Letter from the Chair
Eric Brewe ........................................................................................................................................................2

From the Editor: Issue on Communicating Science
Jennifer Docktor .......................................................................................................................................................2

Call for Nominations for the FEd Executive Committee
Daniel R. Claes ......................................................................................................................................................3

Call for Invited Session Ideas for the 2023 March and April Meetings
Susan Blessing .......................................................................................................................................................3

Report From Council Representative
Laurie McNeil .......................................................................................................................................................4

Public Engagement in Physics
Shane Bergin .........................................................................................................................................................5

Science Communication in Popular Media Using Three Rules
Rhett Allain ..........................................................................................................................................................7

PERbites: A Model to Share Education Research
Nicholas T. Young ................................................................................................................................................8

Introducing CourseSource Physics, A Teaching Resources Journal
Melissa Dancy and Andy Rundquist ..................................................................................................................9

Teacher Preparation
Alma Robinson ......................................................................................................................................................10

How to maintain local efforts to educate future physics teachers?
Stephanie Chasteen .............................................................................................................................................10

Roll Up Your Sleeves, People
Samantha Spytek .................................................................................................................................................12

Executive Committee of the FEd ..........................................................................................................................14
Letter from the Chair

Eric Brewe, Drexel University

Summer is for many of us, a time to step back from teaching somewhat. We get time to recover from grading and planning the day to day that teaching brings. I hope you are taking this time! But it is also a time for reflection on the past year of teaching and planning on a more macro level. For the FEd, we are also reflecting - not so much on grading, but on how we can better support the teaching endeavors of the FEd membership. This means reflecting on the return to in-person meetings at March and April Meeting, and to planning for the future - considering questions of what types of sessions are going to land with the broadest constituency in FEd, and also how we can partner with other groups within APS.

The return to in-person meetings was by and large a success! We had a number of well attended sessions at the March and April meetings. But also it was a different type of in-person, as the meetings had both an in-person and remote component. This is a step forward in terms of inclusivity and helping to meet the needs of all of our members. The sessions had a good mix of remote attendees with good in-person crowds. This blended meeting format was not without challenges, but is a model that can help to better meet the needs of FEd members.

Just like at the end of the term, while there is a short time to relax and appreciate what has been accomplished, one eye always turns toward the next set of meetings. One of the things that certainly promoted strong engagement at the past meeting has been sessions that come from the membership. During the past two years, FEd has partnered with the Division on Quantum Information to jointly sponsor sessions on teaching Quantum across all levels. These sessions have been some of the best attended FEd sessions and have been of very high quality. Thanks to Ben Zwickl, Justyna Zwolak, and Andrew Cleland, this year’s session was also a success. And as we plan for future meetings, please consider organizing sessions, because no one knows the interests of the membership quite like the members of FEd. Susan Blessing is the Program Committee Chair for 2023, so if you have ideas about sessions you would like to see at March or April meetings, please reach out to Susan.

Finally, on the subject of meetings, there is a strong overlap between the Topical Group on Physics Education Research and the Forum on Education. This is, in part, education is both something APS members are interested in supporting (which is the role of FEd) and a research area (which is GPER’s domain). While sometimes this is confusing, it also amplifies the educational mission of APS. GPER is currently pushing to increase the presence of PER within the APS April meeting, and FEd wants to support this. So if you are a GPER member, you’ve already seen emails and surveys about participating in the April meeting. If you are a FEd member, this is a potential benefit to you as well, as there may be more education sessions at April meeting, and the FEd sessions can focus more on general interest education topics.

As we enjoy summer and recharge, we also plan for the future. FEd, is a volunteer organization, and responsive to members. This means that as you plan for the future, consider how you might want to become involved with FEd. The nomination committee, Chaired by Daniel Claes, is looking for executive board members - don’t be afraid of self-nominating! The Award Committee, chaired by Catherine Crouch, is hard at work reviewing nominees for the awards and honors within FEd - perhaps you have a group or individual that you think should be celebrated it is never too early to start planning your nominations. But also, take some time for yourself. Relax, recharge, and be ready for the fall because the work of education is never done.

From the Editor: Issue on Communicating Science

Jennifer Docktor, University of Wisconsin – La Crosse

This spring I had the opportunity to attend the APS March meeting in Chicago, and was invigorated by a return to in-person conferences! One of the FEd-sponsored sessions focused on Communicating Science, and I invited those speakers to summarize their talk in a written piece for the summer newsletter. Three presenters were able to contribute to this issue (Bergin, Allain, and Young.) Others might be able to contribute in future newsletters, so stay tuned! My hope is that you will be inspired by their ideas on how to communicate your science to a broader audience and engage with the public.

I would like to personally thank everyone who contributed to this issue. If you have ideas for future newsletter themes, recurring columns, or an article you would like to contribute, please e-mail me at jdocktor@uwlax.edu. The deadline for the fall 2022 newsletter is October 1.
Call for Nominations for the FEd Executive Committee

Daniel R. Claes, University of Nebraska

Five new members of the Forum on Education Executive Committee will be elected this fall to take office in January 2023: a joint APS-AAPT member (with a 3-year term), one of our Members-at-Large (3-year term), a graduate student member (2-year term), the Secretary/Treasurer (3-year term), and the new Vice-Chair. The Vice-Chair serves in a four-year Chair succession line with different responsibilities each year.

The FEd Executive Committee plans education-related sessions at APS meetings, nominates new APS Fellows, and presents FEd awards. They represent the goals and concerns of the FEd membership to the APS Council of Representatives. Serving as a FEd officer is also an excellent way to learn about APS and its various educational missions and to influence science education at the national level.

Please send suggestions nominating yourself or a colleague (or an interested graduate student!) to:
Daniel R. Claes (dclaes@unl.edu)
FEd Vice Chair and Chair of the Nominating Committee
Department of Physics & Astronomy, University of Nebraska

Nominations must be received by July 31 for full consideration although nominations received later will be given whatever consideration is still possible. (New officers are elected every year, so even if your nomination is too late for this year, it can be considered for the following year.) The nominating committee will consider all nominees and assemble a ballot.

Call for Invited Session Ideas for the 2023 March and April Meetings

Susan Blessing, Florida State University

What education-related topics would you like to learn about at the American Physical Society’s March and April Meetings in 2023?

The Forum on Education is allocated invited sessions at both meetings (three at the March Meeting and five at the April Meeting), and we can increase our reach by co-sponsoring sessions with other units, such as the Forum on Outreach and Educating the Public, the Topical Group on Physics Education Research, the Forum on Physics and Society, as well as the Committee on Minorities and the Committee on the Status of Women in Physics, and any of the scientific divisions represented at the meetings.

Please send your suggestions for invited session topics and potential invited speakers to: Susan Blessing, APS FEd Chair-Elect and Program Chair for 2023, at sblessing@fsu.edu.

FEd also sponsors contributed sessions at both meetings, and we encourage you to contribute a talk or poster to the education sessions (using the physics education sorting categories) – you are permitted to present to an education session in addition to a presentation at a technical physics session.
Report From Council Representative

Laurie McNeil, University of North Carolina at Chapel Hill

Since 2021 I have had the honor of representing the Forum on Education (FEd), the Forum on Outreach and Engaging the Public (FOEP), and the Topical Group on Physics Education Research (GPER) in the APS Council of Representatives; I am also a member of the APS Board of Directors. It is my job to bring issues of concern to the membership of these units to the Council, and to keep the units informed about the Council’s business. Here I report to you about the discussions and actions at the April 2022 Council meeting.

At the meeting the Council was updated on recent changes in the administration of the journals published by APS. As of 1 August 2022 Michael Thoennessen, currently Editor-in-Chief of APS (a staff position), will become Interim Editor-in-Chief (an officer of APS). APS President Frances Hellman is leading a search for the new Editor-in-Chief, with the expectation that the person chosen will assume that position on 1 January 2023. (If you have a suggestion for a good candidate, please contact Frances.) The Physical Review family of journals, which the Editor-in-Chief oversees, continues to grow; Physical Review Energy published its first papers on 7 April 2022.

APS is leading the preparation of an official proposal to UNESCO to declare an International Year of Quantum Science and Technology. The proposal will be brought before the Council in Spring 2023, so if you have any suggestions or would like to get involved in the effort, please let me know.

The Council also considered its communication with units (to which 65% of APS members belong). The APS Communications Department would like to help units encourage their members to participate more actively in unit business and tailor messages to specific groups within the unit without overwhelming them. The department would like to hear feedback about the use of APS Engage as a platform for this and other purposes; feel free to contact me if you have something to say about this.

The Council spent a considerable amount of time in its meeting discussing APS’s response to the Russian invasion of Ukraine. It endorsed the principles put forward by the APS Committee on International Scientific Affairs, namely that APS and its units should continue to facilitate physicist-to-physicist engagement regardless of an individual’s nationality, ethnicity, location or residence, as these interactions are beneficial to the global physics community. Individual benefit should be considered over any incidental institutional benefits. The official APS response condemns the invasion, decries attacks on and near Ukrainian nuclear facilities, and expresses concern to Ukrainian science leaders for the loss of life and property resulting from the invasion.

The Council received and approved the report “Monitoring Methane Emissions from Oil and Gas Operations” that the APS Panel on Public Affairs jointly authored with Optica (formerly the Optical Society of America). This report identifies several policy recommendations that can substantially enhance the detection of methane released by the oil and gas sector. Methane (CH₄) is the second-most-abundant anthropogenic greenhouse gas and significantly contributes to global warming. These recommendations could strengthen measures already taken by that sector to manage methane and enhance worker safety.

Finally, the Council approved the establishment of the Neil Ashcroft Early Career Award for Studies of Matter at Extreme High-Pressure Conditions, made possible by a generous donation from Judith Ashcroft and her family. The award will recognize outstanding theoretical or experimental contributions by a scientist within 10 years of the PhD to studies of matter at extreme static or dynamic high-pressure conditions within the disciplines of Physics, Chemistry, Materials Science, Earth and Planetary Science, Soft Matter and Biology. It will be administered by the APS Topical Group on Shock Compression of Condensed Matter (GSCCM). Nominations for the first award are due 1 July 2022.

As always, if you have comments or concerns that you would like to convey to the Council, do not hesitate to get in touch with me (mcneil@physics.unc.edu). I look forward to hearing from you!
Public Engagement in Physics

Shane Bergin, University College Dublin, Ireland

Public engagement offers multiple opportunities for physics. Beyond recruiting more students to physics degrees or justifying public money for research, it offers space for physicists to connect with their passion for physics, to form community, and to engage diverse groups in informal learning. While I enjoy a day in the lab as much as any other physicist, I have always found myself drawn to public engagement. A good deal of my current role sees me create, run, and research public engagement programmes. Below, I cite three values I associate with successful programmes.

Diverse teams lead to diverse outcomes.
When I began to work on public engagement, I felt the appropriate project management style was to find grant money and hire the services I needed. I was wrong. This utilitarian approach to collaboration limited the associated projects to my views of physics and public perceptions of physics. I was fortunate that the designers, physics students and educators that worked with me, challenged me: for each project more diverse view of what the project was, and thus how it should work emerged. That diversity brought a sophistication I would not have achieved on my own or in a team where I ‘hired’ the help.

In 2021, I co-authored and published Peigi’s Adventures in Science – a storybook for young children that blends social justice issues with science. The book uses story (as opposed to the facts and figures approach taken by most children’s science books) to explore topics like space, energy, and movement. Coupled with diverse characters, the stories gently touch on issues of equality and inclusion such that children can make meaning and empathise with the characters. For example, a chapter centres on building a space suit to fit the lead character Peigi, the cocker spaniel. I wrote the book with my colleague Dr Declan Fahie – a sociologist and former primary school teacher. Working with the illustrator, book designer, and other experts, we used a shared-ownership model to guide our work. Thanks to partnerships with primary school teachers, the National Council for the Blind, and National Council for Special Education, etc. the storyline within the book was informed by people with lived experience.

While written for a young audience, Peigi’s Adventures in Science has allowed many within my physics community to discuss the structural inequalities that limit the inclusion of many. Projects like this might remind us (older) scientists that stories are an essential part of understanding people’s lived experience and encouraging all to make meaningful change to reduce barriers to access.

People have diverse interests – public engagement should reflect that.
If I were not a physicist, I think I’d like to be a musician. I have memories of making college choices at 18 years of age, thinking I was leaving my love of music behind. I never thought my career identity could encompass both. Fortunately, Science Foundation Ireland (our equivalent of the US National Science Foundation) encourages those working in science to partner those in the arts on public engagement projects.

Since 2014, I have run Quavers to Quadratics with colleagues at the Irish National Concert Hall. Quavers to Quadratics sees primary school children from urban educationally disadvantaged backgrounds play with ideas common to science and music. Over their 3-month involvement in the programme, the children are led in their play by undergraduate students from science and music. They play with the nature of sound, the shape of instruments and the materials they are made from.

Core to the sustained success of the programme is the Community of Practice framework that informs our work. It has seen members of the community (e.g. undergraduate students) shape and adapt the programme in various ways. For example, an undergraduate with an interest in Irish led us to developing an Irish-speaking version of the programme that runs in Gaeltacht (Irish-speaking) communities. Our research has shown participating in the programme positively affects the identities of the undergraduate facilitators. Quavers to Quadratics (and other programmes that rely on a Community of Practice framework) offer students agency, friendship, fun, and shared practices in service to something they collectively value.

Mindful that so many undergraduate physics students don’t feel like they are a physicist, I feel public engagement projects like Quavers to Quadratics offer a place to form such an identity – one free of assessment, that builds on intrinsic interests and motivators.

The ways scientists work is as important as the claims scientists make.
With the rise of populist politics, ‘alternative facts’ have inveigled themselves into our vernacular. Facts are to be accepted, it seems, but only for now and only until a more attractive set comes along. In the associated scramble for who and what to believe, science has, I believe, positioned itself as a final arbiter of truth. This bothers me, for at the very core of the scientific process lies an acknowledgment of uncertainty. Science is wary of the absolute, and it is weary of conviction. While I don’t wish for one moment wish to give oxygen to the buffoonery of the those who peddle alternative facts, neither do I wish to see science sell itself short. The choice between facts and alternative facts is a false dichotomy, and the most rudimentary understanding of the scientific process bears this out. I would suggest that too many public engagement projects focus on outcomes: if we engage the publics in how we work, the impacts on public trust in science and scientists increases. This has been a finding of a pan-European project I’ve been working on since 2020 – PERITIA, investigating public trust in expertise. Through collaboration with philosophers of
science and scientists from various disciplines, I am producing a podcast series that examines trust in science. As we emerge from a pandemic and face numerous other socio-scientific issues (most notably the climate and biodiversity emergency), we highlight the importance of public engagement. You can follow me on Twitter (@shanedbergin) if you’d like to hear the podcast when it is released.

As with physics education, the success of public engagement relies on the wider physics community supporting it through creating positions, reading research outcomes, and making funding available. Public engagement is something each of us can engage with. There is a wealth of good-practice and research that you can draw upon if you wish to get involved.

Dr. Shane Bergin is a physicist and lecturer in science education at University College Dublin, Ireland.
Science Communication in Popular Media Using Three Rules

Rhett Allain, Southeastern Louisiana University

I like to have some rules when dealing with science communication. But these aren’t rules in the same sense as “don’t run with scissors” or “be sure to turn off the lights when you leave”. Instead, these are just some of my own personal guidelines that I use when creating science content in popular media. This could be anything like a blog post, a youtube video or even a tweet on twitter. I also used these rules in my role as technical consultant for both MacGyver (CBS) and The MythBusters (Discovery).

Whatever the platform, a science communicator is trying to share some scientific idea with the broader public. With that in mind, here are my three rules.

You can’t be totally correct, but you can be completely wrong
I think we can all agree that science can get rather complicated. You can’t really explain all of kinematics in a 30 second snippet in a TV show. I mean, in an introductory course, you might spend two weeks on that topic. So, with that, it’s pretty much impossible to be totally correct.

Suppose I said that New Orleans was close to Chicago. Is that right or wrong? Well, it’s neither. If you are considering the scale of the solar system, then these two cities are essentially in the same place. But at the size of the USA, then it would be OK to say these two places are NOT near each other. However, if you said Chicago is a pizza—that would be completely wrong (but they do have great pizza).

The same is true with science. Suppose you have a show with a car driving on a track that does a vertical loop. What if you said that there is a force pushing the car up to keep it on the track? Well, that would just be wrong. Or how about this? You have a human pulling a heavy sled over a distance of 10 yards (on a football field) and you calculate his power output to be 57,000 watts. That’s just plain incorrect.

As scientist sharing ideas with the general public, we really need to avoid these kinds of mistakes.

Building a bridge from the science to the audience
Really, this idea is the key. When we communicate scientific ideas, we are essentially setting up a type of classroom. But just like there are different grade levels, there are also different audiences that we need to consider. Let me use an example from the sport of gymnastics. In particular, how do you explain the physics behind a complicated tumbling move—like a triple-double. In case you aren’t familiar, a triple-double is a double flip while rotating three times about the long axis and it’s really difficult.

For a full explanation of this move, there’s some fairly high level physics required. You would need the concepts of angular momentum, torque and even the moment of inertia tensor. Tensors are even complicated for undergraduate physics majors—but that’s what you need to explain the rotation of a rigid object (and humans aren’t even completely rigid).

Perhaps you would instead like to build a bridge to a different audience without all the complicated math. Yes, this is indeed possible. How about tossing something like an eraser into the air. It doesn’t just have a simple rotation, but instead “tumbles”. This is a great opportunity to talk about the difference between angular velocity and angular momentum. Sure, it’s not a full explanation of a triple-double, but it’s still fun.

Finally, there is the lowest level bridge. I like to call this “shiny physics” and it comes up all too often. It’s an explanation that uses scientific words, but doesn’t actually explain much. Here is an example that I made up for the Olympic gymnast, Simone Biles.

“Simone is incredible and it has to do with kinetic energy. **Kinetic energy is the quantity an object has when it is moving.**”

It’s not really physics, but it is shiny.

Science Fiction is Still Fiction
I’ll be honest—I’m a huge fan of science fiction. All of it. But of course, the science in science fiction isn’t always perfect and that’s OK. We just have to accept the idea that the goal of science fiction is to tell a story and not necessarily to teach a science lesson. Really, this is for the best. Would Star Wars or The Avengers be as exciting if they stuck to just concepts you could find in your physics textbook? I think not.

Yes, I can still enjoy movies with sounds in space and star fighters that bank when they turn. It’s not correct, but it just looks cool. However, that doesn’t mean I can’t use these moments to have a discussion about why explosions don’t make sounds in space or why you can’t use infrared to see through walls (well, you can if the walls are super thin).

So, that’s what I do—I use these things in science fiction movies as just an excuse to talk about real science. Sometimes, those real scientific concepts are just as awesome as the events in movies.

Rhett Allain is an associate professor of physics at Southeastern Louisiana University. He likes to take things apart but can’t always put them back together. In his spare time, he writes for WIRED.com (https://www.wired.com/author/rhett-allain) and creates youtube videos (https://www.youtube.com/c/PhysicsExplained) using python to solve physics problems.
It started with an off-hand comment. One of my undergraduate astronomy professors forgot to minimize his internet browser and as he switched between PowerPoints, the homepage for Astrobites, “the astro-ph reader’s digest” [1], appeared on the screen. I had hoped to learn about evidence-based teaching practices or how to inform my teaching and how I interacted with students. I felt overwhelmed reading papers. I wished there was something like Astrobites for physics education. A “reader’s digest” of recent papers written with novice education researchers like myself in mind would have helped me learn about the new and interesting work happening right now. A few years later, that became a reality with the launch of PERbites [2].

At the time, I was just getting started in physics education research. I felt overwhelmed reading papers. I wished there was something like Astrobites for physics education. A “reader’s digest” of recent papers written with novice education researchers like myself in mind would have helped me learn about the new and interesting work happening right now. A few years later, that became a reality with the launch of PERbites [2].

While the original goal had been to create short summaries for early career researchers, the goal soon began to shift. In the months after launching PERbites, I became a teaching assistant for the first time. While I had some training in teaching and pedagogy before stepping foot in the classroom, it was limited. Even throughout the semester, teaching meetings focused on preparing for next week’s classes and how to address common student questions. I had hoped to learn about evidence-based teaching practices to inform my teaching and how I interacted with students. Again, I was faced with an overwhelming number of papers to comb through. Recognizing that many other instructors likely felt the same way, PERbites began to focus on creating summaries of education research targeted towards the needs of instructors too rather than only the needs of researchers.

After all, instructors face many of the same problems researchers do when accessing research. Papers are often placed behind expensive paywalls that require an institutional subscription to access. Even after gaining access to the papers, readers are greeted with long prose filled with complex, technical language and acronyms. In addition, there’s limited time to read research papers not directly related to one’s work.

Of course, these issues weren’t specific to education research but rather were and are persistent across research fields and have been so for years [3-4]. These problems are what originally led to the creation of the larger ScienceBites organization that PERbites is now part of [5].

Consistent with the nearly two dozen other ScienceBites sites, PERbites’s approach to discussing research tries to address these problems. As a group of early career researchers in or interested in discipline-based education research, we write, short, plain language summaries of noteworthy or especially interesting education research papers. Because these summaries are written as blog posts, they are also open access and require no special resources or login to read.

While readable in approximately five minutes, these summaries still aim to cover what information would be important for an instructor or researcher to know. Namely, what the study found, the implications of the results, the context the study occurred in, and what researchers still don’t know because of the study.

Since launching PERbites nearly four years ago, we’ve covered almost 100 papers. We’ve also expanded our focus from only physics education research to discipline-based education research in general.

As PERbites neared that milestone, we reached out to our readers to understand our impact as well as how we can improve. We found that most readers found our summaries easier to understand than a typical journal article and at the same time, they felt that all the important information was still present.

In addition, many readers expressed having learned something they could apply in their research or classroom. Yet, few actually had done so.

Reflecting back, it seems like we have been successful in our first goal of making the results of discipline-based education research more accessible for both researchers and instructors. At the same time, sharing the results is only the first step. Ultimately, one of the goals of education research is to affect practice and improve education for all students. In this aspect, getting the word out about education research isn’t enough [6]. As a community we also need to think about how to support instructors in enacting these changes and ensuring a bidirectional flow of information between researchers and instructors.

[1] https://astrobites.org/
Introducing CourseSource Physics, A Teaching Resources Journal

Melissa Dancy, Western Michigan University
Andy Rundquist, Hamline University

We are excited to announce a new opportunity to share research-supported teaching resources for undergraduate physics and astronomy in a peer-reviewed journal. CourseSource Physics is a parallel publication along with the current CourseSource Biology journal, leveraging the online publishing platform that is already in place. Our current funding model allows us to make articles available online free of charge to both users and authors. CourseSource Physics supports developers by providing a venue to share resources with a broad audience. And because it is a peer-reviewed journal, publications in CourseSource can be listed on a CV for professional acknowledgment.

While CourseSource Biology benefits from clear learning goals curated by various life science professional societies, the new CourseSource Physics uses broad categories at first and encourages our authors and editors to develop a list of article metadata tags that can both facilitate searching for resources and help readers explore various aspects of the lessons. Both Biology and Physics CourseSource will be exploring opportunities for users to discuss ways they use lessons and to share these modifications with the larger CourseSource community.

This journal sits among other similar journals like the American Journal of Physics and the Physics Teacher. CourseSource is different in several ways. We focus on publishing ready-to-use and field-tested teaching resources (searchable by numerous metadata, such as topic, audience, and course level) that practitioners can download and use directly along with guidance to support implementation. Additionally, many of the lesson articles published include direct evidence of effectiveness. Our articles detail the authors’ approach taken to teaching a lesson and how it helped meet the learning goals of the class. While some details about the outcomes or effectiveness of the lesson is required, the focus is primarily on the nuances of implementing the materials. We provide mechanisms for you to a) describe your approach, b) publish your materials, and c) collaborate with others who might be interested in your approach but for a different context (different in class size, type of students, teaching modality, etc.).

We hope you will consider contributing. Please check out our website for additional information. https://qubeshub.org/community/groups/coursesource/

We are also seeking reviewers and would greatly appreciate your expertise. You can register as a review here http://coursesource.msubmit.net/.

We are currently seeking submissions and expect the first articles to be published in a few months.

Let us know if you have any questions.

Thank you,

Melissa Dancy
CourseSource Physics Editor-in-Chief

Andy Rundquist
CourseSource Physics Senior Editor
This issue of the Teacher Preparation Section offers two very different perspectives on educating future physics teachers. The first is a wide view, given by Stephanie Chasteen, who highlights the key findings of her study on the sustainability of the 16 Comprehensive PhysTEC sites funded between 2010-2015. By finding common themes among the programs that were able to sustain or grow their physics teacher graduates following PhysTEC funding, she gives a model of how to make lasting structural and cultural change that reinforces effective physics teacher education.

The second, a more personal perspective, is given by Samantha Spytek, one of my former students who teaches physics at Rock Ridge High School in Ashburn, Virginia. As one of our top students, Samantha had many bright career options, but she chose to be a physics teacher. I reached out to her to ask if she could share why she made that decision and how her experiences in the PhysTEC program have impacted her teaching. In addition to those reflections, she also challenges us to focus more on teacher retention by supporting teachers in the field and helping them advocate for better working conditions.

**How to maintain local efforts to educate future physics teachers?**

*Stephanie Chasteen, Chasteen Educational Consulting, PhysTEC External Evaluator*

As the external evaluator for the Physics Teacher Education Coalition (PhysTEC.org), part of my job is to determine the degree to which there are lasting impacts of the work. The PhysTEC project has supported 30 institutions as “Comprehensive” sites. These sites receive $300,000 of funding to establish a strong physics teacher education program. A previous study by Scherr et al. evaluated the sustainability of the first set of funded sites, finding that a champion for physics teacher education, and institutional motivation and commitment were critical for sustainability of physics teacher education efforts. Based on this previous study and other work, we developed a rubric for analyzing the features of physics teacher education programs, such as recruitment, mentorship, institutional commitment, leadership, and assessment.

Armed with these tools and knowledge, I conducted an in-depth study of the sustainability of the second set of Comprehensive sites, the 16 institutions funded between 2010-2015. The main findings of the study are in the table which follows, but I’d like to tell you some of the particularly interesting aspects of the study to me and to PhysTEC.

**First, change can create a proof of concept for future change.** PhysTEC funding often established a course, paid Learning Assistants (LAs), or hired a Teacher in Residence (TIR). Once these things were in place, and there was a demonstrated need and interest, it was easier to make a case for continuing and growing these efforts. For example, students enrolled in the pedagogy course and served as LAs, and faculty were interested in using LAs. Administrators saw that the program could graduate future physics teachers. In this way, the institutional capacity and culture for physics teacher education (PTE) both led to, and was generated by, successful outcomes. If you are working to create change in your department, how might you demonstrate that proof of concept, to generate such a positive feedback loop?

**Structural change lasts.** The most resilient programs were able to name a variety of structural changes that “kept things going”, such as having a course in the catalog, undergraduate course reforms, teacher certification pathways, or collaborative advising structures. **Routine** was also a valuable type of structure – after
something is done in a particular way for a few years, it becomes institutional memory. One of the most named structural changes was an LA program. Many institutions began or maintained LA programs during the grant, and these were easily maintained due to their connection to undergraduate education; 13 out of 15 sites with an LA program maintained them. These LA programs were not always deeply connected to the physics teacher education efforts. Rather, the existence of the LA program had many ancillary benefits which ended up being crucial for physics teacher education. The need for a pedagogy course for the LAs provided justification for having such a course at all, and/or for having a TIR to run it. Having LAs strengthened undergraduate education, supporting an overall culture where teaching is valued. Local teachers who worked with the PhysTEC program (Teachers in Residence) were often able to be maintained as LA program coordinators. So, LA programs provided a needed connection of physics teacher education and the undergraduate program. How might your change effort “hook onto” the existing institutional mechanisms supporting teaching excellence and a thriving undergraduate program? For example, rather than having conversation about how to support an undergraduate pathway to teaching certification only, a broader conversation about career pathways and concentrations in the major might be easier.

Changes to structure and capacity are necessary, but culture change really keeps things going. I rated sustainability on many measures, including strength of the physics teacher education program, structural changes and outcomes, apparent resilience of the program to shocks, and the graduation numbers (see figure below). The sites that were unsustained lacked someone to lead the effort; a champion is still critical. But there were several sites that had good champions, but mixed results – they often had good physics teacher education programs, but the structures and leadership were mixed (e.g., the champion was spread too thin, the advising structures for teachers were not streamlined). The well-sustained sites had strong motivated people and effective structure but did not always have a strong institutional commitment to physics teacher education. However, a fourth group of truly exemplary sites were continuing to grow their graduation rates and activities; these sites were typified by a strong institutional culture of physics teacher education. (Examples of cultural changes are listed on page 24 of the full report.)

These findings led me to co-opt a model5 (see Chasteen-Lau model, previous page) to describe sustained physics teacher education programs, showing how people, capacity, structure, and culture are all necessary elements for sustained change, with success further reinforcing change.

Where do you see your institution and change efforts (in physics teacher education, or other work) in the Chasteen-Lau model?

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**Key findings of the Comprehensive II Sustainability Study**

1. Most sites sustain their outcomes; all have a functional program and over half are rated with high sustainability.
2. Teacher graduation increased by 1/year on average across sites and by 2/year for those sites which increased their graduation rates.
3. Future teachers represented about 10% of undergraduate majors, in line with conventional wisdom.
4. About half of future teachers were certified through post-baccalaureate routes demonstrating that undergraduate routes are insufficient.
5. PhysTEC funding supported strong culture, norms, and capacity for physics teacher education.
6. Learning Assistant programs were often maintained; these were often only indirectly related to physics teacher education, providing a home for future physics teachers and a physics pedagogy course.
7. Teachers in Residence (TIRs) were only maintained about half the time; many were maintained to help run an LA program.
8. The loss of people’s time led to fragility; the amount of time and effort was always reduced post-PhysTEC due to the loss of TIRs or of site leader time.
9. There were three hallmarks of sustainability:
   a. Motivated people were necessary but insufficient.
   b. Structures and routine supported improvements in physics teacher recruitment and the quality of their preparation.
   c. Cultural supports exemplified the exemplary sites.
10. Successes during PhysTEC promoted a positive feedback loop; by demonstrating that there was interest among students and courses were viable, sites PhysTEC demonstrated proof-of-concept.
To learn more
You can access the full Comprehensive II Site Sustainability Evaluation Study here. Note that examples of structural and cultural changes, motivated people, opportunities and threats, are listed on page 24.

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Roll Up Your Sleeves, People
Samantha Spytek, Rock Ridge High School, Ashburn VA

There are a litany of statistics\(^1\),\(^2\) attesting to the crisis in high school physics education and its consequences for the later pursuit of STEM careers. I should know, I’m one of those statistics. I happen to be among an all too small number of high school physics teachers who have a degree in physics and graduated from a Tier 1 university. Reflecting on my own experiences at Virginia Tech, I realize now how fortunate I was to find myself in such a well-designed PhysTEC training program. It had enticing undergraduate courses that involved learning how to give physics demos to K-12 students, courses that addressed learning from physical, psychological, and neurological perspectives, and an accelerated Masters of Arts in Education (MAED) program for physics undergraduates.

Those fun, service oriented courses I enrolled in as a freshman were particularly important in my own recruitment process. Teaching and learning, when done correctly, can be a very enjoyable experience especially when you have cool visuals and interactives to use. These kinds of elective physics courses can be enjoyed by anyone. Importantly, they give university students the opportunity to engage with young people, providing the first litmus test toward those students potentially seeing themselves as future physics teachers.

The subsequent physics teaching and learning course I took then set the basic foundation of pedagogical practices within a physics context, and offered such a strong foundation that I still utilize content from that course in my classroom today. From there, it was a simple step to the accelerated Masters of Arts in Education program that is streamlined within the physics major curriculum. There was even a pathways planner already created for it. That continuity between the Physics Department and School of Education made the transition seamless and demonstrated the value my Physics Department placed on teachers and teacher training.

It is important to note that this valuation of teaching is especially important when considering the conversations around and perceptions of what a “quality physics student” should pursue. It is typically a foregone conclusion that the top students will pursue graduate studies in a physics related field or, at least, enter industry. Rarely is teaching seen as a suitable option for high achievers. And yet I was at the top of my class, and here I am - teaching. Having the confidence to turn against the tide and follow my passion was made easier by my program’s belief in me, and the support I received from them. It was clear to me that my department saw teaching as a valuable pursuit - just as valuable as any other career option.

At Virginia Tech, the physics students who pursue the MAED program are supported by Graduate Teaching Assistantships in the Physics Department. By serving as a Physics Graduate Teaching Assistant (GTA), students are given a tuition waiver and a stipend for living expenses as they complete their MAED. This allowed me to not only gain experience in my student teaching roles at local schools, but also allowed me the opportunity to gain experience teaching college students the same material. This has been especially important to me as an AP physics teacher; my classroom follows the norms set in the college classroom I maintained as a GTA. I feel confident knowing my students will be well prepared for their physics coursework in college, not only content-wise but also expectations-wise.

At the heart of the success of Virginia Tech’s PhysTEC program is the close relationship and communication between the Phys-
ics Department and School of Education. Those connections must be made and maintained in order to be effective. Virginia Tech’s willingness to hire a Teacher in Residence (Alma Robinson) as an instructor for this coursework is especially innovative. In my opinion, she is the lynchpin for this program’s success. Having a former high school physics teacher who teaches the introductory physics courses allows students considering physics education to experience the techniques they will eventually learn to implement - thus they can see first hand the benefits of such pedagogy. All these aspects of the program come together to create a course of study that is extremely effective at preparing physics students to become good physics teachers.

Having said all that, it’s important to understand that creating more effective teacher training programs, especially in STEM, is only part of the answer to addressing the crisis in physics education in this country.

Teaching is a messy, hard, emotionally draining job. It involves working with people who often don’t believe in themselves, who perform self-destructive behaviors, and who cannot see that you are there to help and support them. The pay is often insufficient, the professional respect can be lacking, and the pressure never-ending. It is the kind of job where you could end up asking yourself why you’re there in the first place.

The thing that keeps me going, that keeps most teachers going, is the feeling of purpose and meaning behind our work. But love for the profession can only get you so far. Schools have turned into battlegrounds, both actual and political. Teacher burnout is real, and worse than ever before. I am entering that critical fifth year after which many teachers leave the workforce[3]. It is honestly hard for me right now to recommend becoming a teacher, despite the fact that I remain here with my students.

Part of the answer, in my opinion, is for universities and teaching programs to not only recruit and train new teachers, but also to proactively address issues around retention as well. Prospective teachers need to understand the sources of stress that can lead to teacher burnout and learn ways to process that inevitable stress. They need to understand the kinds of local, state and federal policies that may impact them. They need to learn how to advocate for better teaching conditions, and training programs need to provide ongoing support to schools and teachers in these areas. This may include advocating for changes to curriculum requirements at the state level, offering STEM extracurriculars for high school students, and maintaining partnerships with graduates of their programs. It’s not just about creating effective physics teachers, it’s about retaining them as well.

Until this country elevates the value of education, and sees the importance of teaching and learning as essential to our collective wellbeing, we will continue in these dire straits. In the meantime, doing what we can is all we can do. So please, improve teacher recruitment and training programs, build up the support at that juncture in the pipeline, and start working to create ongoing assistance to aid teacher retention.

In an ecosystem as complex as the American education system, it is not unreasonable to think that improving one aspect of the problem will positively impact the rest. For example, my work in college led me to opportunities related to STEM education equity and policy. Having such a strong foundation from my PhysTEC program has helped me to become an inadvertent leader, and has shown me I can affect change for the better.

So now I call on you to join me in my quest to make our education system better. Roll up your sleeves people, we have work to do.

Samantha Spytek just completed her fourth year teaching physics at Rock Ridge High School in Loudoun County Public Schools Virginia, where she serves on the physics curriculum development committee. She also recently completed a fellowship on education policy through the Institute for Educational Leadership. Ms. Spytek was an invited speaker at the American Association of Physics Teachers Summer 2021 Meeting, where she gave a talk titled “Priming Young Scientists: Identity and Physics”. She is a 2022 Local PhysTEC Physics Teacher of the Year.

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