

# Forum on Education

## American Physical Society

### Fall 2017 Newsletter

*Richard Steinberg, Editor*

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*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.*

## From the Chair

*John Stewart, West Virginia University*

The summer is the busiest time for the Executive Committee (ExComm) of the Forum on Education (FEEd). The Nominating Committee chaired by Vice Chair Laurie McNeil has selected the next slate of FEEd candidates. Elections will be held this fall. The Program Committee chaired by Chair Elect Larry Cain is just wrapping up the program schedule for next year's March and April meeting. Laurie will discuss the process in more detail later in this newsletter. The ExComm also voted to provide \$2000 to support travel and registration fees for graduate students, post docs, and early career physicists at next year's Gordon Conference in Physics Education Research. Nancy Ruzycki and Dawn Meredith will describe the conference in more detail. The awards committees have finished their work selecting new APS Fellows, the *Excellence in Physics Education Award* awardee, and the *Jonathan F. Reichert and Barbara Wolff-Reichert Award for Excellence in Advanced Laboratory Instruction* awardee. The winners have not yet been announced.

The FEEd has also been working to revise its bylaws to incorporate language compatible with the new APS governance structure, to conform with APS best practice, and in response to suggestions by members. The set of revised bylaws approved by the ExComm follow. These changes are being incorporated into the bylaws document. If anyone has any concerns or suggestions please let me know. After the revised document is approved by the ExComm, it must also be approved by the APS Council, and then voted on by FEEd members. I hope we can have the bylaw election early next year.

Proposed Revisions to Bylaws:

1. Revise bylaws to conform to changes in APS governance structure.
2. Change the beginning of officer terms to January 1<sup>st</sup>.
3. The Chair Elect will continue as program chair until the end

of the March or April meeting for which he/she is the chair of the Program Committee.

4. Increase the number of Members-at-Large to seven. One of the Members-at-Large would be a graduate student who would serve a two-year term. This member would have travel funded for the ExComm meeting like any other member. The student would be invited to serve out his or her term even if he or she graduates during the term.
5. Create a membership committee with the ExComm Chair as the chair of the committee. This would be a committee internal to the ExComm; however, the chair could invite non-ExComm members to serve at his or her discretion.
6. Formalize Member-at-Large roles. Members-at-Large will take on a sequence of roles like ExComm members in the Chair line, but in reverse order. Members-at-Large would be on the awards committees their first year, the program committee the second year, and the nominating committee the third year. All would serve on the new membership committee in their second and third years. The graduate student member would serve on the membership and program committee. These roles are the typical roles and the Chair, with consultation of the Members-at-Large, can adjust the roles or assign additional tasks as needed.
7. If the Secretary/Treasurer runs for a second term, the Past Chair is responsible for overseeing the election of the Secretary/Treasurer position.
8. The Secretary/Treasurer is responsible for notifying the Chair of all expenditures.
9. The Chair-Elect, Chair, and Past Chair will also serve on the APS Committee on Education. Typical duties require two face-to-face meetings and a few teleconferences each year.

## Election Process for the Executive Committee of the Forum on Education

*Laurie McNeil, University of North Carolina, Chapel Hill*

The Forum on Education has assembled a slate of candidates for election to the Forum's Executive Committee. The candidates for Vice Chair are Eric Brewe (Drexel University) and Gerald Feldman (George Washington University). Whichever one is elected will serve as Chair-Elect, Chair, and Past Chair in subsequent years. The candidates for the Member-at-Large seat to replace Andrew Heckler (whose term ends in 2018) are Homeyra Sadaghiani (California State Polytechnic University – Pomona) and MacKenzie Stetzer (University of Maine). The candidates for the APS-AAPT Member-at-Large seat currently held by Geraldine Cochran are Eleanor Close (Texas State University – San Marcos) and Mary Bridget Kustus (DePaul University). The elected Members-at-Large will take office in April 2018 and will serve a three-year term.

To produce this slate, a Nominating Committee (chaired by Laurie McNeil, Forum Vice Chair) comprising Janelle Bailey (Temple Univ.), Andrew Heckler (Ohio State Univ.), Laird Kramer (Florida

International Univ.), Beth Lindsey (Penn. State Univ.), Ramon Lopez (Univ. of Texas – Arlington), David Meltzer (Arizona State Univ.), and Monica Plisch (APS) was appointed in May 2017. Each member of the committee was provided with a list of all Forum members (one-third of the list going to each committee member) and asked to propose potential candidates; the process produced at least forty names for each position. (Nominations in response to the call issued in the Summer 2017 Forum newsletter would have been added at this stage, but none were received.) The committee as a whole then selected at least eight top choices for each position and rank-ordered them, keeping in mind diversity of demographics, institution type, career stage, and focus of educational interests. In August the Vice Chair contacted (in order) the persons named to identify those willing to stand for election, completing the slate by early September. The ballots for the election will be available on 19 October 2017 and voting will close on 11 November. The results of the election will be announced by 15 November.

## Forum on Education Sessions at the Upcoming 2018 APS March and April Meetings

*Larry Cain, Chair Elect – Forum on Education, Davidson College*

The Forum on Education program committee has completed its work selecting the sessions for the APS March Meeting from March 5-9, 2018 in Los Angeles, CA and the APS April Meeting from April 14-17, 2018 in Columbus, OH. The Chair Elect of the Forum on Education is the chair of the program committee. The program committee has developed a great slate of sessions which should be of interest to a broad audience.

As program chair, I would like to thank the committee for all their hard work putting together these sessions. This year's program committee included Forum on Education Executive Committee members Chuhee Kwon and Geraldine Cochran, Janelle Bailey representing the American Association of Physics Teachers, Larry Gladney representing the Forum for Outreach and Engaging the Public, Alex Maries who contributed an AAPT co-sponsored session, and Monica Plisch representing APS and who also contributed an AAPT co-sponsored session. The committee also consulted closely with Ted Hodapp from APS and John Thompson from the topical group on physics education research (GPER). Informal invitations have gone out to the speakers who will soon receive a formal invitation from the APS, so a speaker list cannot be announced at this time. However, session titles can be announced.

### **APS March Meeting from March 5-9, 2018 in Los Angeles, CA**

**Session 1 – Reichert Award Session** – This session will feature the Reichert Award recipient and other speakers discussing Advanced Laboratory instruction.

**Session 2 – Diversity and Inclusion in Graduate Education** (co-sponsored by Division of Materials Physics) – This session will feature speakers discussing programs designed to change physics graduate education so that it is more diverse and inclusive. It will feature discussions of the Bridge Program, admissions requirements, fostering diverse programs, and student mental health in high-diversity STEM programs. A panel discussion as the last slot in the session will allow questions from the audience.

**Session 3 – Effective practices for student career preparedness and departmental programmatic assessment** – This session will feature speakers discussing recent efforts to improve physics undergraduate education, including talks on 21<sup>st</sup> century careers and outcomes, effective practices in undergraduate physics programs, and Physics Innovation and Entrepreneurship Education.

**Session 4 – *How to Get a Job: Expanding Career Perspectives for Physicists*** – This session addresses the issue of careers for undergraduate and graduate students in physics, both within academia and in the private sector. It will feature speakers from industry, national labs, a primarily undergraduate institution, and speakers who have taken alternate career paths. It is meant to be particularly appropriate for the many student (graduate and undergraduate) attendees at the meeting.

**Session 5 – *Physics for Everyone*** – We are co-sponsoring this Division of Materials Physics session which will have the theme of “Physics of Life”. The speakers will be asked to give general talks about contemporary approaches to solving grand problems in biology using a physicist’s approach.

**APS April Meeting from April 14-17, 2018 in Columbus, OH**  
**These sessions are not complete at this time, but session topics**

have been determined. When these sessions are finalized, an announcement will be placed on the Forum website.

**Session 1 – *Forum on Education Excellence in Physics Education Award*** – This session will present this year’s award recipient and include two other talks on physics education topics.

**Session 2 – *The Cutting Edge of Physics Education Research (co-sponsor with GPER)*** – This session will feature speakers whose work is pushing forward the boundary of physics education research.

**Session 3 – *Research in Recruiting Physics Teachers*** (AAPT contributed session)

**Session 4 – *Preparing graduate students for careers outside academia*** (AAPT contributed session).

**Session 5 – *Effective Practices for program review and improvement: APS Task Force preliminary report.***

## June 2018 Gordon Research Conference: Physics Research and Education – “Energy as a Subtle Concept”

*Nancy Ruzycki, University of Florida, Dawn Meredith, University of New Hampshire*

The Gordon Research Conference: Physics Research and Education has been bringing together a community of researchers, educators, and education researchers since 2000. This conference is unique among the GRC’s due to the focus on education and the connection between cutting edge research and how we make this work accessible to our students. Every two years this conference brings together leaders in a content area of physics, leaders in physics education, and leaders in physics education research. Although the underlying theme of Physics Research and Education is a common thread for this GRC, every two years the focus of the meeting changes. The June 10-15, 2018 conference at Bryant College in Smithfield, RI will focus on energy.

The teaching of energy is generally considered by physicists to be an important core concept to understand the material world. Educators at all levels teach basic concepts of energy to students; however, many of the core energy ideas taught to students are not consistent within the physics community, or between physics and other disciplines like life science and chemistry. Energy is sometimes regarded solely as an accounting principle, a calculated quantity representing an abstract idea, not a physical construct. Unlike matter, it is difficult for students to construct a physical representation of energy, and they often struggle to understand energy as a conserved quantity. As Richard Feynman noted in a speech to teachers; “Energy is a very subtle concept. It is very, very difficult to get right.”<sup>1</sup>

This PRE GRC will have both researchers and educators as speakers. See our website (<https://www.grc.org/physics-research-and-education-conference/2018/>) for the program details.

The energy researchers will share some of the cutting-edge topics in energy research – from energy harvesting to energy flow modeling. There are many transformative topics in energy research which could be used as application examples in the teaching of undergraduate physics students, and the public.

The education speakers will look at the teaching of energy from several perspectives: embodied cognition, conceptual metaphors,<sup>2</sup> how to present a more coherent understanding of energy across the disciplines of chemistry, biology, and physics<sup>3,4</sup> and resources and students’ productive ideas about energy.<sup>5,6</sup>

This year, for the first time, the GRC will be preceded on Saturday and Sunday by a Gordon Research Seminar (GRS), whose purpose is to give junior researchers (graduate students through Assistant Professors) a forum to discuss their work and work with mentors. The GRS website <https://www.grc.org/programs.aspx?id=17679> has details of the program.

For those not familiar with Gordon conferences, the format of the GRC conferences promote open discussion and community building. Afternoons are free each day for in-depth conversations, attendance is capped at 200 to promote a sense of community, and the GRC “off the record” policy for all communication encourages and protects open communication about new ideas.

Generous contributions towards the funding of this conference has been provided by the APS Forum on Education, the Gordon Research Conferences, and NSF Grant 1744229. A continuously



updated list of sponsors is available on our website <https://www.grc.org/physics-research-and-education-conference/2018/>.

Nancy Ruzycski ([nruzycski@mse.ufl.edu](mailto:nruzycski@mse.ufl.edu)) and Dawn Meredith ([dawn.meredith@unh.edu](mailto:dawn.meredith@unh.edu)) are co-chairs of the 2018 GRC on Physics Research and Education. The co-vice chairs are Drs. Shane Larson ([s.larson@northwestern.edu](mailto:s.larson@northwestern.edu), Northwestern University) and Sean Robinson ([spatrick@mit.edu](mailto:spatrick@mit.edu), Massachusetts Institute of Technology). The GRS co-chairs are Serena Eley ([seley@lanl.gov](mailto:seley@lanl.gov), Los Alamos National Lab) and Daryl McPadden ([dmcpadden621@gmail.com](mailto:dmcpadden621@gmail.com), Florida International University).

### (Endnotes)

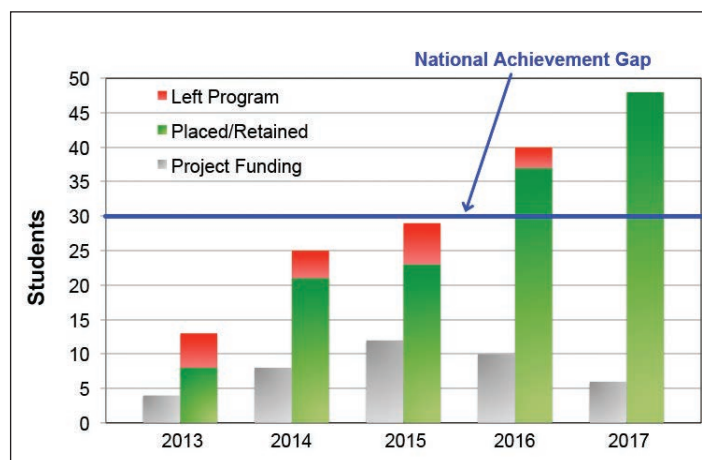
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## Director’s Corner

### Theodore Hodapp

About 9 years ago the American Physical Society wondered aloud (actually the Executive Board discussed this in their meeting) whether the APS could take actions to improve the participation of underrepresented minority (URM) students in physics. From that conversation came the APS Bridge Program – its 5-year mission to seek out new ideas and new strategies, and to boldly go where no project had been successful at going to before – has been remarkably successful. This past year, we funded only 6 students, but were able to place 48 into graduate programs across the country. The number 48 is significant because the number of URM students who receive PhDs needed to go up by only 30 in the US, in order for the fraction of bachelor’s degrees and doctorates to be the same. Forty-eight is also significant, as this demonstrates there is enough interest in the community to sustain the program’s efforts into the future (42 were funded by the institutions themselves). APS, however, is not getting out of this program – we will continue to gather applications for all graduate programs to consider, and we will be exploring how the efforts that began with admissions reform in 2013 will be sustained, and expanded into insuring all students are supported to complete their degrees. What’s more, we recently invited our colleagues at several other professional societies, including the American Chemical Society and American Mathematical Society, to consider mounting parallel efforts in their discipline.

As we have seen in other projects, listening to students and understanding the challenges they face allow us as educators and mentors to help them overcome obstacles that might defeat an



otherwise highly capable individual from making contributions to the discipline. We are delighted that this process has resulted in improving diversity, and enabling a number of students to complete doctoral degrees who would otherwise not have had the opportunity.

*A side note:* In an effort to understand why our sites were able to maintain high retention rates, we asked our site leaders to describe induction practices for new bridge students. The result (just published) can be found here: <http://www.apsbridgeprogram.org/resources/manual/index.cfm>. You may find this induction manual helpful for all of your students. Please let us know.

## FFPER 2017: Reports from collaborative groups

*Rachel E. Scherr, Seattle Pacific University*

*Michael C. Wittmann, University of Maine*

*Paula R. L. Heron, University of Washington*

In June of 2017, 60 members of the Physics Education Research (PER) community gathered at the College of the Atlantic in Bar Harbor, Maine, for the 7th biennial “Foundations and Frontiers in Physics Education Research” (FFPER) conference. First held in 2005, and modeled after the Gordon Conferences, this meeting is a venue for specialists who are active researchers in the field of physics education. Talks at the conference are all in a plenary format, typically addressing the speaker’s take on the major accomplishments of the field of PER (Foundations) or describing possibly promising research directions (Frontiers). This year’s plenary speakers were: Eleanor Close (Texas State University), Andy diSessa (University of California – Berkeley), Ben Dreyfus (George Mason University), Antje Kohnle (University of St. Andrews), Cassandra Paul (San Jose State University), Geoff Potvin (Florida International University), Vashti Sawtelle (Michigan State University), Trevor Smith (Rowan University), and Ben Zwickl (Rochester Institute of Technology). The plenary sessions are followed by coffee breaks and discussion sessions in which attendees engage deeply with the speakers and with each other.

Afternoons at the conference are spent in smaller sessions. Conference attendees self-organize into collaborative groups that exam-

ine particular research interests or explore current issues in PER. This year, the collaborative groups included one that examined the state of accessibility and inclusion for people with disabilities in physics, one that invited community engagement with the Best Practices for Undergraduate Physics Programs (BPUPP) task force, one that discussed the use of statistics in the PER community, one in which PER graduate students, postdocs, and faculty co-created a resource for newcomers to the field, and one in which PER graduate students worked with faculty mentors to review and improve each other’s short papers. Each of these groups has provided a short write-up of their discussion for this newsletter.

The FFPER conference continues to exist and flourish in part because of the financial support of the Forum on Education and the Topical Group on Physics Education Research. Members of the PER community value FFPER as a space in which to immerse ourselves in current research and to form connections and collaborations with other members of the community.

*Rachel E. Scherr, Michael C. Wittmann, and Paula R. L. Heron co-founded FFPER and have co-organized it since its inception.*

## Accessibility and Inclusion in Physics: A Working Group Summary from FFPER

*Jacquelyn J. Chini, University of Central Florida*

*Jennifer Blue, Miami University*

The Working Group on Accessibility and Inclusion in physics met twice during the Foundations and Frontiers in Physics Education Research conference in June 2017. The group focused on exploring how the physics education research (PER) community could more intentionally incorporate people with disabilities in our teaching, curriculum development and research.

About 13% of the United State’s population is diagnosed with a disability, including 11% of undergraduate students and 7% of graduate students.<sup>1,2</sup> Of college students with disabilities, about 25% pursue an undergraduate degree in STEM (science, technology, engineering and math) and 20% pursue a graduate degree in STEM.<sup>2</sup> While many of us consider physical disabilities (like mobility, visual and hearing impairments),<sup>3</sup> many students have “hidden” or “invisible” disabilities, such as attention deficit/hyperactivity disorder, autism spectrum disorder, and learning disabilities.<sup>4</sup>

Since research has shown we tend to focus on physical disabilities,<sup>3</sup> our working group began with a brainstorming activity to

generate a list of disabilities. Some pre-existing lists are available in references 5-7. We discussed how not all the lists were the same. For example, the American Disabilities Act lists drug addiction as a disability,<sup>5</sup> while that is not something people are asked to disclose when they apply for a job,<sup>6</sup> nor are students with drug addiction accommodated by university offices.<sup>7</sup> Conversely, while learning disabilities are accommodated in the education system, people are not typically invited to disclose learning disabilities when they apply for jobs.

Next, participants brainstormed topics they would like to learn more about. Proposed topics included:

- Interaction of anxiety and test anxiety with student participation and performance in social, participatory courses.
- Participation and performance in collaborative groups of students with difficulty self-regulating.
- Creating accessible conferences.
- Interaction of student’s mental health with self-efficacy and academic performance.

- Support available for students with dyslexia or other reading challenges.
- Universal Design and other pedagogical strategies for students with disabilities.
- Specific university programs that support students with disabilities, such as the Tufts and Rochester Institute for Technology programs for deaf students.
- Methods for conducting research on sparsely populated groups, such as physics students and practicing physicists with disabilities.

Since most of the interest on Day 1 was related to teaching, we decided to discuss the Universal Design for Learning framework.<sup>8</sup> Universal Design is a concept initially developed for architecture and emphasizes “the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design.”<sup>9</sup> Universal Design for Learning translates this concept for education through three main principles: 1) provide multiple means of representation (perception; language, mathematical expressions and symbols; and comprehension); 2) provide multiple means of action and expression (physical action; expression and communication; and executive function), and 3) provide multiple means of engagement (recruiting interest; sustaining effort and interest; and self-regulation). When applying Universal Design for Learning, an instructor intentionally plans for learner variability at the start, which may reduce (though likely not eliminate) the need for specific accommodations down the road.

After this brief introduction to Universal Design for Learning, participants brainstormed ways to implement the principles in physics courses. Due to time constraints, groups were only able to report out about their ideas for providing multiple forms of engagement. Ideas included:

- *Be flexible about room arrangement.* One participant supported a deaf student’s engagement in a physics lab by moving the lab table and equipment. The standard setup had two lab partners standing side-by-side, facing a wall; this did not allow the student to see his interpreter. However, once the table was rotated, the students and interpreter were able to find an arrangement that worked for them.
- *Support student group work.* Instructors should be attentive to the fact that group work can be challenging for many students, especially those with disabilities such as autism spectrum disorder, anxiety, and post-traumatic stress disorder. Participants discussed supports, such as providing students norms for how the group should function, sentence starters, group contracts and/or group roles. Additionally, instructors should consider varying the type of engagement; a student may be able to better participate in 20 minutes of group work if she knows an activity that is less challenging for her to engage in will happen next.

We also discussed ways to demonstrate empathy to both students with disabilities and all students to support open lines of com-

munication between instructors and students. Some students with disabilities have expressed negative reactions to “boilerplate” disability statements that are often provided by post-secondary institutions. Instead, they request faculty to make a public statement about their commitment to accessibility and inclusion and to invite students to discuss their needs with the instructor personally. A participant suggested another option could be to survey all students in a course about what they would like the instructor to know about how they learn. This would put students with disabilities on equal footing with students without diagnosed disabilities in the course.

At our second meeting, we focused on issues involved with research on students with disabilities. We considered several questions:

*How do we identify participants in our population of interest?* Several methods for identifying participants were discussed. While a researcher or instructor does not have access to a list of students and their identified disabilities, a campus Disability Services Office will have a list of the students who have received services through their office. This office may be able to send your recruitment information to students matching your inclusion criteria. One disadvantage of using this method alone is that not all students with a diagnosed disability register with the campus Disability Services Office. To cast a wider net, the researcher could recruit entire classes and make explicit the eligibility criteria. If this technique is used to recruit students with non-apparent disabilities, it may be possible to use a measure to assess the dimension of interest to support the validity of your sample. For example, a study recruiting students with executive function disorders could use the Barkley Deficits in Executive Functioning Scale<sup>10</sup> to assess participants’ executive function. Additionally, researchers could use the “snowball” method, by starting with individuals who have disclosed a disability to the researcher, and asking participants to suggest future participants.

*How do we operationalize or categorize disability in our research?* As discussed on Day 1, there is no generally “accepted” framework for describing disabilities. In fact, the categories used in the education system change from K-12 to postsecondary.<sup>11</sup> Thus, researchers should carefully select a framework for operationalizing disability that matches their research question. One participant suggested being explicit about the dimensions the research addresses (e.g., social, physical, cognitive and affective). For example, a study about ways to support students with visual impairments to experience the motion of a cart on a track might categorize students as “identified as visually impaired” and “not identified as visually impaired”. However, a study about participation in social learning may require a more complex categorization, as multiple diagnoses, from social anxiety to hearing impairments, may impact participation.

It is also important to make sure your recruitment methods and research instruments are accessible to anyone you are inviting to participate in your research.

Participants were encouraged to attend sessions on access and in-

clusion for students and physicists with disabilities at this summer's American Association of Physics Teachers (AAPT) meeting and Physics Education Research Conference (PERC). Several sessions focused on these topics, including an AAPT session on Being Disabled in Physics and a PERC session on Accessibility and Universal Design in Physics Education. Both sessions included a mixture of presentations on personal experiences with disability and research on accessibility and inclusion. Another PERC workshop focused on Considerations and Best Practices in Operationalizing Identity through Demographic variables. All sessions were well attended, and the community is encouraged to continue discussing how we can better integrate students with disabilities in our teaching and research.

### Resources

The following references may be useful for readers in learning more about teaching individuals with disabilities:

- Guidelines from the National Center on Universal Design for Learning<sup>8</sup>
- Free resources from the Center for Applied Special Technology<sup>12</sup>

The following references may be useful for readers in learning more about researching individuals with disabilities:

- "Researching Students with Disabilities: The Importance of Critical Perspectives"<sup>11</sup>
- "Students with Disabilities in Higher Education: A Review of the Literature and an Agenda for Future Research"<sup>13</sup>

### Acknowledgments

We thank the working group participants for their interest and insights. Of the 56 participants at FFPER, 25 participated in the first day of the working group and 14 participated in the second day, indicating their continuing interest in this topic. This work is supported in part by National Science Foundation grant #1612009.

*Jackie Chini is an Assistant Professor at the University of Central Florida. She conducts research on how research-based instructional strategies work for diverse populations of students and instructors.*

*Jennifer Blue is an Associate Professor at Miami University. She works to give more people access to physics, including advocating for traditionally excluded populations.*

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## Best Practices for Undergraduate Physics Programs (BPUPP) Task Force

*Sarah McKagan, American Physical Society*

*Theodore Hodapp, American Physical Society*

*David Craig, Oregon State University and Le Moyne College*

*Michael Jackson, Millersville University*

The Best Practices for Undergraduate Physics Programs (BPUPP) task force<sup>1</sup> is a group of national leaders in physics program evaluation and revitalization, charged with creating a guide for programmatic assessment, review, and improvement, and to train departmental reviewers and department chairs how to use the guide. The goal of this guide is to help departments answer challenges they already face with a collection of knowledge, experience, and proven effective practices. The guide will allow departments to create, improve, and assess their individual programs in a way that can respond to local constraints, resources, and opportunities, while being informed by current research and good practices within the discipline. The guide will include both a set of effective practices, and a guide for self-evaluation suitable for departmental review. It will include considerations of curricula, pedagogy, advising, mentoring, recruitment and retention, research and internship opportunities, diversity, scientific skill development, career/workforce preparation, staffing, resources, and faculty professional development.

### Motivation

In recent years there has been a growing emphasis on accountability in higher education. Regional accrediting bodies for colleges and universities, as well as other organizations administering professional standards, have increased emphasis on measures of performance based on agreed upon learning goals and closed-loop assessment processes at all institutional levels. Program-level and student learning assessments are becoming ever more important to institutional decision-making processes. Yet individual departments frequently must waste time creating assessment models entirely on their own, without the benefit of the experience of the broader physics community or from published research informing such models.

At the same time, many specific challenges face the discipline of physics as a whole. Physics remains among the least diverse of all STEM disciplines<sup>2</sup>, in spite of continuing efforts to increase representation of women and other underrepresented groups. Students are not learning as much as they could in physics courses<sup>3</sup>, in spite of an abundance of research-based pedagogies that have demonstrated improvement<sup>4,5</sup> in learning gains and student retention, especially of underrepresented groups, but that have not been widely adopted<sup>6</sup>. Many undergraduate physics programs are modeled after those designed to prepare students as research physicists, while in reality over 60% of students graduating with bachelor's degrees in physics do not pursue a graduate degree in physics or astronomy<sup>7</sup>. Few physics programs include significant development of critical professional skills suitable for the wide variety of professions pursued by our graduates<sup>8</sup>. Finally, physics programs

nationwide are not producing well-prepared high school physics teachers in numbers sufficient to meet the national demand<sup>9</sup>.

There is thus a timely opportunity to create a nationally recognized process that addresses these issues. This project will leverage the needs of physics departments to satisfy external pressures for accountability, while fulfilling their desire to improve the education of their students by implementing known effective practices.

### The Guide for programmatic assessment, review, and improvement

The guide will include two main sections: (1) a guide for self-assessment, and (2) an effective practices guide with concrete solutions to common problems.

The guide for self-assessment will support physics programs in the process of program assessment including strategic planning, creating vision and mission statements, designing and sustaining program assessment plans, creating program and course-level student learning objectives and how to assess them, and preparing for university-level accreditation and program review.

The effective practices guide will provide evidence-based strategies for achieving specific goals in a wide range of areas such as improving curricula, pedagogy, advising, mentoring, recruitment and retention, research and internship opportunities, equity and diversity, scientific skill development, career/workforce preparation, staffing, resources, faculty professional development, and departmental leadership.

These practices will be based on the best available information, which may range from research published in literature reviews and National reports to community recognition that physics programs have successfully implemented these practices to achieve a particular goal or outcome. A range of practices will be given to provide physics programs with the flexibility to prioritize and adapt these practices to their individual goals, environments, resources, and constraints.

There will be a staged release of the guide, with the first few sections available in early 2018, and the first version of the guide available in the spring of 2019.

*Sarah McKagan is the project manager for the Best Practices for Undergraduate Physics Programs Task Force and is the creator and director of PhysPort.org, a website that supports physics faculty in using research-based teaching and assessment in their classes and departments.*

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*Michael Jackson is the co-chair of the Best Practices for Undergraduate Physics Programs Task Force and is Dean of the College of Science and Technology at Millersville University of Pennsylvania.*

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## Supporting Quantitative Research in PER

*Jayson Nissen, California State University – Chico, John B. Buncher, North Dakota State University, Paul Emigh, Oregon State University, Daryl McPadden, Florida International University, Michigan State University, Caleb Speirs, University of Maine, Ben Van Dusen, California State University - Chico*

At the Foundations and Frontiers in Physics Education Research (FFPER) 2017 conference we formed a working group to discuss the use of statistics within the PER community. Our purpose was to identify common challenges that the PER community faces in using statistics and potential solutions. A major challenge we identified is that it is difficult for our community to educate graduate students about study design, statistical analysis, and reporting practices. Physics departments often require PER students to take many physics courses, leaving little flexibility in what courses they can take. When students want to take statistics courses in other departments, it is often very difficult to find courses that meet their needs: the pace in introductory courses is too slow, subsequent courses require the introductory courses, and faculty are reluctant to let students skip the introductory courses. While PER students in Schools of Education often have easier access to statistics courses, they also face similar limitations in their choices and may not be encouraged to enroll in statistics courses. This leaves students with few options other than to teach themselves or to learn from their advisors, who may have also taught themselves. To address this challenge and others we identified, the working group focused on solutions that used both formal and informal structures to le-

verage the substantial expertise in our community to strengthen the community's overall knowledge and use of statistical methods.

The challenges of doing high-quality statistical work are not unique to PER. Instead, the PER community's challenges with statistics represent a much larger issue within science as a whole. The widespread prevalence of poor statistical methods in science has led the American Statistical Association (ASA) to release a statement on p-values<sup>1</sup> in which they state, "Statistical significance is not equivalent to scientific, human, or economic significance. Smaller p-values do not necessarily imply the presence of larger or more important effects, and larger p-values do not imply a lack of importance or even lack of effect." The ASA released this statement, in part, as a response to the growing discourse in the media around the validity of science and prominent statisticians pointing to p-values and poor statistical methods as a culprit in the 'replication crisis' that is besetting science. Transforming how science as a whole uses statistics is a daunting but necessary task<sup>2</sup>. Focusing on improving our community's use of statistical methods is a task well within the abilities and expertise of our community that can contribute to the scientific community

as a whole. In drafting our proposed solutions we focused on activities that will enable rich conversations within our community.

The working group proposed five activities to improve the PER community's use of statistics.

1. Develop a central location for sharing knowledge and resources about statistics.
2. Run workshops at the PER Conference and AAPT Meetings.
3. Develop or identify online learning materials to support graduate students and PER newcomers in learning statistics.
4. Produce resource articles directly for the PER community.
5. Create a space to critique each other's work constructively.

We focused on the first three activities because these were broader in scope. We did not focus on producing resource articles for the PER community because the recent call for papers<sup>3</sup> in Physical Review Physics Education Research on quantitative methods will hopefully meet this need. As for critiquing others work, we hope that this article and ongoing efforts to improve statistics in PER can support constructive critiques being published in peer reviewed journals where they can have the greatest impact on our community.

The working group expressed a strong desire for a central online location for sharing statistical knowledge and resources specific to our community. The location that seems most suited to meet this desire is the PER wiki (<http://www.compadre.org/per/wiki/>) hosted by PER-Central. As a wiki, this resource would be editable by members of the community and it could change fluidly to meet any changing needs and knowledge. While many members of our community already access PER-Central, links from other PER organizations (such as PERCoGs, PhysPort, and the AAPT) would help increase the visibility of the new resources. The largest barrier to developing a Wiki on PER Statistics is soliciting volunteers to generate the initial content. To kick start this development, we have surveyed several members of the community to identify individuals who have the requisite knowledge of statistics and can contribute to the project. With the PER-Central Wiki serving as a centralized location for curated statistical resources for individual study, we wanted to create opportunities for practitioners to work together with experts. We identified AAPT/PERC workshops as an ideal structure for a focused session on applying and interpreting statistical methods for different types of data. A key aspect of these workshops will be to enable attendees to work with each other and with experts to analyze their own data and answer statistical questions from their current projects. We anticipate piloting the workshop at the 2018 PER Conference. The end goal is an AAPT workshop series comprising two parts: a morning workshop to introduce graduate students and PER newcomers to statistical methods for their current research projects and an afternoon session focused on advanced topics that would change from year to year (e.g., Hierarchical Linear Models or Network Analysis).

Regarding online learning materials, our group could not identify an existing online resource that would meet the needs of the PER community: a course that balanced mathematical rigor

with the conceptual underpinnings of introductory statistics in contexts practical for PER. We propose gathering existing materials and writing short problem sets in the context of PER to create our own online course and creating an infrastructure to enable students to work through these materials together. During our discussion, we identified a series of existing tutorials in statistics (created by education researchers) as the backbone of the course. Links to these tutorials on the wiki and three problems per tutorial in the context of PER, which need to be developed, would be a foundation for online learning resources for our community. We did not identify ready solutions to several problems that still need to be addressed: developing the infrastructure for students to coordinate working through the materials, integrating the online material and the workshop, and getting support for community members developing these resources. The first step we identified is to gather existing tutorials and other resources in the online wiki and determine which to use in the online course.

The PER community has been a trailblazer for the broader Discipline Based Education Research community. For example, the creation and use of concept inventories as quantitative measures of student change began in PER and has driven significant transformation across the STEM disciplines. We have the responsibility as scientists to ensure that the methods used to collect, analyze, and share quantitative data in PER are high-quality and facilitate accurate interpretations of the data. The resources proposed by the working group at FFER can support each other. The wiki can support developing the workshops and online materials, which can both work together to provide a far more effective learning experience than a short workshop or a handful of online tutorials could on their own. These resources build upon the high quality work our community produces and are a step forward in improving the breadth and depth of our community's statistics knowledge and practices. Ultimately, it will be up to the community to develop, share, and implement these learning resources, and to hold itself accountable for using high-quality statistical methods.

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## Creating a Student-driven Literature Resource for Newcomers to PER

*Lisa Goodhew, University of Washington, and the PERCoGS Executive Committee*

Several members of the Physics Education Research Consortium of Graduate Students (PERCoGS) attended the Foundations and Frontiers of Physics Education Research Conference (FFPER), supported in part by a grant from the APS Forum on Education that reduced costs for all graduate students attending FFPER. A key feature of FFPER, its afternoon working groups, organized by conference attendees in which groups of conference attendees meet to discuss a particular goal relevant to the PER community. This format provided PERCoGS a fantastic opportunity to work with PER graduate students, postdocs, and faculty to create a new literature resource for newcomers to the field.

### What is PERCoGS?

The [Physics Education Research Consortium of Graduate Students](#) (PERCoGS) formed in 2013 as a means to develop and maintain a stronger PER Graduate Student community. PERCoGS consists of three elected officers (President, Secretary, and Publicist), graduate student representatives to the PER Leadership and Organizing Council ([PERLOC](#)), and the AAPT Committee on Graduate Education. Currently, the PERCoGS president serves as a representative to the APS GPER Executive Committee. (For more information about the formation and structure of PERCoGS, our founding document can be viewed [here](#)). The primary goals of PERCoGS are: 1) to broaden graduate student participation in the PER community, 2) to provide professional development opportunities to graduate students, 3) to represent graduate students in the governing bodies of PER, and 4) to highlight the diversity of PER graduate students. With a view toward these goals, PERCoGS has organized sessions for graduate students at American Association of Physics Teachers (AAPT) Summer and Winter Meetings since 2015 (as these are the most widely attended conferences by PER graduate students). At the April 2017 APS Meeting, PERCoGS organized a student dinner for PER graduate and undergraduate students in attendance, and we hope to continue to build a presence and community at APS April Meetings. PERCoGS has also published a quarterly newsletter and created online resources to support community-building and professional development, which can be found on our [website](#).

### FFPER working group to create a new literature resource

Research within PER is diverse, ranging from university students’ conceptual understanding of quantum mechanics to middle school students’ development of a physics identity to the knowledge that physics teachers need in order to teach well. For those who are

new to the field, it can be challenging to learn about the different areas of PER and to gain a sense of what those various kinds of research might look like in practice. At the Graduate Student Topical Discussions that PERCoGS organizes at AAPT meetings, we often hear that students wish they had an accessible way to familiarize themselves with different kinds of PER. In a field where research groups tend to focus on one or two “kinds” of PER, a resource like this would be useful for undergraduates considering PER graduate programs and for graduate students who want to know about the kinds of research being done outside of their own institution. PERCoGS felt that this gap could be addressed by collecting a list of papers that illustrate the various research agendas that are currently being pursued in PER. Our aim was to create a list of papers that are illustrative of the landscape of PER today, well written, and understandable without a great deal of previous knowledge on the topic.

The efforts of this working group are intended to complement and build upon already-existing literature resources, such as the 2005 Literary Canon in PER,<sup>1</sup> the 1999 Physics Education Research Resource Letter by McDermott and Redish,<sup>2</sup> as well as resource letters on particular areas of research within PER. Like these resources, our list of papers is intended to be a helpful resource for those who wish to familiarize themselves with PER generally or specific research areas within the field. The list of papers created by this working group list adds to these existing resources in two important ways: (1) it gives a current, if rough-grained, assessment of the many kinds of work being done in PER today, taking into account the expansion of the field over the last 10 years, and (2) it attempts to recommend a few concise introductory-level papers, rather than to list the seminal papers relevant to various areas of research.

In creating this list of articles, the PERCoGS committee wanted to be particularly attentive to creating a list that was inclusive of the entire field—to the extent that this is possible in a manageable set of articles—and represent researchers from many different institutions. We felt that this task would be best done in conversation with a broader subset of the PER community, rather than by the PERCoGS executive committee alone. The “working group” format of FFPER provided an opportunity to work with PER graduate students, postdocs, and faculty members to create this resource. Several PERCoGS members who attended FFPER therefore initiated this working group.



A total of 18 PER grad students, postdocs, and faculty attended the working group meeting. The organizers shared the specific goals of this working group: to agree on ~10 categories of PER that could give a newcomer a “lay of the land,” (although these categories may not cover all of PER) and deciding on easy-to-read articles that illustrate these categories. Members of this working group first discussed what they felt were the important areas of research in PER in small groups, which ultimately resulted in a total of 16 categories of PER research. Then, small groups were tasked with brainstorming papers to illustrate each of these categories. Since the final product of this working group was aimed at newcomers to PER, the goal of these small group discussions was to come up with papers that are relatively easy to read and do not require specialized background knowledge. These discussions provided us with many great articles to illustrate each research area, and we are in the process of culling this to an inclusive yet manageable set of articles (no small task!). Ultimately, we aim for a set of 10-15 papers that we recommend as a starting place for learning about the broad space of PER. We hope that this can be useful to anyone who is interested in PER and wants to know more about the diverse research agendas within this field, and that this list provides students

with a starting point to engage in conversation with researchers from other sub-fields or institutions. We expect this may be particularly useful for undergraduate students who are considering graduate work in PER and for graduate students who work in PER but are relatively unfamiliar with the kinds of research being done outside of their own institution. If you, or anyone you know, would find this resource useful, you can find it posted on the PERCoGS website when finalized.

*Lisa Goodhew is a graduate student in the University of Washington Physics Education Group and PERCoGS Publicist. To contact the PERCoGS or to be added to the PER graduate student email list, please send an email to [percogs.excom@gmail.com](mailto:percogs.excom@gmail.com).*

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## Supporting Graduate Students as Professional Writers, Readers and Reviewers

*Leslie Atkins Elliott, Boise State University,  
Katie Ansell, University of Illinois, Urbana-Champaign.*

At each FFER conference since 2005, graduate student participation has been supported by grants from the APS Forum on Education, which has allowed students to pay reduced registration fees. In 2017, at the sixth FFER conference, we continued offering a special Graduate Symposium to allow students and recent graduates to present their own work and have it critiqued by their peers and faculty mentors. The process was designed to support students in producing a publishable paper, and, through that process, develop useful practices around drafting papers, including soliciting and providing informal peer reviews prior to submission. At the same time, the close reading of peers’ work allows participants to broaden their knowledge of contemporary research in PER, network with peers, and strengthen their skills in collaboration and reviewing.

As in the 2015 Symposium, each participating student wrote a four-page paper on part of their PhD research, following the format of the Proceedings of the annual Physics Education Research Conference, and submitted it several weeks before the conference for review. The students were placed in three groups of four to five students to read and provide feedback on those submissions. Based on feedback from the 2015 Symposium, which suggested that structures for providing feedback would be helpful, each group of students wrote a review letter of each other’s papers, following the guidance provided by Rachel Scherr in the PERCoGS [newsletter](#). In order to facilitate face-to-face discussions at the conference, the

reviews were not anonymous. Faculty mentors Saalih Allie, Leslie Atkins Elliott, and Hunter Close also provided feedback, either in the form of a separate review, or a cover letter helping the author interpret and prioritize the reviews.

At FFER, each student group had a 90-minute session to present and discuss their work. During the sessions, each student gave a short oral presentation about his or her work, and then discussed responses to the reviews they had received. In several cases, there was extensive discussion about how best to incorporate suggestions into the paper. There was also discussion about the review process itself, and what participants learned from the process, both as authors and reviewers.

**The faculty mentor view:** Drawing on feedback from the 2015 Symposium, which suggested that the 90-minute presentations could use more structure, one small group submitted their documents not only formatted for the PERC conference, but also as a shared Google Document. These facilitated more informal feedback, with their peers adding in-line comments to the document, suggesting references, linking to other documents, noticing and responding to the feedback others had left, and beginning a conversation around points of disagreement. For example, one student noted that a paper began too abruptly, without enough framing, while a second countered that considerable framing might be un-

necessary for a four-page conference paper for a specialized audience. When we met as a whole group at the conference, these comments – more so than the formal feedback – provided the seed for productive conversations.

**The graduate student view:** The FPER Graduate Symposium provided space to practice writing and reviewing papers, but I think it more importantly humanized the process and encouraged a model of review writing that helps authors' work become better. To me, the most influential resource at the review-writing stage was Rachel Scherr's [advice](#) (and accompanying sample [letters](#)) that critical reviews should aim to help the authors improve their work in a caring, personal way. Although I attempted to apply this advice in my reviews, I think it took the face-to-face discussions

during the Graduate Symposium - where we talked about our comments and worked out ways to improve our papers with our reviewers – to help me understand how strong statements can also be supportive. Other members of my symposium group expressed a similar sentiment. I'm excited about the reviewer culture encouraged by the Graduate Symposium and look forward to applying this paradigm the next time I write reviews.

*Leslie Atkins Elliott is an associate professor of education at Boise State University, where she is a member of IDoTeach, preparing secondary STEM teachers.*

*Katie Ansell is a graduate student in physics education research at the University of Illinois, Urbana-Champaign.*



## Teacher Preparation Section

*Alma Robinson, Virginia Tech*

During the summer AAPT conference, I attended the session on Research on Physics Teacher Preparation and was immediately struck by the immense role physics departments play in shaping our students' perceptions of teaching. Two of the presenters at that AAPT session, Monica Plisch and Wendy Adams, are featured in this issue of the Teacher Preparation Section.

Monica Plisch, APS Director of Education and Diversity, highlights the newest APS Panel on Public Affairs report, which describes the findings of a survey of nearly 8000 STEM students on their attitudes and opinions towards teaching and provides recommendations to STEM departments to help recruit future teachers. Encouragingly, the departments that discuss teaching as a career option recruit more STEM majors into teaching!

Wendy Adams, Research Associate Professor at the Colorado

School of Mines, discusses a new survey instrument designed to measure students' Perceptions of Teaching as a Profession (PTaP) as well as their perceptions of their department's view on K-12 teaching. In addition, PTaP provides departments with a method to identify potential future teachers. Not only has PTaP revealed that many students hold negative misperceptions of teaching, it seems that in many cases, these misperceptions are discouraging students from pursuing a teaching career.

Finally, the 2018 PhysTEC conference, the largest conference on physics teacher education, will be held on February 9-10 in College Park, MD, proceeding the Building a Thriving Undergraduate Physics Program workshop. Please see <https://www.phystec.org/conferences/2018/> for more information.

## The Importance of Talking about High School Teaching

*Monica Plisch, APS Director of Education and Diversity*

There are severe and persistent shortages of qualified K-12 STEM teachers, particularly in the high-need disciplines of physics, chemistry, math, and computer science. According to the 2012 Schools and Staffing Survey, large percentages of teachers whose main assignment is physics (63%), chemistry (66%) or math (38%) have no major or minor in the subject, or no certification to teach it. And computer science is not even offered in most high schools. These teacher shortages have a significant impact on the quality of STEM education and a ripple effect of discouraging young students from pursuing careers in STEM.

The APS Panel on Public Affairs (POPA) decided to take on the issue of STEM teacher shortages in its first-ever education policy study. Led by POPA member Michael Marder, APS undertook a survey of STEM majors to learn about their attitudes and opinions toward teaching and what colleges and universities could do to increase the number of majors who pursue K-12 teaching. APS partnered with the American Chemical Society, the Computing Research Association, and the Mathematics Teacher Education Partnership to extend its reach, and the POPA survey ultimately garnered responses from almost 8,000 current undergraduates and recent graduates in high-need STEM fields, including over 1,200 physics majors.

About half of all STEM majors expressed some level of interest in teaching, indicating a substantial pool from which more teachers could be recruited. Not surprisingly, given the long-standing tradition of math education faculty embedded in many math departments, math majors were most likely to indicate an interest in teaching (54%). Somewhat lower percentages of physics majors (48%), chemistry majors (41%), and CS majors (36%) reported interest.

In one of the most encouraging findings, the survey revealed evidence that talking about teaching with STEM majors helps recruit more teachers. While about two-thirds of students in each discipline reported that their top career choice was discussed in their major department, there was a significant gap when it came to discussing the option of middle or high school teaching. Only 36% of physics majors, 29% of chemistry majors and 7% of CS majors agreed that careers in teaching were discussed in their department; mathematics stood out as the only discipline in which teaching careers received close to equal air time, with 63% of math majors affirming that this option was discussed. These percentages roughly correspond to majors' interest in teaching careers. Further, at PhysTEC sites, where physics departments engage strongly in teacher

education (see [phystec.org](http://phystec.org)), teaching careers were discussed just as much as other careers (showing similar results to math departments). Notably, these sites have more than doubled the number of physics majors who become teachers.

POPA survey results also indicated a lack of information about the salary and working conditions of actual teachers. Nearly all STEM majors with some interest in teaching (and many who declare no interest) reported that a higher salary would increase their interest in teaching. While a teaching salary does lag behind some other professions available to students with a STEM degree, undergraduates underestimated teacher compensation by almost \$20,000 per year. The starting salaries that they reported would interest them in pursuing a teaching position are close to the actual starting salaries of middle and high school teachers. A top concern shared by over 40% of STEM majors about becoming a teacher is dealing with uncontrollable or uninterested students, yet less than 8% of practicing teachers reported this as an issue.

There are many positive aspects of teaching that students may be unaware of. Teachers are six times more likely than STEM majors in other professions to report that they are making a difference in people's lives through their job. Teachers are just as likely to report satisfaction with the level of intellectual challenge and the level of responsibility in their job as those who went into other professions, and almost twice as likely to report satisfaction with job security. In addition, teacher salaries are for a 9- or 10-month position, and summers can be a time to explore other passions or earn an additional salary. Teaching also has some downsides as documented in the POPA study, but to undersell the profession or not even discuss it as an option does a disservice to majors for whom teaching is a good fit, as well as the hundreds if not thousands of young students who would benefit from having a qualified teacher.

The full POPA report, "Recruiting Teachers in High-Needs STEM Fields: A Survey of Current Majors and Recent STEM Graduates," is available at <https://www.aps.org/policy/reports/popa-reports/upload/POPASTEMReport.pdf>

*Dr. Monica Plisch is a co-author of the POPA report and the Director of the Physics Teacher Education Coalition (PhysTEC), a project of the APS and the American Association of Physics Teachers to improve the education of future physics teachers. As APS Director of Education and Diversity, she leads a number of national efforts to advance physics education and promote greater inclusion and diversity.*

## A New Survey Uncovers Strong Misperceptions About the Teaching Profession. What Can We Do to Get the Facts Out?

Wendy K. Adams, *Department of Physics, Colorado School of Mines*

Over the past two years, in a joint effort with the PhysTEC community, we have undergone an intensive study to develop an instrument that can measure students' Perceptions of Teaching as a Profession (PTaP). The PTaP is able to discriminate between those who want to become teachers and those who do not on eleven empirically identified categories, ranging from *personal enjoyment to teaching is scientific*. PTaP data can provide feedback to departments about students' perceptions of that department's view of teaching as a career, as well as identify which students are potential teaching recruits. This work also has revealed student misperceptions about both the tangible and intangible benefits of the profession, which are consistent with the findings of the recent APS Panel on Public Affairs report.<sup>1</sup>

The data from the PTaP are rich, but here I would like to focus on the misperceptions of the tangible and intangible benefits of the profession. During student interviews, these misperceptions appeared to be one of the strongest motivators for students who indicated that they did not want to become teachers. More importantly, a large fraction of students indicated that they would like to become a grade 7-12 teacher if these benefits were better than they perceived them to be. Since these misperceptions are simply a misunderstanding of the facts, shouldn't they be easy to correct?

Unfortunately, reinforcement of these strong misperceptions about the profession are widespread and commonplace. When reviewing news reports about teaching from the past five to ten years, you can find anecdotes of some of the worst teaching conditions presented as if they represent the profession on average. We are bombarded with the message that teachers have a terrible job, they are overworked, under paid, and are leaving the profession in droves. With this strong, consistent messaging, nearly everyone has an opinion about what it is like to be a teacher and is able to speak about the injustices at length. It is not surprising that the numbers of students pursuing teaching has been steadily dropping nationwide over the past five years.<sup>2</sup> Why would students want to (or their parents want their children to) enter a profession where they will be unhappy and underpaid?

The good news is that we do have data on the facts. Teachers are not unhappy in comparison to their counterparts in industry.<sup>3</sup> The typical teacher's pay scale results in a comfortable middle-class living,<sup>4</sup> and their retirement benefits are some of the best, as teachers in most states retire comfortably before age 60. We also discovered a new large-scale longitudinal study from the Department of Education that shows that 78% of secondary teachers remain in the profession at year five.<sup>5</sup> Finding comparable data for industry is difficult, but the Bureau of Labor Statistics data show that people in the private sector are more than twice as likely to leave their position, voluntarily or not, as compared to public educators.<sup>6</sup>

However, even armed with the facts, these deep-seated misperceptions of the teaching profession will not be easily unset. It will require a nationwide concerted effort across institutions to begin to clarify the facts. And the effort will be worthwhile; for every one of your students that becomes a teacher, you've multiplied your efforts a thousand-fold through them. Let's work together to spread a new message: Teaching, worth it in more ways than you may think. When these misperceptions are consistently corrected with facts, we hope to see a strong upswing in the number of students pursuing teaching as a profession.

### How does the PTaP instrument work?

PTaP consists of 58 Likert scale statements that can be completed on line or in class in less than nine minutes. Our motivations for developing the instrument were to better understand:

- What differences in department culture and student perceptions about teaching exist among institutions that are more or less successful in preparing large numbers of physics teachers?
- What is the impact of PhysTEC support, as measured by longitudinal changes in student attitudes?
- What measurable characteristics differentiate students who become teachers from those who do not?
- Do specific interventions, including providing more accurate information about teaching as a profession or participating in an early teaching experience, increase students' interest in becoming a teacher?

Data collected from twelve institutions are shown in Tables 1a. and 1b. Here you can see that when comparing students who want to become a teacher with those who do not, there are significant differences between these two populations for each category.

To identify those who want to teach, we combined those who chose either agree or strongly agree on the statement *I want to become a grade 7-12 teacher*. For those who do not want to teach, we combined students who chose disagree or strongly disagree with this statement. If a student chose neutral, we did not include them in this analysis.

All scores in Table 1a. are % agreement with what the experts identified as positive and accurate perceptions of the profession. A few specific statements of interest are listed in Table 1b. with raw numbers of students who indicated agreement with these statements. The final set of statements listed "I would if..." comprises a group of four statements such as "I would become a grade 7-12 teacher if the pay were equal to my other career options."

Data from the PTaP can be used to help departments identify those who want to teach as well as those who would consider teaching given correct information about the profession. Or it could be



<b>Table 1a. PTaP v2</b>			
<b>I want to become a grade 7-12 teacher.</b>	<b>Neutral</b>	<b>No</b>	<b>Yes</b>
N = 777	156	481	140
Overall (53)		39.4	66.8
Personal Enjoyment		12.2	87
As a Career Choice		37.1	75.8
Support by Others		48.1	69
Department Values & Encourages Teaching		35.5	59.7
Department Supports Me Teaching		47.2	64.1
Employee Benefits and Security		29.4	48.4
Teaching Is Scientific		50.1	80.7
Nurturer		33	86.9
Back Up Plan		42.1	49.2
All Students Can Learn		59.3	80

<b>Table 1b. PTaP v2</b>			
<b>I want to become a grade 7-12 teacher.</b>	<b>Neutral</b>	<b>No</b>	<b>Yes</b>
N = 777	156	481	140
Pursue Teaching Cert at my Institution		5	85
Pursue Teaching Cert other route		18	16
I would if...		179	45

used as a pre/post measure of departmental efforts to improve perceptions of teaching as a career. Watch for our article in the next FED newsletter about how we have been applying what we have learned from the PTaP to design interventions to address and correct misperceptions about the teaching profession.

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**(Endnotes)**

1. APS Panel on Public Affairs. *Recruiting Teachers in High-Needs STEM Fields: A Survey of Current Majors and Recent STEM Graduates*. 2017
2. Department of Education Title II Data retrieved from <https://title2.ed.gov/Public/Home.aspx> on 9/18/17.
3. American Institute of Physics. *Physics Bachelors: Initial Employment*, 2017.
4. Bureau of Labor Statistics. *Occupational Outlook Handbook: High School Teachers*, 2015.
5. U.S. Dept. of Ed. *Public School Teacher Attrition and Mobility in the First Five Years: Results From the First Through Fifth Waves of the 2007–08 Beginning Teacher Longitudinal Study*, 2015.
6. Bureau of Labor Statistics. *Job Openings and Labor Turnover – January 2016*.

## Browsing the Journals

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- On page 293 of the May 2017 issue of *The Physics Teacher* (<http://aapt.scitation.org/journal/pte>) a trio of Japanese educators propose an improved motor design consisting of coiled copper wire suspended on clips above a permanent magnet. Rather than the conventional design which uses a single coil and thus requires a commutator (by stripping the insulation off only one side of the copper wire) and priming (by giving the coil an initial twist to start it), the new design uses a figure-8 pair of coils to avoid those two issues and to increase the energy conversion efficiency. The September 2017 issue has a large number of thought-provoking articles about the issue of racial diversity in physics education.
- Pantaleone analyzes the wondrous chain foundation on page 414 of the June 2017 issue of the *American Journal of Physics* (<http://aapt.scitation.org/journal/ajp>). His key idea is that as a link is pulled up at an angle from the pile, there is an upward reaction force from the pile on that link. Digilov uses the Lambert  $W$  function to analyze the time-dependent weight of a vessel from which liquid is draining out through a capillary tube on page 510 of the July issue. On page 522 of the same issue, three Brazilian physicists present an undergraduate experiment to measure thermal lensing of a Gaussian laser beam in soy sauce. A group at Smith College notes on page 663 in the September issue that the gravitational self-interaction of earth's tidal and terrestrial bulges produce a substantial correction to the conventional values; a helpful analogy is drawn to the solution of Laplace's equation for a charged shell.
- Article 043004 in the July 2017 issue of *Physics Education* uses a unipolar motor to demonstrate angular momentum conservation; article 043006 emphasizes that the stopping potential in the photoelectric effect determines the work function of the collector and not of the emitter; and article 045021 discusses the theoretical upper limit on the possible mass of stars. Article 045402 in the July 2017 issue of the *European Journal of Physics* revisits the issue of the difference between the standard expressions for the phase velocity of a free matter wave in the relativistic and classical limits, and why both disagree with the particle velocity. Article 055202 in the September issue discusses the problem of determining the static charge distribution along a finite straight wire; I was surprised to learn this simple configuration is unsolved and possibly indeterminate. Both journals can be found online starting at <http://iopscience.iop.org/journalList>.
- The June 2017 issue of *Resonance* has an article about radio-frequency identification tags and another about orbital precession due to the general theory of relativity. The July issue has a paper about using interferometry to measure the diameter of stars, as first performed by Michelson. The August issue has a historical review of density functional theory. Finally the September issue discusses some experiments with antibubbles, which are spherical shells of air floating in a soap solution. These articles can be freely accessed at <http://www.ias.ac.in/listing/issues/reso>.
- A Python program to solve Schrödinger's equation is presented on page 813 of the June 2017 issue of the *Journal of Chemical Education*. An editorial on page 825 of the July issue discusses two recent studies which show no evidence that instruction tailored to particular student learning styles results in improved achievement; an article on page 976 of the same issue explains how to construct the periodic table step by step based on atomic orbitals. Synthesis and characterization of carbon and of perovskite quantum dots are respectively discussed on pages 1143 and 1150 of the August issue. The journal archives are at <http://pubs.acs.org/loi/jceda8>.
- Article 010130 in *Physical Review Physics Education Research* at <https://journals.aps.org/prper/pdf/10.1103/PhysRevPhysEducRes.13.010130> discusses the pedagogical implications of the distinction between the gravitational definition of weight (as the net gravitational force acting on an object) and the operational definition (as the contact force measured by a scale). Article 020110 at <https://journals.aps.org/prper/pdf/10.1103/PhysRevPhysEducRes.13.020110> considers student views about the nature and process of experimental physics compared to those of practicing physicists.
- An article published online on 14 September 2017 in the *Journal of Modern Optics* at <http://www.tandfonline.com/doi/full/10.1080/09500340.2017.1374482> shows that the Doppler shift in the emission frequency of a moving atom gives rise to a velocity-dependent frictional force, in apparent contradiction to relativity. (The velocity of the atom and hence the force depends on the motion of the observer.) This paradox is explained by the change in momentum due to the relativistic loss in mass of the atom when it radiates away a photon, making for an alternative method of deducing Einstein's mass-energy relation.



## Web Watch

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- SciTech at <https://www.osti.gov/scitech/> is a database of publications (with full text) by Department of Energy researchers.
- A visual introduction to probability and statistics is online at <http://students.brown.edu/seeing-theory/>.
- World Science U at <http://www.worldscienceu.com/> is a set of videos and courses about complex current topics in physics.
- AAAS maintains the webpage <https://www.eurekalert.org/> devoted to science news stories. *R&D Magazine* has another at <https://www.rdmag.com/>, as does PBS at <http://www.pbs.org/newshour/topic/science/>.
- Did you know you can build any other logic gate (such as an AND or MUX) entirely out of NAND gates alone? The required configurations are listed at [https://en.wikipedia.org/wiki/NAND\\_logic](https://en.wikipedia.org/wiki/NAND_logic).
- Despite modern technology, chalk & talk still hasn't gone out of style among physicists according to <http://physicsworld.com/cws/article/indepth/2017/jun/01/the-power-of-the-blackboard>.
- As reported at <https://www.sciencedaily.com/releases/2017/06/170623100433.htm>, University of Illinois engineers have designed a signal that can be broadcast in a room. The signal is inaudible to human ears but creates white noise in any surreptitious microphones in the room, preventing spies from listening in.
- Dartmouth has an audio lecture and related documents by Oppenheimer online at <http://www.dartmouth.edu/~library/digital/collections/lectures/oppenheimer/>.
- Spectral hole burning plus an applied voltage can be used to slow light down in a rare-earth-doped crystal, as briefly highlighted at <https://physics.aps.org/synopsis-for/10.1103/PhysRevA.95.032104>.
- Read about a tiny camera that works without lenses at <http://www.caltech.edu/news/ultra-thin-camera-creates-images-without-lenses-78731>.
- Three lectures by Hans Bethe on quantum theory are online at <http://bethe.cornell.edu/>.
- The webpage <http://latinamericanscience.org/> is devoted to science in Central and South America.
- Comprehensive universities in the US straddle the range from liberal arts college to research institutions. An essay about working at such an institution can be read at [http://www.adfl.org/cgi-shl/docstudio/docs.pl?bulletin\\_111014](http://www.adfl.org/cgi-shl/docstudio/docs.pl?bulletin_111014).
- When in a medium, does the formula for photon momentum have the refractive index in the numerator or in the denominator? The debate is summarized at [https://www.osa-opn.org/home/newsroom/2017/july/the\\_momentum\\_paradox\\_revisited/](https://www.osa-opn.org/home/newsroom/2017/july/the_momentum_paradox_revisited/).
- Experiments you can do in your kitchen are presented at <http://kitchenpantryscientist.com/>. Some could make good science fair projects.
- We are asked to imagine the future at <https://futurism.com/> resulting from science and engineering innovations.
- College Factual's ranking of the best universities in the US at which to study physics is at <http://www.collegefactual.com/majors/physical-sciences/physics/rankings/top-ranked/>.
- Water droplets evaporating off the surface of a computer chip might be an efficient means of local cooling according to <http://physicsworld.com/cws/article/news/2017/apr/05/jumping-droplets-could-cool-computer-chips>.
- *Nature Magazine* highlights the recent interest in topological insulators at <https://www.nature.com/news/2010/100714/full/466310a.html>.
- Finally edX has a MOOC titled "Quantum Mechanics for Everyone" that is accessible at <https://www.edx.org/course/quantum-mechanics-everyone-georgetownx-phyx-008-01x>.



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#### *Upcoming newsletter deadlines:*

Spring 2018: January 15th, 2018

Summer 2018: June 1, 2018