Forum on Education
American Physical Society

Spring 2018 Newsletter

Richard Steinberg, Editor

In this issue:

From the Chair

John Stewart, West Virginia University

At this writing, you should have an email asking you to vote on the revised bylaws. The election closed on Thursday February 22nd. The revisions should simplify the Forum on Education (FEd) governance, allow us to attract more members, and to better serve our graduate student members. The most important changes are summarized below.

This will be my last "Note from the Chair." Larry Cain will become Chair at the April Meeting; there will be a transition period where we both are chair if the bylaws are adopted. At the April Meeting, Past Chair Tim Stelzer and Members-at-Large Andrew Heckler and Geraldine Cochran will complete their terms and rotate off the Executive Committee. I would like to thank them for their exemplary service.

The new membership committee is already working on some ideas to increase FEd membership (I sure hope the bylaws are approved). The APS is designing a poster that will allow meeting attendees to enter their badge number at a website to join the FEd. This poster will be placed outside our meeting rooms and at the APS Education and Diversity booth. We are also pursuing a lapsed member drive to ask former FEd members to return. On the first of the year, the APS changed its policy to allow members to join as many forums as they want for free.

Beyond the revision of the bylaws, and the changes that they will bring, we are also trying to formalize our relation with the Division of Atomic, Molecular, and Optical Physics (DAMOP) to continue to offer one invited education session at their annual meeting.

We are also testing having a Forum on Education/Education and Diversity reception at the March Meeting. This popular event at the April Meeting allows the FEd and GPER to introduce their fellows and award winners and have a chance to socialize. I hope all FEd members at either meeting will attend.

Proposed Revisions to Bylaws:

1. Revise bylaws to conform to changes in APS governance structure.
2. Change the beginning of officers' terms to January 1st. This makes the officers' term the same as the FEd fiscal year term and allows newly elected officers to participate immediately.
3. Increase the number of Members-at-Large from six to seven. One of the Members-at-Large would be a graduate student who would serve a two-year term.
4. Create a membership committee with the FEd Chair as the chair of the committee.
5. Formalize Member-at-Large roles. Members-at-Large will take on a sequence of roles like FEd 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, could adjust the roles or assign additional tasks as needed.

Thanks to all Forum on Education Members. Serving as the Chair of the Forum has been a great honor.

From the Editor: An Introduction to a Special Themed Edition[1]

Richard Steinberg, City College of New York

My grandparents were from Eastern Europe and came to New York to escape religious persecution and poverty. They came through Ellis Island, in the shadow of the Statue of Liberty. They settled in the Bronx, where my parents grew up not far from City College. Both of my parents subsequently graduated from City College. They were only able to have access to higher education because of the existence of public education. I now teach at City College where many of my students have similar stories of hardship, hard work, and becoming successful contributors to a better society, as my parents have done so successfully.

In the past year, I have struggled with changes in public policy affecting my ability to do what is so obvious should be done. Multiple science teacher candidates for whom I am advisor have been to my office and identified themselves as children of undocumented immigrants asking for guidance with the fate of DACA uncertain. They want to go back to the communities in which they grew up (from a very young age) and teach science, often in schools where others do not want to teach. They are afraid that this will not be possible.

I received a letter from the New York State Office of Higher Education that given the "range of changes being made to federal funding… [we] do not expect to issue a new RFP… once the current funding ends" in 2018. We have received funding from this program for the past 10 years to support science education in inner-city schools. Among other projects, we have provided free course work, on-site support, and over $75,000 of laboratory supplies to over 110 middle school science teachers throughout NYC, including to the school district where my mother taught at PS 4 across the street from Crotona Park in the Bronx. I have been informing schools and participants for the last six months that this program is now ending.

I go to countless faculty and college-wide budget meetings looking for a strategic plan as City College wrestles with challenges such as crumbling facilities, cuts in personnel, and ever-growing class sizes. We recognize how current changes in federal tax policy are almost certain to exacerbate budget shortfalls. It is not clear what will happen next.

With the above as a backdrop, I asked informed physicists to share their perspectives about the current state of the intersection of government policy, science, and education. My goal in doing so was to learn, share, and hopefully facilitate positive change. I am so impressed with the cross section of contributions that follow. I am also in great appreciation of all that these individuals do.

1. For a more detailed account of the information here and the motivation for this theme, go here.

Forum on Education Sessions at the Upcoming 2018 APS March Meeting (March 5-9, 2018 in Los Angeles, CA)

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

The program for the APS March Meeting is now completed. Sessions sponsored by FEd or of interest to FEd members include:

The **Reichert Award Session** (Session C43) will feature the Reichert Award recipient, Kurt Wick from the University of Minnesota, and other speakers discussing advances in Advanced Laboratory education. The **How to Get a Job: Expanding Career Perspectives for Physicists Session** (Session E43) addresses the issue of careers for undergraduate and graduate students in physics. It will feature speakers from industry, national labs, a primarily undergraduate institution, and speakers who have taken alternate career paths. It is particularly appropriate for the many student (graduate and undergraduate) attendees at the meeting. Thanks to organizer Chuhee Kwon. The **Diversity and Inclusion in Graduate Education Session** (co-sponsored by the Division of Materials Physics) (Session K16) will feature speakers discussing programs designed to change physics graduate education so that it is more diverse and inclusive. Thanks to organizer Monica Plisch. The **Effective Practices for Student Career Preparedness and Departmental Programmatic Assessment Session** (Session R16) addresses recent efforts to improve physics undergraduate education, including talks on 21st century careers and outcomes, Physics Innovation and Entrepreneurship Education, and effective practices in undergraduate physics programs. Thanks to organizers Crystal Bailey and Ted Hodapp.

Other sessions at the March meeting of interest to Forum members include the four Undergraduate Research contributed paper sessions (A06, B06, C06, and E06), the two Topics in Physics Education contributed paper sessions (F20, H20), and the poster session (G60) which includes both undergraduate research papers and physics education papers. FEd is also co-sponsoring the DMP session on **The Physics of Life** (L42) where speakers will give general talks about contemporary approaches to solving grand problems in biology using a physicist's approach.

The April Meeting program is in the final stages of completion and session topics were mentioned in the Fall newsletter. Further details will be forthcoming.

Excellence in Physics Education Award Reaches Full Endowment

Randy Knight, California Polytechnic State University

The Excellence in Physics Education Award is the American Physical Society's highest recognition of outstanding contributions to physics education. The award, established in 2007, recognizes and honors a team or group of individuals (or, on exceptional occasions, a single individual) who have shown sustained commitment to excellence in physics education. The award consists of a $5,000 monetary award, a travel allowance to the April APS Meeting where the award is presented, and a certificate citing the achievements of the winners.

The initial fundraising effort, ten years ago, was sufficient to establish the award but not to fully endow it; the FEd has been subsidizing the award out of its yearly operating budget. In 2016, the FEd Executive Committee appointed Wendy Adams, Andrew Heckler, and Randy Knight as a fund-raising committee charged with increasing the endowment from $135,000 to $200,000, the level needed for full endowment.

We succeeded! Approximately 20 donors made contributions following an appeal in Spring 2017, capped by exceptionally generous gifts from Carl Wieman and Sarah Gilbert and from the Sciences Education Foundation of General Atomics (former FEd chair Lawrence Woolf is President of the foundation).

Our heartfelt thanks to the many donors – both in the initial fund-raising phase and in this final push – who have helped to ensure that APS will continue honoring outstanding contributions to physics education for many years to come.

Director's Corner

Theodore Hodapp

As an academic, it is easy (and necessary much of the time) to focus on our personal space: teaching and research. The issues are all around us, and confront us directly: what topics to discuss in class, what approach to use in a measurement, etc. Despite this, there is a policy and political action terrain that impacts our efforts to practice, teach, and learn physics – an action landscape we may want to avoid (politics are irrational), or feel ill prepared to encounter (never took a course in this). Having waded into this arena a few times, I can tell you that not only will it reinforce the more urgent goals you have for your research and students, but it can also give you a sense of improving things on the larger stage.

Let me share a story of how this unfolded for me back in the mid 90's. For some unknown reason I became aware that the State of Minnesota was about to toss out teacher licensure by discipline, and adopt a set of policies that would allow the state to license just about anyone to teach just about any subject in science at just about any grade (5-12, all science). This seemed ~~stupid~~ short-sighted to me, so I wrote a letter, and got a bunch of other people in the state to agree (several hundred faculty at institutions across the state). To make a long story not nearly as boring, the end result was that I, along with Pat Heller at the University of Minnesota and a bunch of others ended up writing all teacher-certification standards for the state. It was not what I had planned to do that year, but I learned a lot, listened respectfully to people who controlled such things, and offered rational solutions that dovetailed with their needs. All of us also felt like the system could work, and we could be a part of it.

So, my suggestion to you is: don't shy away from wading into conversations on state or federal policy. Do visit your elected officials when you are in Washington DC, or even better, back in your local area. Do write letters to the editor. Do participate thoughtfully in discussions of how education and science is managed. Do listen, and do offer your help – you might be surprised at how willing people are to hear a reasonable and thoughtful solution. I know I was.

I Believe in Science

Andrew Zwicker, Princeton Plasma Physics Laboratory and 16th Legislative District of the New Jersey General Assembly

The Trenton War Memorial is a national historic site overlooking the NJ Statehouse and dedicated to "beauty, dignity, and civic utility" in honor of those who died fighting in WWI. On April 22, 2017 which was, not coincidentally Earth Day, I stood on those grand steps in front of a podium getting ready to speak looking out at thousands of people who had gathered together in solidarity with the many thousands of people gathered around the country and the world for the "March for Science."

I stood at the podium looking out at the assembled crowd and opened my remarks with, "Hello to all you fact checking, evidence seeking, science believing, Earth loving people out there." I spoke about how I was angry and frustrated by the lies about scientific results that didn't fit a particular political point of view, how I was horrified by the attacks on scientific principles, deeply concerned about the proposed federal funding cuts, and outraged by the attempts to stop scientists from speaking out on climate change.

For some scientists, there was a deep philosophical concern about whether or not to even participate in a March for Science. That doing so politicized science when we know that scientific results and the scientific process have never been about politics. That evidence has no association with any political party and facts are never alternative. However, a few years ago, I decided to live in both the world of science and the world of politics. I felt strongly that we needed more scientists to participate in the political process and that I had to start with myself. (I've written about this decision and my political journey that resulted in becoming a member of the NJ Legislature in 2016 in the November, 2017 edition of the *APS News*.)

Neil deGrasse Tyson has said, "The good thing about science is that it's true whether or not you believe in it." Of course that is correct, but it is also clear to me that it is not enough. Today, we live in a time where misinformation and an attack on scientific principles has become a part of the daily news. We live in a time when there is still an astonishingly large number of people that believe the Earth is flat, that humans and dinosaurs lived at the same time, that Darwin's theory of evolution is not the best explanation we have for the origin of organisms. We live in a time of nearly instantaneous communication, of ubiquitous social media posts and the ability to "Google" any question conceivable. Yet all of this information, as powerful as it is, has added to the confusion of who to believe, what to believe, or even why to believe.

Twenty years ago, Carl Sagan wrote, "We've arranged a global civilization in which most crucial elements profoundly depend on science and technology. We have also arranged things so that almost no one understands science and technology. This is a prescription for disaster. We might get away with it for a while, but sooner or later this combustible mixture of ignorance and power is going to blow up in our faces."

I don't know what you think, but when thousands of people in Trenton, NJ and across the globe come together to march for science I believe it is because, in part, that Sagan's prediction has come true.

A few months after the March for Science, I was in the NJ Statehouse for a hearing on the status of NJ's train system. We were there to hear from witnesses about train safety and the decaying infrastructure of our rail system when, near the end of the hearing, a group of parents made a presentation against a proposal by a local utility company to run a new high voltage line along the right-of-way of an existing rail line. The group was well-prepared and had clear and logical arguments about their concerns of suspending a high voltage wire directly above a commuter train and the potential impact on property values along the route from the 100 ft high towers that would be erected for the power line. What got my attention, however, was when they brought up their concern about an increase in childhood cancer rates from the proposed power line. When I pointed out that there has been numerous studies that have shown that the correlation is either zero or extremely small and pointed out to them that the magnitude of a magnetic field from this power line would be less than what is generated by a typical household appliance, their reply was that they disagreed with me but "respected my opinion."

My opinion? Since when did referring to peer-reviewed studies and calculating the magnitude of a magnetic field become a matter of opinion?

The politician and the parent in me understands that these advocates were expressing their deeply held concerns about the safety of these power lines. I, too, want to do everything in my power to keep children safe. The scientist in me understands the data used to reach the conclusions from the various studies and the implications from the uncertainty in the studies. Given the deluge of information that bombards us every day, it has become even more difficult to determine what scientific results to believe.

Cancer and power lines. Vaccinations. Alternative medicines. GMO food. Climate change policy, and so much more. So what should we, the scientific community do?

There is no easy answer to what is a large and difficult problem. But I'd like to offer one suggestion that I believe has the opportunity to make a significant difference. We, the scientific community, have to make a more concerted effort to improve and increase the dialogue between scientists and the general public. One of the things that I learned early in my political career is that genuine dialogue between divergent opinions is by far the most efficient way to come to an understanding. And given the divide between much of the general public and science, the more ways we do that and the more of us that do that, the better. For example, if you haven't already, give a public lecture on your research. The key is not the lecture itself, when we tend to simply read our powerpoint slides out loud, but in the Q&A afterwards. That's when there is a chance for a true dialogue. If you want to go further, help organize a public lecture series or a "Science Cafe." Use your scientific training to learn the details of topics with difficult public policy implications, even if they are not in your field of expertise. Then, make an appointment with your elected officials at the local, state, and federal level to talk about the importance of your own research and offer to consult on any scientific or technical public policy issues. In the end, do what you are comfortable doing but make sure you do something. It won't change things overnight, but the cumulative effect will make a difference.

My dual life as a scientist and a politician has brought me to the conclusion that there is no more important time than now to make your voice heard. That we must all work to ensure that peer-reviewed science is funded, that scientists are free to work on their research, free to publish their research, and free to speak out on their discoveries. If we don't fight for this, who will?

Andrew Zwicker is the head of Communication and Public Outreach at the Princeton Plasma Physics Laboratory, and a member of the New Jersey General Assembly representing the 16th Legislative District. He is a Fellow of the APS, Past-Chair of the Forum on Physics and Society (FPS), was editor of the FPS newsletter "Physics and Society," and was Past-Chair of the Mid-Atlantic Section.

Science in an Era of Trump

Michael Lubell, City College of New York

If you believe that science is under attack by the Trump Administration, you're probably correct. But if you believe that science and technology had nothing to do with President Trump's election, you're probably wrong. I'll deal with that shortly, but first, let's look at the status of science in the Administration.

Donald Trump has yet to appoint a science advisor, and the odds are growing that he never will. The Office of Science and Technology Policy, which was a beehive of activity during the last seven presidencies, is virtually abandoned property in the Eisenhower Executive Office Building.

Even though the White House renewed the charter of the President's Council of Advisors on Science and Technology at the end of September, it has yet to fill any of its seats.

The Center for Disease Control sent out an advisory to its staff not to use the phrases "science based" and "evidenced based."[1] The Environmental Protection Agency (EPA) has removed academic scientists from its advisory committee and replaced them with industry shills.

The White House has eliminated offshore drilling-rig regulations put in place to minimize the risk of another Deepwater Horizon blow out. Remember that is the one that devastated the Gulf Coast in 2010 and cost BP, which owned the well, an estimated $62 billion.

The EPA has lifted controls on coal ash dumping into rivers and streams and has rolled back emission limits on coal-fired power plants.

President Trump calls climate change a hoax and has said he will withdraw the United States from the Paris Climate Accord in 2020. He also threatened he will no longer certify Iran's compliance with the 2015 multi-nation nuclear deal, even though the International Atomic Energy Agency has reported there is no evidence – oops there's that forbidden word – Iran has violated its commitment.

Ernie Moniz, a superb nuclear physicist, who was then Secretary of Energy, was instrumental in developing the terms and safeguards in the Iran agreement. If any international negotiation was science based – oops, another no-no – it was that nuclear deal.

There's plenty more to be said, especially about the quality of many of the people the White House has appointed to the science and technology positions it has actually found time to fill, but space limitations prevent me from doing so. Also, I don't want to besmirch reputations of people whose only failings are their lack of science and technology credentials.

But I would be remiss if I didn't comment on the potential science and education impacts of the tax bill the president signed into law in December. By saddling the nation with an immense deficit – close to $1.5 trillion over ten years according to the Joint Committee on Taxation – the bill will constrain discretionary spending from which research and science education draw their support. And by capping deductions on state and local taxes (SALT) at $10,000, the bill may ultimately force many states to ratchet back their support for education, especially higher education.

Now let's move on to the role science and technology played in electing Donald Trump. There's no evidence – I just can't avoid using the word – that scientists voted for him in great numbers. In fact, I haven't found a single one who admits to doing so. But there's ample evidence that science and technology helped lay the groundwork for Trump's victory.

I didn't see the connection when I first forecast that Hillary Clinton would have a really tough time beating Donald Trump. I wrote about it in the late spring of 2016, even as polls were showing she had a big leg up.

At the time, Trump had enough delegates to secure the Republican nomination, and with her lock on "super-delegates," Hillary was the certain Democratic standard bearer. For each party, the candidate die was cast, but for me, so, too, was the electoral outcome.

Even though my home state of Connecticut was solidly in the Clinton column, away from the cities and Fairfield County's "Gold Coast," Trump's "Make America Great Again" lawn signs were evident everywhere. I spoke to some Trump voters in Connecticut and other states and asked them why they were supporting him.

Most said they were struggling economically. Most said they felt abandoned. Most said they had lost faith in government. And most said they were willing to roll the dice and "shake up the system." They didn't necessarily agree with policies Trump was trumpeting – many of them had no idea what they were – but they found his belligerency, bellicosity, bullying and lack of political correctness refreshing.

I concluded Trump was tapping into populist anger, and Clinton, to her enduring peril, was floating above it. Although he was a billionaire, at least by his own account, his supporters saw him as one of them. Clinton, by contrast, they saw as an elitist, finagler, befitting Trump's "Crooked Hillary" label he pinned on her,

The difference in voters' perceptions of the two candidates ultimately led to Trump's victories in Pennsylvania, Ohio, Michigan and Wisconsin and with them, his Electoral College majority. I had foreseen the populist uprising, which was actually manifest in the 2010 Tea Party movement, but I hadn't yet understood its origin.

After the election, as I tried to sort it all out, I began looking at data: productivity, wages, jobs and the economy. The numbers told a compelling story. The conventional wisdom was that globalization and trade deals had undercut jobs. There is some truth to that, but the story is more complex.

For a quarter of a century following the end of the Second World War, wages fairly well tracked productivity. To be precise, between 1948 and 1973, productivity increased 96.7 percent, and hourly compensation of non-supervisory workers corrected for inflation, rose 91.3 percent, according to the Bureau of Economic Analysis and the Bureau of Labor Statistics. But between 1973 and 2014, while productivity continued to climb, rising another 72.2 percent, hourly compensation rose by a mere 9.2 percent.

Over that latter period, as the growth curves diverged, there were hardly any blips. The trend lines were remarkably featureless, and the divergence simply grew.

It's hard to see how trade pacts had anything to do with the phenomenon until the mid 1990s. The first multilateral treaty, the North American Free Trade Agreement (NAFTA), signed by the United States, Mexico and Canada, didn't kick in until 1994. It might have depressed manufacturing wages as a number of production plants moved to Mexico in the aftermath, but it couldn't have accounted for the productivity-wage divergence prior to that.

Globalization undoubtedly played a major role. Cheaper labor in countries like China led manufacturers to relocate plants overseas. But without technology, the monetary savings would have been substantially less. Containerization – an engineering achievement – reduced overseas shipping costs, and information technology coupled with rapid growth of satellite communication provided a critical seamlessness that would have been unimaginable without them.

At home, the increasing use of automation also depressed wages, as machines began to displace workers. Machines were cheaper, didn't require maternity or paternity leave and didn't burden HR offices with personal problems. The displacement of workers has accelerated in the last decade, as the price of robots has dropped dramatically and artificial intelligence has begun to make its mark.

Price Waterhouse Coopers last March projected that automation would result in the loss of almost two out of every five American jobs by the middle of the next decade. New jobs might appear in large numbers, but they will require different skills, especially STEM skills, and will likely be located in different geographic areas than the places where jobs vanished.

Manufacturing and coal mining have led the way in permanent job dislocation. And the states and localities where they once dominated were the hotbeds of the populist revolt. People there not only lost their jobs, they also lost hope their condition would ever improve. They voted for Trump in large numbers, buying into his false promise that he would bring back manufacturing jobs from overseas and reopen shuttered coal mines in Appalachia.

He sold them on the restoration of manufacturing jobs by promising to abandon NAFTA and nixing the Trans-Pacific Partnership. He sold them on bringing coal mining jobs back by demonizing climate change and blaming environmental regulations on the closure of coal-burning power plants.

But the reality is that even if some manufacturing returns from overseas, robots will replace many of the workers in the new factories and assembly lines. As for coal, cheap natural gas has been the culprit. And it's "fracking" and, more importantly the horizontal drilling technologies, that have made natural gas so cheap and consequently the preferred energy source for electricity producers. Donald Trump has a long history in real estate and other business enterprises of promising miracles but delivering bankruptcy as the outcome six times. The promises he made to his base are likely to result in similar failures. The question is, how will those people react?

The despair they feel is evidenced in the opioid crisis. And the anger and disillusionment they have continued to experience explain their unwavering support for Donald Trump. Once they see that technology is the cause of their plight, will they turn on scientists and academics, whom they already see as the privileged elite, or will they look for another false prophet, perhaps one with even greater autocratic tendencies?

Scientists can help tip the balance by leaning on policymakers and elected officials to plan for a future in which large number of American workers will be permanently displaced from the jobs they currently hold or have already lost. After all, scientists understand the impacts of technology better than most people.

Helping to guide policy on an issue of such profound importance is not only a moral imperative, it is one of self-preservation. If the public turns on science – and there is evidence from recent polling that support for science is an inch deep – scientists might find themselves in the same jobless predicament. It's time to shed the cloak of superiority and elitism and work for a more equitable future.

Michael Lubell is the Mark W. Zemansky Professor of Physics at The City College of the City University of New York and the former director of public affairs of the American Physical Society. His new book, "Navigating the Maze: How Science and Technology Policy Shape America and the World," is scheduled for publication later this spring.

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Education Policy was a Gas in 2017

Eric Brewe, Drexel University

The Education Policy Committee (EPC) is a sub-committee of the Committee on Education (COE) of the American Physical Society (APS) charged with providing advice and suggesting actions for COE, APS Leadership, and the APS Office of Government Affairs on matters of education policy. The membership includes the Current Chair of COE, representatives appointed by Forum on Education, the Topical Group on Physics Education Research and three by Committee on Education. In addition, ex-Officio members include APS staff from Education and Diversity and Office of Government Affairs, and advisors from the Panel on Public Affairs. The chair of the EPC also sits on the Physics Policy Committee as an ex-officio member.

Three policy priorities guide the work of the committee, and are updated annually. Coming into 2017, the priorities included:

- Ensure all high school students have access to a year of high quality physics.
- Promote widespread use of evidence-based education practices throughout the undergraduate physics curriculum.
- Increase the participation in physics in the broadest possible ways.

The work of the EPC in 2017 was wide ranging and collaborative with APS's Office of Government Affairs (OGA, formerly Office of Public Affairs). It has been a challenging year, as the current administration has failed to fill posts that have been influential in science and science education policy in previous administrations. The Office of Science and Technology Policy (OSTP), an office previously led by physicists with a deep interest in education, is currently operating without a Director and with a much smaller staff than previously. Other offices, including those in the Department of Energy, have also had reduced staffing. This is important in the work of the EPC, as the OSTP has been a friendly organization and willing to work on policy issues.

As Chair of EPC, during this year I learned a great deal about the nature of advocacy work. I liken it to a gas in a container where policy advocates are like the molecules and governmental agencies are the walls of the container. Gasses exert pressure when multiple molecules collide with a wall. Each individual molecule might feel like they did not contribute to the overall pressure, but when there are enough molecules colliding the pressure increases and the walls bend a bit. Conversely, if individual molecules stop colliding with the wall, the pressure drops.

Through the EPC and OGA, we had a number of coherent efforts to collide against the wall. The two biggest efforts included budget advocacy. The first came during the drafting and voting on appropriations bills. The House Bill removed funding for Title II of the Every Student Succeeds Act, which had previously included $2.1 Billion in funds for teacher professional development. These funds had previously been accessed by PhysTEC, UTeach, Modeling Workshop Project, and the Learning Assistant project. Thus, it was a good candidate for action as it fit well with our policy priorities. OGA organized two congressional visits by 2017 APS President Laura Greene and me to members of the House and Senate who sat on their respective Appropriations Committees. We met with staffers who noted our visit, and to various degrees, sympathized with the need to provide funds for teachers. Following our visits, the Senate bill included the full $2.1 Billion for Title II. We cannot be sure that it was due to APS members crashing into the wall that the Senate reinstated funding for Title II, but this is the nature of advocacy work. The House and Senate will next conference to determine the final version of the bill, but from our conversations on the Hill, it is likely that the Senate's version will prevail.

A second substantial effort, orchestrated by OGA, was a letter writing campaign in response to the tax bill. The House version included a potentially catastrophic tax on graduate student tuition waivers. OGA provided links to send letters to representatives and senators in partnership with the Forum on Education, Forum on Graduate Student Affairs, and Forum on Early Career Scientists. Through this initiative APS members sent over 6800 letters to Congress, and ultimately the tax bill did not include a tax on graduate student tuition waivers.

In addition to specific efforts, in the EPC ex-officio position on the Physics Policy Committee, we have the opportunity to weigh in on policy statements, board statements, and presidential statements. This year we advocated statements on UNESCO, support for ARPA-E, H1B Visas, Federal Funding for Research on Gun Violence, FY18 Budget, Racial Violence, and APS's position on the March for Science. APS has been active on a variety of fronts, and the weight of the membership truly amplifies APS's voice.

There are ample opportunities to engage more members of APS in education policy initiatives. If you are interested contact the Office of Government Affairs, Forum on Education, Topical Group on Physics Education Research, or members of the Education Policy Committee. Remember, the more we crash into that wall the greater the pressure we can exert.

I'd like to thank and acknowledge Greg Mack, Francis Slakey, Laura Greene, Ted Hodapp, Monica Plisch and members of the Education Policy Committee: Noah Finkelstein, Rachel Scherr, Tim Stelzer, Scott Franklin, Laura Henriques, and Michael Marder for their efforts and commitment to crashing into the education policy wall with me this year.

Eric Brewe is an Associate Professor at Drexel University and served as Education Policy Committee Chair during 2017 and 2018.

Personal and Professional Engagement in Education Policy: Roles of Individuals and the American Physical Society

Noah Finkelstein, University of Colorado Boulder

In the late 1990's while at the University of California, two students with whom I worked closely in physics classes and community-based programs approached me both to celebrate our successes in building thriving educational programs in physics and to let me know they would likely have to leave school. Recent federal legislation would force them to pay out-of-state tuition, despite their living almost their entire lives in California; they were not eligible for federal financial aid. Their parents had brought them as infants to U.S for a better life; however, a system that once supported undocumented immigrants shifted to exclude these remarkable students. They informed me about moves to create a state response and helped build what would become the DREAM Act.

While I was busy building and studying programs to support all students' access to, engagement with, and success in doing physics, larger structures were at work that impacted my (and our collective) abilities to achieve these goals. I began to realize our classroom and community-based work in physics do not sit in isolation but were deeply connected to broader social and political enterprises. This coupling is even yet more apparent today.

From this understanding, I started to argue (to whomever would listen) that higher education is one of the essential forms of infrastructure for the welfare of both individuals and our society. While the dominant rhetoric around the benefits of higher education is about workforce development, the role of education is far greater. It empowers individuals – supporting healthier, longer, enriched, more community-based lives. It simultaneously empowers our society as the locus of knowledge generation and curation, a locus of cultural knowledge and advancement. But what had stood for many decades as a social, collective good, has shifted to being considered a private personal opportunity and commodity. The burden of paying for schools has shifted from the collective to the individual, and commensurately, the value and worth of higher education is being challenged.

Making the case for, engaging in, and fostering this essential social and individual good, sits at the intersection of science, policy, and education.

Disciplinary societies, including the American Physical Society, and their members have an opportunity and obligation to advance educational policy. We matter. Of course APS has a large constituency of roughly 50,000 members. We are distributed across the country which allows us, should we engage, to reach all members of congress, as well as state and local legislatures. Finally, we have unique and valuable perspectives from within the disciplines – The domain of physics has been, and ought remain a key tool for advancing our society; simultaneously, we are the ones grounding our work in the classrooms, laboratories, and research labs in manners that contextualize and personalize the larger scale perspectives (that can otherwise remain generic).

An afterschool science program built with university students

Of course, when done best, this policy work occurs in collaboration other professional organizations (such at AAU, APLU), societies, and stakeholders.

The APS has longstanding history of such involvement and engagement and I encourage your participation. It was based on calls from the Education and Diversity office of APS that I stepped up in the early 2000's to work with my US Congressional delegation advocating for retaining (if not increasing) funding for the National Science Foundation; notably the Education and Human Resources division was under threat of being entirely eliminated. Answering this call for action, I engaged in regular interactions with my congressional staff that started with cold-calls. As a result, a bipartisan group of senators offered a written statement and oral testimony to the Senate about the value of STEM education and evidence-based instructional practices that have been supported by NSF, and spoke about their grave concerns about funding. This was prior to and may have helped the establishment of 2007 America COMPETES Act which sought to enact the calls of the National Academies' report Rising Above the Gathering Storm.

Following, with lead APS staff (Ted Hodapp and Monica Plisch (APS education), Frances Slakey, Tyler Glembo and later Greg Mack (OGA)), we worked in concert with the White House Office of Science arguing for both pragmatic actions and lofty ideas, such as investing billon dollar scale funds to establish regional centers to advance our STEM education infrastructure. We simultaneously, partnered with the US Department of Education to place interns and fellows to support a push for STEM education that the Department was understaffed for. All of these approaches were designed to create federal support for the educational efforts and programs we have shown to work in physics.

In parallel efforts, I spent time working with the House Science, Space and Technology Committee during the COMPETES reauthorization of 2010. I invoked and shared the significant impacts of the physics education research community to argue for evidence-based practices. Through this committee work, we successfully secured increased funding for graduate fellowships, revived a key postdoc program, and broadened the funding base for NSF's EHR. That was just the Committee outcomes however… Learning a lesson that politics can undermine policy, most of the innovative approaches of the bill were scuttled on the House floor.

As such, we adapt.

While remaining involved in and arguing for action at the federal level, we appear to be in a new landscape where the current climate is not one of central, federally driven policies, despite their history of seeding great advances in higher education and science. Now is more of a time to engage in strategic regionally based work that collectively adds to and supports productive federal action. And, indeed, unfortunately, we must engage in collective work to stave off bad federal policies. A remarkable recent example is contributing to maintained status of tax-free graduate stipends. I'm so proud of the thousands of APS constituents, including many of the graduate students I work with, who called, emailed and petitioned their representatives; I'm very grateful and impressed with the tireless efforts to the APS staff and offices (Slakey and Mack) who empowered our community to make this difference.

While we adapt to the changing goals and processes of engagement, one thing that remains is the power and impact of the American Physical Society.

APS provides a host of ways to get involved. http://www.aps.org/policy

There is no effort that is too small… and of course there are grand

2010 Congressional Testimony on the America COMPETES Act

efforts — there are a variety of federal reauthorizations under way, the Higher Education Act and America COMPETES Act, both of which have significant impacts on physics and education. Locally, because of successful work from APS members and staff, Title II funds are potentially available for the remarkable work in education that APS has developed (such as PhysTEC) – these are now local decisions, where you can influence your state on gaining access to these federally allocated funds.

What are your issues? It sounds like it is time to work on the DREAM Act once again. We must get and stay involved.

I encourage you to volunteer to work on policy priorities as outlined in the letter from Eric Brewe, the chair of the education policy committee, or to consider joining the education policy committee, or provide the committee suggestions of areas to work on.

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Engaging with Others Across Divides

Stamatis Vokos, California Polytechnic State University, San Luis Obispo

On Christmas Eve 1914, British and German soldiers stuck in dreary trenches stopped killing each other long enough to sing carols together, share drinks, and wish each other Merry Christmas. (The superior officers soon moved the troops to new positions, alarmed at the fear that the determination to kill might be dampened when one has treated the enemy as a human being.) In 2018, our country is ravaged by political tribalism in which not even facts can be agreed upon, anti-science sentiment pervades our national policy debates, and dreary entrenchment scars the landscape.

Question: How should we engage in dialogue with others, including public officials, who do not necessarily agree with us on issues of science or science policy? Answer: Pedagogically. I confess that although this answer makes perfect sense in English, my Greek side reminds us that in such interactions we are not "leading children," which is what pedagogy means. We are to be approaching adults as intelligent and moral agents. This article is about considerations to bear in mind as we converse with others, equipped with the curiosity, knowledge, and skills of educators who are convinced of the inherent productivity of their interlocutors' ideas, even when we can see that the ideas themselves are factually or scientifically flawed.

In the last fifteen or so years, I have had the opportunity to participate in a variety of dialogues across epistemic tensions. After 9/11, I was part of a panel of members of different faiths who—while avoiding the facile (and false) "All religions are the same" motto—communicated the unambiguous message that although every religion can be and has been historically hijacked by extremists, extremists do not speak for the inner beauty and outward positive manifestations of religious faith. In the following dozen years, at the invitation of my students, I dialogued with their pastors who preached erroneously, in my opinion—on both scientific *a*nd theological grounds—that human evolution is incompatible with scripture. I have co-taught honors courses on the complex two-thousand-year interaction of natural philosophy and science with Christian theism. I have taught physics to Tibetan Buddhist monks in India and discussed scientific, Christian, and Buddhist epistemological points with senior Buddhist monks. I have taught professional development courses to science teachers about the energy balance in the atmosphere and the impact of warmer oceans on extreme weather events, giving them scientific tools to use with their students and their students' families. I have used multiple physics education efforts in the Middle East as a vehicle for developing critical thinking and evidence-based reasoning skills. I have worked with K-20 systems that interpret the needs of teachers and students of physics in profoundly different ways than I do. And I have attempted to understand physics learning environments in which more students, especially women and persons of color, can thrive.

Twenty years ago, I thought I had all the answers to the framing question above. Nowadays, I believe that I have few answers but I have instead struggled with some important points that may be worth sharing.

1. **Benefit to the other person**
   The research literature on conceptual change documents that human beings have good reason to believe what they believe. We know that star baseball pitchers achieve greatness despite believing that "their force on the ball runs out."

   We need to seek to understand what benefit will accrue to the other person (student, politician, school board member, community member) if they were to change their mind. Why do they believe what they currently believe? What do they gain from this perspective?

   The word *why* here is often not a causal, mechanistic why. Rather it signifies an invitation to try to put oneself in the other person's skin to understand their reward structure and to attempt to feel what they feel.

2. **Potential loss to the other person**
   We do not usually change our minds under psychological stress. When emotionally challenged, we tend to dig in and defend our point. There is an evolutionary advantage to this. Having decided that we will not flee or freeze, the mind goes into a fighting mode, which is hardly a promising physiological setup for perspective-expanding stances.

   We need to seek to understand what is at stake for the other person. What precious thing do they feel they would have to give up in order to consider our position seriously? People are very unlikely to adopt a worldview that threatens one of their core identities.

   In our research on student understanding of the relativity of simultaneity, Rachel Scherr discovered that advanced special relativity learners (including graduate students and physics faculty who had not thought about the subject in many years) became silent—totally still—when confronted with the unbelievable implications of the train paradox. Having faced several intellectually unpalatable possibilities, they were deeply preoccupied with trying to identify *which* of their commitments they could afford to give up and which they should retain at all costs. Similarly, in a physics classroom, an evangelical student or a woman or a person from a minoritized community might be trying to reconcile what they think are two irreconcilable, for them, positions. A physicist who expresses themselves without appreciating the identity-type *Sophie's Choice* nuances that the interlocutor may be facing can do psychological violence to them in the short term, and most surely does little to help them re-organize their internal understandings in a way that does justice to all parts of that person's worldview.

3. **The appropriate role of evidence**
On one hand, we can all agree that either we landed on the moon, or we didn't. (Similarly, either he used an expletive or he didn't.) On the other, physicists of all people know that data never speaks for itself. When I was a teenager disputing the time my sainted mother claimed I had returned home the previous night, I loved to remind her that Nietzsche presciently had said that there are no facts, only interpretations of facts. This statement on its face may be the hardest thing for a physicist to swallow, especially in a political climate that seems to disparage scientific evidence. And yet, if data alone were sufficient to change someone's worldview, no physics faculty would doubt the implications of the vast body of research results on the learning and teaching of physics. As a teenager, I had an agenda—I was not interested in agreeing with my mother. It is clear that some people—of all persuasions—manipulate, deny, or distort certain facts in service of a particular agenda. But most people do not. Most of us just subconsciously cherry pick data that agree with our foregone conclusions.

We need to find out through continuing dialogue what the other person cares about and which type of argument works with them, fully realizing that no single argument will work for everyone. Unless data is part of a convincing overall narrative, data will rarely do the trick. PER has taught us that instructors cannot exorcize a "misconception" without allowing a student to reflect on their ideas in the context of a new, student-constructed conceptual framework.

4. **The ineffectiveness of derision**
Lecture full of righteous indignation is rarely effective rhetorically. Every teenager knows this but many of us tend to forget it. I have listened to many lectures presented by otherwise stellar, wildly popular physics and astronomy communicators whose undisguised contempt, however, for some of their audience members' values did not allow the speaker to engage with the substance of their listeners' concerns or doubts.

We need to approach others with the human dignity they deserve. In the context of the extreme current political polarization, most of us—including yours truly—have fallen in the trap of deriding others. Any diminution of our interlocutors' human dignity transforms our noble scientific motives into a desire to win the verbal or political contest by defeating what we consider as the opposition's lame, ignorant, self-inconsistent, self-serving, duplicitous, and hypocritical arguments. Our rising anger, sense of self-righteousness, and feeling of intellectual or moral superiority fuel this desire and further pervert our motives from wanting to crush the opposing argument into wanting to crush the opponent.

Galileo putting the words of his erstwhile admirer Pope Urban VIII in the mouth of a character he called Simplicio (Simpleton) was probably a greater influence in the Galileo episode than the scientific debate. When approaching sensitive issues we need to understand deeply the perspectives of others and reflect their ideas and arguments in the most positive light for our conversation partners to take us seriously and feel heard and understood.

5. **Our professional responsibility**
Ultimately, we need to own up to one thing. The main reason why most physicists who are not climate scientists believe in anthropogenic global warming or the discovery of the Higgs or the dawn of multi-messenger astronomy is not because we all understand the ins-and-outs of the LHC Monte Carlo simulations or the LIGO sensitivity curves or the inner guts of climate models. We believe in these things because we *trust* our colleagues and we *know* first-hand how scientific sausage is made. We believe in these things while we also allow for new developments and are thrilled, rather than crestfallen, with the prospect of new physics. We believe in these things because we are cultural natives in a science-y (and physics-y, in particular) way of being. This cultural immersion did not come to us by solving kinematics equations or drawing free-body diagrams. It came from being in the lab for hours tending to an experiment that stumped us. It came from wastebaskets full of calculations. It came from poring over video data of students working together and messy interview transcripts with coding schemes that ended up being contradictory. It came because we engaged in authentic scientific practices. It came from developing well-deserved trust with the people down the hall. We developed scientific habits of mind and habits of practice over many years in a community of apprenticeship.

If we want policy that is consistent with science we need to work smarter in educating the future policymakers. They don't need scientific facts only. They need to understand deeply how the scientific community makes progress. And they can only understand this as learners by participating in the authentic cultural practices of our community.

In the long run, if we want citizens who are critical thinkers we need to rethink our physics teaching. We claim that we teach people how to think. An assessment of the public square indicates that *all* of "them" are products of "our" education. We failed them the first time around. In our continuous engagement with them, for the sake of democracy, science, peace, and human thriving, let us not fail them again when we engage in dialogue.

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Section on Teacher Preparation

Teacher Preparation Section

Alma Robinson, Virginia Tech

The fall issue of the Teacher Preparation Section highlighted research on STEM student's attitudes and opinions of teaching: The APS Panel on Public Affairs report and the Perceptions of Teaching as a Profession (PTaP) assessment. This issue will continue that conversation while also addressing the theme of government policy, science, and education.

At the Colorado School of Mines, Kristine Callan, Wendy K. Adams, and Lacy Cleveland have created "Mythbusters", an interactive presentation that helps debunk the misperceptions of the teaching profession. Because these misperceptions are so widely held, they have developed two programs, one geared towards students and one geared towards faculty and staff.

Gay Stewart, of West Virginia University, challenges us to think deeply about how policy changes could help ameliorate the state shortages of highly qualified STEM teachers. In particular, she discusses the accreditation of teacher preparation programs, the admission requirements for certification programs, and the effects these policies have on the potential pool of future physics teachers.

MythBusters: Interventions to Address and Correct Misperceptions About the Teaching Profession

Kristine Callan, Wendy K. Adams and Lacy Cleveland, Colorado School of Mines

A recent study[1] revealed that about half of STEM majors reported some level of interest in becoming a high school or middle school teacher, indicating a large recruiting pool. In contrast, physics, chemistry, and mathematics are rated "considerable shortage" areas for new teachers, demonstrating that the demand for open positions far exceeds the supply.[2] These seemingly inconsistent pieces of data can be understood in light of research that was highlighted in the last edition of the FEd newsletter.[3,4] These articles present research that has identified strongly held beliefs about the teaching profession, many of which are misperceptions. Further, these misperceptions discourage STEM undergraduates from exploring teaching as a viable career option. Study results also suggest that college and university faculty in STEM departments either do not mention middle or high school teaching as a career option or inadvertently misrepresent the profession. To encourage discussion, and to change the conversation at both the Colorado School of Mines (Mines) and the University of Northern Colorado (UNC), we have implemented an information campaign we call "MythBusters."

Mines is a public applied science and engineering university that prides itself upon their students' high job placement success and the ability of their graduates to obtain competitive engineering salaries. We first began offering a pathway for students to obtain a Colorado secondary teaching license in science or math in the fall of 2015 and have been working to spread the word and encourage positive and accurate conversations with the hopes of empowering more students to pursue their interest in teaching. UNC, a former normal school, prepares the state's largest fraction of teachers. The pursuit of teacher licensure is generally well supported, with 25 – 30% of physics majors earning licensure.

MythBusters is an interactive presentation designed to address the major misperceptions that this recent research has identified, including: (1) the inaccurate belief that the salary gap between teaching and private sector employment is very wide; and (2) inaccurate beliefs about tangible and intangible benefits of the profession. Our efforts have included directly addressing students and high school teachers, in addition to the university faculty and staff whom students often go to for career advice.[5] To address these different audiences, we have developed two versions of MythBusters: one that is student-facing, and one faculty/staff-facing.

MythBusters: Student-facing

To recruit students into our teacher preparation program, and to spread awareness about teaching career pathways in general, we find that we first need to address some of the myths and realities of the teaching profession before providing any specifics about our program. For example, if students don't believe that they could have a good career as a teacher, it doesn't matter how streamlined our program is or how attractive the scholarship opportunities are.

The *Student MythBusters* is an interactive presentation that utilizes peer-instruction,[6] runs between 20-30 minutes, and has had measurable impact. The presentation involves addressing three common misperceptions by providing students with actual data for teaching and private sector positions related to: 1) pay differential, 2) retirement, and 3) job satisfaction. For example, we ask students to estimate the salaries for teachers in their first year and their 15th year, and then we immediately show the students the salary schedules of nearby districts where our graduates would likely work. We also show comparisons of secondary teaching salaries to those of college teachers with the same degree levels, as well as comparisons to private sector jobs. This gives them a chance to recognize and confront any potential misperceptions that they or their classmates may have.

Materials also include handouts with local teacher salary schedules, data on retirement benefits, information on loan forgiveness programs, and job satisfaction survey data. The handouts are shared at *Student MythBusters* events or during one-on-one meetings. Students frequently use these materials to have conversations with their parents. In a few instances where we have had the opportunity to speak with parents directly, a short conversation with handouts seemed to have a positive impact.

At both UNC and Mines, student knowledge of the profession has improved over the last two years, indicated by an increase in the percentage correct on clicker questions from about 30% initially up to about 60% at recent student events that included both new recruits and veteran candidates. We've also seen an increase in the fraction of students who express interest: At a recent Mines event with ~30 Engineering Physics majors, 12 asked to be contacted to learn more about teaching options.

MythBusters: Faculty/staff-facing

In addition to raising the perception of the profession among students, we also need to do so with the faculty and staff whom students often turn to for career advice. For example, we've run workshops for admissions, first-year advising, residence life, and faculty at a campus-wide conference. Goals for participants are listed in Table I to the right.

Table I: Faculty MythBusters' Goals
After the workshop participants will be able to
provide realistic information comparing local teacher salaries, STEM private sector salaries, and college faculty salaries;
generally explain retirement options for Colorado teachers compared to private sector STEM jobs;
share other non-tangible benefits of teaching such as intellectual fulfillment and job satisfaction; and
provide accurate teacher retention data.

The *Faculty MythBusters* workshop involves intensive collaboration and data mining by participants, and it takes about an hour for the conversation to reflect a more accurate understanding of the teaching profession. In comparison, when participants are high school teachers, it can take more than an hour due to deeply-seated misperceptions and limited knowledge of the actual benefits and drawbacks of private sector STEM jobs. As part of the faculty-facing workshop, we share the outcomes of this exercise when it was conducted with our Teacher Advisory Group (TAG), which is made up of middle and high school science and math teachers, state administrators, and industry stakeholders (including Mines' alumni). In short, given the same data sets along with many person-years of experience in the teaching profession, the conversation started off negative and focused on the common misperceptions. But after some reminders to look at the data, and with some valuable perspective from our industry representatives, the conversation changed to one where the rewards and benefits of teaching were being celebrated.

The Faculty MythBusters is also improving faculty acceptance of teaching as a valued profession. The workshop closes with an anonymous clicker statement, "I would feel comfortable with my favorite student becoming a 7-12th grade teacher," and all participants have agreed or strongly agreed with the statement.

Looking ahead

At both a competitive engineering institution and a teaching oriented former normal school, we have found these same common misperceptions and have had success in getting the facts out. However, we know there remain many students at Mines, and elsewhere, who are interested in teaching, but who don't pursue or complete a teaching license because of misperceptions about the profession. We are hopeful that with continued outreach to students, faculty, and staff, we can continue to elevate the view of the teaching profession and ultimately see the number of students who become teachers grow. If you are interested in implementing MythBusters on your campus, please feel free to contact us.

Dr. Kristine Callan is a Teaching Professor in the Physics Department at the Colorado School of Mines. She has led the Mines side of TEAM-UP (Teacher Education Alliance Mines – UNC Partnership) since its inception.

Dr. Wendy Adams is a Research Associate Professor in the Physics Department at the Colorado School of Mines. She has focused her efforts on science teacher preparation for the past seven years and is now helping Mines build their teacher preparation options for science, engineering, and math majors.

Dr. Lacy Cleveland is a Teacher in Residence with the TEAM-UP program at the Colorado School of Mines. She is a former high school science teacher, with a background in biology education research.

(Endnotes)

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Potential Impacts of Policy on Teacher Preparation and Certification

Gay Stewart, West Virginia University

One area where the intersection of government policy, science, and education come into play is teacher preparation and certification. Because teachers have an enormous impact on the economic future of their students, evidence-based policy on teacher certification is essential. However, research on the effectiveness of teachers is sometimes contradictory or lacking.

In many states, especially for particular disciplines (mathematics, chemistry, physics, and special education for instance), there are significant teacher shortages. While influenced by national organizations, the certification of teachers, the process by which someone becomes officially licensed to teach in a public school classroom, is controlled individually by each state. Contrast this to the process of being licensed as a doctor or a certified public accountant, both of which require national standards to be met. Examples of areas open to state control include the fields in which to allow certification (i.e., physics, physical science, or general science), the minimum scores on standardized tests to add additional certifications (i.e., a teacher holding a life science certification wishes to add physics), and the accreditation requirements of preparation programs.

One national organization involved in program accreditation is the Council for Accreditation of Educator Preparation (CAEP). CAEP's mission is to advance "equity and excellence in educator preparation through evidence-based accreditation that assures quality and supports continuous improvement to strengthen P-12 student learning." CAEP has a prominent role in the teacher preparation accreditation processes in over 30 states. While it may seem clear that accrediting agencies should collect and report data on teacher placement and effectiveness, previous requirements for oversight and reporting mostly ignored the impact of program graduates on their students, giving little attention to where they taught, how long they remained in the profession, or the quality of their teaching. Instead of focusing on collecting student outcome data, which could provide evidence to help improve preparation programs, the emphasis has been on changing policies on admissions and certification requirements. These requirements are based on a body of evidence that may not be well supported in science, technology, engineering and mathematics (STEM) disciplines, as many teacher effectiveness studies have focused on elementary school.

According to the National Academy of Sciences Report *Preparing Teachers: Building Evidence for Sound Policy*,[1] "The primary need is to build a body of evidence, developed from multiple perspectives and using an array of research designs, that establishes links between teacher preparation and learning—both teachers' learning and K-12 students' learning." Because the evidence available concerning teacher preparation and its links to student learning is so limited, "high-stakes policy debates about the most effective ways to recruit, train, and retain a high-quality teacher workforce remain muddled."[1] In fact, the US Department of Education decided that because "effectiveness of graduates is not associated with any particular type of preparation program … the only way to determine which programs are producing more effective teachers is to link information on the performance of teachers in the classroom back to their teacher preparation programs."[2]

The move to "raise the bar" for educator preparation programs by applying stricter admissions standards on university-based programs has restricted the potential number of candidates. As states try to fill the gaps in their teacher workforce, universities are becoming less dominant in teacher preparation and alternative licensure and for-profit alternative pathways are on the rise. Further, decisions on appropriate licensure routes are being made without sufficient evidence to inform policy. In fact, in some cases alternative programs are not held to the same admissions standards as university programs, so they cannot be based on the same evidence. One example is grade point average (GPA). In West Virginia, for a program to be CAEP accredited, each candidate must have a minimum GPA of 2.75, but the cohort must have an average GPA of 3.0, so a student with a 2.9 GPA who has truly demonstrated himself to have potential as a teacher may be dismissed from the program if there are not enough higher grades to balance his. Yet, the minimum requirements to enter the Alternative Certification program are a bachelor's degree with an overall 2.5 GPA from a regionally accredited institution of higher education.

While one's first instinct is that it might be appropriate to hold future teachers to a high GPA standard, such rules have no flexibility or insight into the causes of a poor GPA. In fact, despite the national need for greater equity, the higher GPA requirement greatly disadvantages college students who come from a lower socioeconomic background. For instance, a student who significantly struggles with grades in the first year or two of college but then turns around and demonstrates a good understanding of her major may not meet the GPA requirements for entering the cohort. While there is some evidence showing that a higher GPA may lead to better elementary school teachers, there is lack of evidence that a higher GPA makes someone a better physics teacher. This highlights another point that must enter the policy discussion. Because there are many more elementary teachers produced than high school teachers of any discipline, there is more research on the elementary teacher population. It is not clear, however, if that research holds for high school science teachers; such evidence may not be appropriate for making policy decisions.

Although the research is unclear as to how much or what properties it must have, there is some evidence that pedagogical preparation does improve educator effectiveness. The alternative or emergency licensure programs that must be put in place to ensure there is a teacher of some sort in every classroom do not necessarily offer an equivalent pedagogical preparation. By raising the entrance requirements on university-based programs, as well as increasing the cost to those programs and its students through additional requirements on what must happen in those programs, more potential teachers are forced into routes that offer potentially less effective preparation and may result in their leaving the teaching field more quickly. An analysis of four waves of data from the nationally representative Schools and Staffing Survey (1999-2012) discovered that allowing for already high turnover rates in at-risk schools, alternatively certified teachers have an attrition rate that is almost 8 percentage points higher than that of graduates of a standard university-based teaching curriculum—25 percent vs. 17 percent.[3] It would seem these interrelated policy issues should be discussed more holistically.

Gay Stewart is Professor of Physics and director of the Center for Excellence in STEM Education at WVU since 2014. At the University of Arkansas from 1994-2014, she focused on three interrelated issues: improving introductory courses, improving physics majors' preparation for many careers options, and preparing future faculty, both high school and professoriate. UA saw a 10-fold increase in physics graduates and was one of the six initial Physics Teacher Education Coalition institutions.

(Endnotes)

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2. US Department of Education. (2016a). *Teacher preparation issues: Final regulations*. pp. 566. Retrieved from http://www2.ed.gov/documents/teaching/teacher-prep-final-regs.pdf

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Browsing the Journals

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- Page 460 of the November 2017 issue of *The Physics Teacher* (http://aapt.scitation.org/journal/pte) has a nifty article explaining how to construct a boat propelled by a magnetohydrodynamic drive, like in the movie "The Hunt for Red October." The demonstration highlights many of the downsides of such a propulsion system compared to what the movie portrays. On page 588 of the December 2017 issue, James Lincoln convincingly argues that slow-motion video greatly improves the pedagogy of many common physics demos. Finally the January 2018 issue has a variety of short articles that analyze the physics behind interesting effects such as an ice-hockey slapshot on page 7, the tendency for dirt to accumulate along edges of melting snow on page 10, optical deflection of light by prisms on pages 14 and 18, and properties of homopolar motors and generators on pages 47 and 61.

- Romanelli proposes a Stirling cycle based on a polytropic (intermediate between an isothermal and an adiabatic) process on page 926 of the December 2017 issue of the *American Journal of Physics* (http://aapt.scitation.org/journal/ajp). McCreery and Greenside insightfully analyze the electric field of a uniformly charged cubic shell on page 36 of the January 2018, as a contrast to the familiar textbook examples of spherical and cylindrical shells for which the internal field is zero.

- Article 065010 in the November 2017 issue of *Physics Education* experimentally investigates why a cup filled partly or completed with liquid, covered with a sheet of paper, and inverted does not necessarily spill its contents. The surprising demonstration of disassembling a charged capacitor consisting of a sheet of glass between two metal plates, handling the separated parts, and then reassembling the capacitor and finding it is still charged is discussed in article 065202 of the November 2017 issue of the *European Journal of Physics*. Article 065204 in the same issue investigates why fluorescent tubes begin to flicker before they burn out. Article 015002 in the January 2018 issue explains why Newton's bucket cannot be used to determine earth's rotation, the problem being that the necessarily finite size of the bucket means that earth's gravity will be nonuniform over the surface of the liquid in the bucket. Other papers that caught my eye in the same issue are Hecht's discussion of the arrow of time in article 015801, and measurement of the sodium doublet with a Michelson interferometer in article 015704. Both journals can be found online starting at http://iopscience.iop.org/journalList.

- The November 2017 issue of *Resonance* has an article on page 1061 reviewing the properties of perovskite solar cells, a topic of current industrial interest. A spin coater in a dry box is mostly all one needs to prepare such devices, thereby making this research field accessible to undergraduates. In the same issue, a paper on page 1085 explains how the Rayleigh-Taylor instability is responsible for many of the rolling swirls seen in clouds, nebulae, and similar gas interfacial dynamics. These articles can be freely accessed at http://www.ias.ac.in/listing/issues/reso.

- The November 2017 issue of the *Journal of Chemical Education* is devoted to polymers, with a wealth of articles about their properties, syntheses, and classroom experiments & demonstrations. The journal archives are at http://pubs.acs.org/loi/jceda8.

- Article 020124 in *Physical Review Physics Education Research* at https://journals.aps.org/prper/pdf/10.1103/PhysRevPhysEducRes.13.020124 finds a significant correlation between personality types of students (such as their Myers-Briggs temperament) and their performance on the Force Concept Inventory which tests understanding of concepts in basic Newtonian mechanics. This study collected data measuring such correlations, but does not attempt to explain the cause of these correlations, nor how classroom pedagogy could be modified to address them.

Web Watch

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- The Newton Project at http://www.newtonproject.ox.ac.uk/ is seeking to put online all of Isaac Newton's writings, whether originally published or not.
- Science News online at http://esciencenews.com/topics/physics.chemistry presents popular science articles about physics and chemistry.
- All three volumes of the Feynman Lectures on Physics are available to be read freely at http://www.feynmanlectures.caltech.edu/.
- Brains On is a set of podcasts at https://www.brainson.org/ on science topics for "kids and curious adults." Another podcast archive is of the one-minute Science Updates produced by AAAS at http://www.scienceupdate.com/.
- A Swiss team has recently reported direct observation of hydrogen bonds, as summarized at https://www.sciencealert.com/hydrogen-bonds-have-been-directly-detected-for-the-first-time.
- Seismic Illumination is a richly illustrated discussion of Pacific rim earthquakes, online at https://storymaps.esri.com/stories/2017/seismic-illumination/. Similarly, *National Geographic* has a storyline presentation about the evolution of Mars at https://www.nationalgeographic.com/science/2016/11/exploring-mars-map-panorama-pictures/. Also see the timeline of space exploration at http://inspacewetrust.org/en/.
- "Science says the first word on everything and the last word on nothing." That quote from Victor Hugo starts the blog at http://www.lastwordonnothing.com/.
- A recent report discusses how light behaves in a waveguide that has an effective index of refraction of zero at https://phys.org/news/2017-10-zero-index-waveguide-infinitely-wavelengths.html.
- The Pew Research Center analyzes in 10 detailed webpages how most Americans get news about science starting at http://www.journalism.org/2017/09/20/science-news-and-information-today/. You can decide whether the results are cause to sigh or celebrate.
- Progress in constructing photonic neural-net processors is reported at https://www.osa-opn.org/home/newsroom/2017/june/doing_neural_nets_with_photons/.
- Ken Ford has a collection of essays organized into seven sections on introductory physics topics from one of his books at http://www.basic-physics.com/.
- A colleague recently put me onto the wonderful web graphing tool Desmos that lets you easily create and share animated graphs. As a starting point, see the classroom activities at https://teacher.desmos.com/.
- *Quanta Magazine* has a science blog at https://www.quantamagazine.org/abstractions that is worth checking out.
- A new article in *Physics World* re-examines the perennial favorite argument about whether or not hot water freezes faster than cold at http://physicsworld.com/cws/article/indepth/2017/dec/01/when-cold-warms-faster-than-hot.

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Upcoming newsletter deadlines:

Summer 2018: June 1, 2018
Fall 2018: October 1, 2018