape and we encourage instructors and researchers alike to join in this important conversation. We all need to think critically about what students are really learning in labs and how we are measuring that learning. One example from our own experience is troubleshooting. While students often engage in troubleshooting in electronics lab courses, we don't necessarily know whether they are learning and developing expert-like troubleshooting skills or simply becoming frustrated and relying on novice tactics (e.g., rebuilding the entire circuit or securing assistance from the instructor or TA). Answering these sorts of questions will require the development of validated assessments and other research-based measures of learning in labs. (For a broader discussion of laboratory assessment, see Zwickl, "AAPT Recommendations for Undergraduate Labs: Implications for assessment," in this newsletter.) Moreover, as instructors, we should look carefully at our existing course assessments to identify what they are actually measuring. Because students' behaviors are often guided by course assessment practices, aligning grading rubrics with these desirable learning outcomes is crucial. Often, we focus on whether or not students have labeled the axes on their graphs and properly propagated their uncertainties, rather than evaluating whether or not students have thought critically about their experi-

mental design, interpreted the data in their graphs, and understood what those uncertainties actually mean.

We encourage instructors and researchers who are passionate about laboratory instruction to share their experiences and their work with the physics teaching and research community. In particular, the AAPT Committee on Laboratories is hosting sessions on each of the broader laboratory goals outlined in the recommendations at each of the upcoming national meetings (summer and winter). We hope to see you there.

- [1] Subcommittee of the AAPT Committee on Laboratories - Joseph Kozminski (Chair). AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum. (2014). <https://www.aapt.org/Resources/upload/LabGuidelinesDocument_EBendorsed_nov10.pdf>
- [2] C. Wieman and N. G. Holmes, "Measuring the impact of an

instructional laboratory on the learning of introductory physics," *Am. J. Phys.*, 83(11), 972–978, 2015.

Natasha Holmes is currently a postdoctoral researcher at Stanford University. She completed her PhD in 2015 at the University of British Columbia, where her dissertation focused on using structured quantitative inquiry labs to develop critical thinking skills in introductory physics labs. She is a member of the Physics Education Research Leadership Organizing Council (PERLOC).

MacKenzie Stetzer is an Assistant Professor of Physics at the University of Maine. He is active in the field of Physics Education Research, and has a particular research focus on student learning of content and skills in upper-division laboratory courses on analog electronics. He was part of the organizing committee for the 2015 Physics Education Research Conference, which focused on the topic of laboratory instruction.



Teacher Preparation Section

Alma Robinson, Virginia Tech

"Our chief want in life is somebody who will make us do what we can." – Ralph Waldo Emerson

Having expert physics teachers support preservice and new physics teachers through mentoring is one of the 10 key components that PhysTEC has outlined in successful physics teacher preparation programs. For this edition of the Teacher Preparation Section, two institutions with robust induction and mentoring programs will share how their programs have supported students in both their physics teacher preparation, as well as during their first few years of teaching, the delicate time when teachers are most likely to leave the profession.

Jennifer Docktor discusses her various roles as the mentor for preservice and new physics teachers at the University of Wisconsin – La Crosse (UWL). Through her support as an academic advisor, outreach experience coordinator, pedagogy instructor, field supervisor, and workshop leader, UWL physics teacher candidates are able to seek guidance as they navigate the teacher education program and the induction phase of their teaching.

Elizabeth Rosendale, an alumni of the University of Wisconsin – La Crosse's Physics Education program echoes the importance of mentoring in her teacher education preparation and first years of teaching. Elizabeth currently teaches Physics and AP Physics at Holmen High School in Holmen, Wisconsin.

Brigham Young University (BYU) graduates more physics teachers than any other institution in the United States, and Duane Merrell plays a key role in BYU's success. Duane describes how BYU's mentoring program begins from the moment that a student expresses interest in teaching science, and continues indefinitely, as a two-way relationship where both the mentor and the mentee learn from each other.

Finally, PhysTEC will hold its annual conference on physics teacher education in Baltimore from March 11- March 13, preceding the APS March meeting. This conference will offer wonderful opportunities to attend workshops, presentations, and panel discussions on physics teacher education, as well as network with the leaders in field.

Mentoring Future Physics Teachers at the University of Wisconsin – La Crosse

Jennifer L. Docktor, University of Wisconsin – La Crosse

College is a time for making decisions. These decisions shape the course of a student's career path, such as what to pick for a major and whether or not to change that major along the way. Students rely on advice from a variety of mentors throughout this process including their parents, families, friends, and also their faculty instructors. College is also a time when students build relationships and acquire the skills and resources necessary to be successful when they transition into their chosen career. This is especially true for future teachers.

In addition to teaching physics courses, my role at the University of Wisconsin – La Crosse (UWL) includes working closely with future physics teachers. I have found that this mentoring role is multifaceted, including advising students on coursework, providing them with opportunities for early teaching experiences, instructing them on physics curricula and pedagogy, and offering them resources and feedback when I observe them teach in local schools. Mentoring also extends beyond graduation through e-mail contact and professional development workshops for in-service teachers. In the sections that follow, I describe each of these mentoring roles in more detail.



Jennifer Docktor gets "vacuum sealed" inside a trash bag during a demonstration on pressure

culture where teaching is viewed as a valuable career. My faculty colleagues help to identify students who show some interest in teaching and encourage them to meet with me. Once a student formally commits to being a physics education major, I am assigned as his/her academic advisor, and we have follow-up meetings a minimum of once a semester. Although these meetings are primarily focused on mapping out a sequence of courses for the upcoming semesters, they often lead to more general conversations about life events.

My second mentoring role is as an *outreach experience coordinator*. Although I don't formally hold this title, I am frequently contacted by local schools or institutions who are seeking volunteers for upcoming events, such as judges for science fairs, coaches for robotics tournaments, or counselors for summer science camps. I also occasionally receive requests from local teachers to coordinate a demonstration show or physics fair event for K-12 students. In addition, the Physics Department also has a partnership with the local children's museum to coordinate demonstrations during some of their STEM-focused events. These are all excellent opportunities for physics majors and physics education majors to acquire early experiences teaching youth, which can spark (or confirm) their interest in teaching.

My third mentoring role is as a *pedagogy instructor*. Although UWL doesn't have a physics-specific pedagogy course, our science methods course, *Teaching and Learning Science in the Secondary School*, is co-taught by faculty specializing in physics education, biology education, and chemistry education. In addition, we developed a new course on *Curriculum and Assessment in Math and Science* in which students complete projects and receive feedback



Area teachers attempt to make Jennifer Docktor "rise up" using air pressure during a professional development workshop

My first mentoring role is as an *academic adviser*. Most students who decide to pursue physics teaching at UWL do not declare a major in physics education when they enter as freshmen. To encourage them to think about this possibility, I give an annual talk at the freshmen physics majors' seminar about *Why you should teach high school physics!* This establishes me as a point-of-contact for questions related to the secondary teacher education program in physics, and then I meet individually with students who are interested in learning more. UWL also has a supportive departmental

from content specialists. For example, in one project future science teachers are paired with future math teachers to design and teach an interdisciplinary lesson based on national standards. I also actively recruit students who are interested in teaching to assist me with a course I teach on physical science for elementary and middle education majors, where we engage in pedagogical techniques for teaching science. Finally, I encourage future physics teachers to do an independent study or conduct physics education research with me for course credit, which allows them to explore research-based curricula and instructional strategies in more depth (such as research on teaching problem solving).

My fourth mentoring role is as a *field supervisor*. At UWL secondary education students complete two classroom field experiences prior to student teaching: one in a middle school and one in a high school. Faculty work with the School of Education's Office of Field Experience to carefully select school sites and mentor teachers for these experiences. As a supervisor, I visit science students during their classroom experiences and student teaching to observe them teach and to provide written and verbal feedback on their progress. I also help to facilitate a mentoring relationship between the student and their cooperating teacher.

Transitioning to Teaching through Mentorship

Elizabeth Rosendale, Holmen High School, Wisconsin

Permanent marker.

As I started working towards my degree in physics education, a professor offered me the opportunity to be a teaching assistant (TA) for his *Physics for Elementary Educators* class. My job was pretty basic: help groups with lab work, enter student score data, and take notes on the whiteboard while he explained an idea.

It was so simple. Yet there I stood, realizing that I'd just drawn an entire diagram in permanent marker. I picked up the nearest dry erase marker (WHY couldn't I have seen it minutes earlier!?) and frantically scribbled over my lines. I then took the eraser in my other hand and followed my marks along the board, spastically glancing to the professor to ensure that he hadn't yet noticed.

A hand went up on my side of the room.

"What are you doing?"

He's looking at me. Panic. Try to sound confident.

"Well, I accidentally wrote on the board with permanent marker, but the dry erase marker dissolves it." The class and professor looked interested. While I'd worried about being reprimanded, I discovered that instead, I was being supported.

Teaching is all about scaffolding. We need to give tasks to our students in doses that are equal parts challenging and manageable.

My fifth mentoring role is as a *workshop leader*. I continue to serve as a resource for graduates and practicing teachers by coordinating and leading professional development workshops, either through grant-based programs (such as a Mathematics and Science Partnerships grant) or at the request of local school districts. Recent examples include sessions on the Next Generation Science Standards for the La Crosse school district and a session on teaching science with technology. I have found these workshops help to further develop partnerships with K-12 schools and teachers.

As I've discussed here, mentoring future physics teachers can take a variety of different forms. Ultimately, I think effective mentoring boils down to the following: fostering a community environment where students are comfortable seeking your advice and making a commitment to invest your time in their preparation. I encourage all physicists to consider their role in physics teacher recruitment, preparation and mentoring, and the widespread impact this has on future generations of students.

Jennifer Docktor is an Assistant Professor in the Physics Department at the University of Wisconsin – La Crosse. She specializes in Physics Education Research in the areas of problem solving and teacher education.

Frustrate them, but only a little. Throughout my college career, I was fortunate enough to have amazing professors and mentors who were able to do the same for me, including trusting me to write notes on the whiteboard.

I attended the University of Wisconsin – La Crosse (UWL) to obtain a degree in physics education and minors in chemistry and mathematics. My college journey included rigorous coursework in each of my content areas, as well as in pedagogy. The most beneficial aspect of the program for me, however, was the strong field experience I received and the mentorship component that came with it.

In addition to being a TA in the aforementioned class, I was able to tutor and spend three semesters in four unique classrooms in local middle and high schools. I had varying levels of participation throughout these experiences, but each step of the way, there was a professional mentor to guide my practice and hold conferences with my cooperating teacher.

None of these experiences were easy. In fact, each one brought its own specific dose of terror, whether it be working with middle school students (not my strong suit), writing my first unit plans and tests, mixing chemicals for a class lab, or discovering that my teaching philosophy contradicted that of my cooperating teacher. But through these experiences, I struggled, I learned, and I fell in love with the job.



asked to teach the Advanced Placement Physics course, and the following year I helped start our school's robotics team.

When I began teaching, the district appointed me one trained

The questions don't stop at graduation. I had the good fortune of being hired in one of the districts where I had student taught. During the first year, my goal was to survive while learning as much from my coworkers as possible. By the summer, however, I was starting to feel more confident in my abilities. Then, I was

“mentor” within the school, but I adopted many unofficial mentors along the way, including my physics teacher colleague, whomever happened to be in teachers' lounge after a lesson flopped, my mentors from UWL, and an online community of AP Physics teachers. While I'm only a few years in, each year has been even more rewarding, but also significantly more demanding, than the last. Fortunately, much like my experiences in college, the challenges are scaffolded, and each step of the way there was an encouraging mentor to listen, support, and guide me through it.

Elizabeth Rosendale earned her BS in Physics Education with Chemistry and Mathematics minors at the University of Wisconsin-La Crosse. She is a third-year teacher who currently teaches Physics and AP Physics at Holmen High School in Holmen, Wisconsin and helped start the school's robotics team. She enjoys the outdoors, running, and the incessant wit of her students.

Brigham Young University's Physics Teaching: Mentoring Physics Teachers

Duane Merrell, Brigham Young University

A student wanders into the physics department and asks the first adult he/she finds, “If I am interested in teaching high school physics, where do I start?”

At Brigham Young University it doesn't matter if this conversation happens in the Physics Department, the College of Math and Physical Science, or the College of Education. In each case, the student is sent to see Duane Merrell in the Physics Department. That is me.

This is when the mentoring begins. We first look at the requirements from the Physics Department's curriculum maps. We then move to the requirements of the State of Utah for teacher licensure, and we finally progress to questions about the classes that the student has already taken and the remaining courses/requirements that are still needed to finish.

Next, the students must be fingerprinted since they will be in the local schools for their first exploration of teaching in the physical science classroom, during the methods for teaching physical science class, and throughout their student teaching or internship. In all these cases, I work closely with them, both in the college classroom and in the K-12 schools. Because I place all of our students in their student teaching assignments, I have the freedom to choose the most appropriate schools and mentors for their placements. Since many of our former students have been in the classroom long enough to be able to take student teachers, I can now pair our alumni up with our preservice teachers. Our former students have become the mentors.

During the student teaching and internship phase of our program, my partner and I work together to visit the students and give them feedback every week. So, during the 15 week semester, we try to

make 30 visits. We use the Reformed Teaching Observation Protocol (RTOP) evaluation, as well as other forms of feedback, to help our students continually reflect on their practice.

Throughout all of this, we work together when problems come up: a bad grade that needs to be redone, sickness, and all of the other real life experiences that students live through.

It doesn't end after graduation, however. We stay in touch, we talk on the phone, and we genuinely care about the differences that our graduates are making in their physics classrooms. Even though our graduates are teaching all over the country: California, Washington, Wyoming, Colorado, Texas, Virginia, New York, Boston, etc., we try to stay in touch with them during their induction phase of teaching.

Mentoring is a two-way, never-ending process. In addition to the feedback I give to the students, they will also share things with me that they've tried and think I will incorporate into the training of the next cohort of teachers. They have a good feel for what I like, and as we work through this process, we are able to learn lessons together. They become better young teachers, and I become a better old mentor.

Duane Merrell is an Associate Teaching Professor in the Department of Physics and Astronomy at Brigham Young University (BYU), responsible for physical science teaching students at BYU who are earning Earth Space Science, Chemistry, Physics, and Physical Science degrees. BYU moved the preparation of these secondary education physical science teachers from the College of Education to the College of Math and Physical Science in 2004, resulting in a robust program that has graduated more than 175 students in the past 12 years, with 139 of those as certified physics teachers.

Browsing the Journals

Carl Mungan, *United States Naval Academy*, mungan@usna.edu

- The December 2015 issue of *The Physics Teacher* (<http://scitation.aip.org/content/aapt/journal/tpt>) has an interesting article on page 518 explaining that giraffes drink not by repeatedly filling their mouths with water and raising their heads, nor by siphoning water up from their mouths to their stomachs like drinking straws, but rather by pumping water into their esophagus through two valves. On page 550 of the same issue there is a useful analysis of the key role played by the motional emf generated in the familiar demonstration of a current-carrying wire jumping out of a magnetic field.
- An article on page 787 of the September 2015 issue of the *American Journal of Physics* (<http://scitation.aip.org/content/aapt/journal/ajp>) provides an introductory-level derivation and discussion of the Boltzmann function from a theoretical, computational, and experimental point of view. I plan to try some of their arguments out this Spring in my introductory majors course. I also appreciated the analysis on page 21 of the January 2016 issue of the “world’s simplest electric train” YouTube video at <https://www.youtube.com/watch?v=J9b0J29OzAU>.
- Article 065044 in the November 2015 issue of the *European Journal of Physics* points out a flaw in Galileo’s thought experiment proving that objects in vacuum cannot fall with differing speeds. If they did, he asked, what would happen if two stones of differing weights were tied together: would the combination fall faster or slower than the heavier stone alone? The flaw is that Galileo’s argument neglects the tension in the string tying the stones together. Article 065047 in the same issue examines rolling friction and mechanical energy dissipation for a ball rolling down an inclined plane. The journal can be accessed at <http://iopscience.iop.org/journals>.
- Page 1111 of the December 2015 issue of *Resonance* has a nice review of the effects of radiative transfer in nature such as when viewing the sun, sky, or clouds. The issue can be freely accessed at <http://www.ias.ac.in/listing/articles/reso/020/12>. (Note the minor figure erratum for this article at (Note the minor figure erratum for this article at <http://www.ias.ac.in/article/fulltext/reso/021/01/0109-0109>.)
- Page 1604 of the October 2015 issue of the *Journal of Chemical Education* at <http://pubs.acs.org/toc/jceda8/92/10> discusses the coming redefinition of the kilogram in the SI system of base units in terms of the Planck constant.
- Article 020137 in *Physical Review Special Topics—Physics Education Research* at <https://journals.aps.org/prstper/pdf/10.1103/PhysRevSTPER.11.020137> considers whether or not it is helpful for students to decompose forces into component vectors that are drawn directly on a free-body diagram. Such diagrams end up with many arrows on them, leading to opportunities for errors and confusion about the fundamental meaning of Newton’s laws.



Web Watch

Carl Mungan, United States Naval Academy, <mungan@usna.edu>

- A list of the top science stories of 2015 as chosen by CBC Quirks & Quarks is at <http://www.cbc.ca/news/technology/the-top-science-stories-of-2015-bob-mcdonald-1.3377063>.
- Animations of engines including Stirling and jet propulsion are online at <http://www.animatedengines.com/>.
- The concept of classroom whiteboard speed dating is creatively described by Kelly O'Shea on her blog at <https://kellyoshea.wordpress.com/2012/01/22/whiteboard-speed-dating/>.
- The Jet Propulsion Lab has a great collection of poster graphics at <http://www.jpl.nasa.gov/infographics/infographic.list.php>.
- Symmetry Magazine <http://www.symmetrymagazine.org/> explores the world of particle physics, published jointly by Fermilab and SLAC.
- CyberPhysics www.cyberphysics.co.uk has loads of graphical materials for middle and high school physics.
- HowStuffWorks at <http://science.howstuffworks.com/> is split into various categories of science and engineering, with individual pages often introduced by a provocative question.
- Want to try video analysis but don't have any good clips to experiment with? Browse the Direct Measurement Videos project at <https://serc.carleton.edu/dmvideos>.
- The website <http://stem-works.com/> has STEM articles and activities for teachers and parents.
- AT&T has archives of a large number of historical technological films at <https://www.youtube.com/playlist?list=PLDB8B8220DEE96FD9>.
- Trying to remove your personal information from web services? A huge directory with links and instructions is online at <http://justdelete.me>.
- The National Science Teachers Association has a list of freebies for science teachers at <http://www.nsta.org/publications/freebies.aspx>.
- A nifty schlieren video of the sound of a hand clap is presented at <https://www.youtube.com/watch?v=px3oVGXr4mo&feature=youtu.be>.
- The National Nanotechnology Initiative has an educational webpage at <http://www.nano.gov/education-training>.
- Screencasts of Paul Hewitt presenting Conceptual Physics can be found at <http://www.hewittdrewit.com/iWeb/list.html>.
- The American Institute of Physics has collected together statistical data related to education and employment online at https://www.aip.org/statistics?dm_i=1ZJE,3MO5P,KVUYI4,D1PPP,1.
- The website <http://www.yummymath.com/> isn't just about fun math, but also science and engineering, with direct applications to everyday life.
- Free software to set up clickers using smart phones, iPads, laptops, and similar devices can be found at <http://webclicker.org/>.
- Dan Schroeder has compiled an eye-opening list of physics textbook prices at <http://dvschroeder.blogspot.com/2015/12/textbook-price-pandemonium.html>.
- Finally a video of a sonic tractor beam can be watched at <http://news.sciencemag.org/physics/2015/10/researchers-create-sonic-tractor-beam>.



Executive Committee of the FEd

Chair: Randall Knight
(04/15 - 03/16)
Cal Poly - San Luis Obispo

Chair-Elect: Tim Stelzer
(04/14 - 03/15)
University of Illinois - Urbana

Vice Chair: John Stewart
(04/15 - 03/16)
West Virginia University

Past Chair: Michael Fauerbach
(04/15 - 03/16)
Florida Gulf Coast University

Secretary/Treasurer: Charles Henderson
(04/14 - 03/17)
Western Michigan University

Councillor: Gay Stewart
(01/13 - 12/16)
West Virginia University

Member-at-Large: Andrew Heckler
(04/15 - 03/18)
Ohio State University

Member-at-Large: Jorge Lopez
(04/14 - 03/17)
University of Texas, El Paso

Member-at-Large: Heather Lewandowski
(04/13 - 03/16)
University of Colorado - Boulder

APS-AAPT Member: Wendy Adams
(04/14 - 03/17)
University of Northern Colorado

APS-AAPT Member: Geraldine Cochran
(04/15 - 03/18)
Rochester Institute of Technology

APS-AAPT Member: Geoff Potvin
(04/13 - 03/16)
Florida International University

Non-voting Members

Chair, Committee on Education: Carlos Bertulani
Texas A&M University - Commerce

APS Liaison: Theodore Hodapp
APS Director of Education & Diversity

AAPT Representative: Steven Iona
University of Denver

Newsletter Editor-in-Chief: Beth Lindsey
Penn State Greater Allegheny

Upcoming newsletter deadlines:

Summer 2016: June 1st, 2016

Fall 2016: October 1st, 2016