APS physics™

Forum on Education
American Physical Society

Summer 2021 Newsletter

Jennifer Docktor, Editor

From the Chair:
Share your ideas for what the FEd can do!

Catherine Crouch, *Swarthmore College*

If you are new to the FEd, or even if you're not, you might wonder: What does the FEd do? In the last newsletter, I wrote, "The APS Forum on Education seeks to support all APS members in their engagement with high quality physics education, whether in public outreach, K-12 through graduate education, or ongoing professional development." But how exactly do we do that?

We're glad you asked, and we are starting to ask a related question ourselves! This summer, the FEd Executive Committee is beginning a strategic planning process to think carefully about what we do, so that we can focus our resources and efforts on the most strategic and effective ways to advance education within the APS.

We are eager to hear from you with your ideas, so we will be sending a survey to FEd members in the summer or early fall.

Presently, the activities of the FEd include:

- Planning invited and sponsoring contributed sessions at the March and April meetings of the APS, and consulting on an education-related session at DAMOP.
- Recommending Fellows to the APS for contributions to physics education.
- Providing the selection committees for the Excellence in Physics Education Award and the Reichert Award for Excellence in Advanced Laboratory Instruction.
- Offering the mini-grant program.
- Advising APS Council about educational engagement through the APS Committee on Education (CoE). The FEd Chair, Past Chair, and Chair-Elect are three of the twelve members of the CoE, which works with APS staff to develop, oversee, and advocate for APS's involvement in education.
- And, of course, publishing this newsletter three times per year!

We welcome your thoughts on what is important among these activities, how to do them better, and what else we might take on! Keep an eye out for a survey coming to you through APS Engage in August or September.

In the meantime, thank you to all of you who nominated Fellows or prize candidates, and please consider suggesting conference sessions or candidates for the FEd Executive Committee!

Request for Session Topic Ideas for Upcoming APS Meetings

Eric Brewe, *Drexel University*

The Program Committee of the Forum on Education organizes invited sessions at the American Physical Society's March and April meetings. The Forum is allocated a number of invited sessions at each meeting (three at March meeting, and five at April meeting). This number can be increased by co-sponsoring sessions with other units such as the Forum on Outreach and Engaging the Public (FOEP), the Topical Group on Physics Education Research (GPER), the Forum on Physics and Society (FPS), or one of the scientific Divisions such as the Division of Atomic, Molecular, and Optical Physics (DAMOP). The Program Committee works with the AAPT to sponsor two April meeting sessions; there is an additional April session on an education topic chosen by the Program Committee.

We are always looking for ideas for session topics (and potential invited speakers) for the 2022 March and April meetings that would be interesting and exciting to the members of the American Physical Society whether or not they are members of FEd, since education in physics affects us all. If you have ideas that would make good invited session topics, or recommended speakers, at one or the other of these two meetings, please send them to Eric Brewe (eb573@drexel.edu). Any ideas submitted will be considered by the Program Committee this year, and if not implemented will be passed on to future program committees for their use.

FEd also sponsors contributed sessions at both these meetings at which are presented papers that are contributed in the Physics Education sorting categories. Focused sessions which are invited/contributed at the 2022 March meeting will include "Improving Education Equity and Outcomes in Biological Physics" in partnership with DBio, and "Teaching quantum at all levels" in partnership with DQI. We encourage FEd members to contribute to either of these sessions or any of the other categories at either the March or April meeting.

Call for Nominations for the FEd Executive Committee

Susan K. Blessing, *Florida State University*

Three new members of the Forum on Education Executive Committee will be elected in the fall to take office in January 2022: one of the joint APS-AAPT members (3-year term), one of the Members-at-Large (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 an excellent way to learn about APS and its educational missions and to influence science education at the national level.

Please send suggestions nominating yourself or a colleague to:
Susan K. Blessing (sblessing@fsu.edu)
FEd Vice Chair and Chair of the Nominating Committee
Department of Physics, Florida State University

Nominations must be received by July 13 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.

Report from Council Representative

Laurie McNeil, *Univ. of North Carolina at Chapel Hill*

The governance of APS includes the Council of Representatives, which is how its 49 units (Divisions, Topical Groups, Sections, and Forums) participate in running the Society. I have 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). The Council focuses on all matters of science and membership, including science policy. I attended my first Council meeting in April (virtually, of course), and learned that an overarching concern for APS is the climate of the society and its meetings in regard to diversity, equity and inclusion. As APS President Jim Gates noted, "For an individual, it has been said that character is destiny. For an organization, perhaps it can be said that culture is destiny." He has launched an initiative he is calling ΔΦ (Delta Phy, "change physics"), which functions like a "temporary Forum" to work on a shorter timescale than an existing unit can. He has organized a series of webinars on "Making Physics Inclusive & Equitable" with more to come. The Ethics Committee is also concerned with this issue, and asks that units draw attention to and promote APS policies; focus on diversifying candidates in unit leadership roles; diversify invited guests at sessions and unit activities; consider creating an Allies program, and forming unit-level committees dedicated to diversity, equity, and inclusion.

One of the main strengths of APS is our scientific meetings, which were greatly disrupted by the global pandemic. Some of the lessons learned from the virtual meetings held since March 2020 are that collaboration and networking are vital and much easier face-to-face, and that each meeting has different needs that can be met with a variety of platforms. It is clear that virtual and hybrid meetings are here to stay, and so APS will be hiring a Virtual Events Manager and will explore the best ways to offer them. The American Institute of Physics has produced a report, Future of Association Convening: Envisioning for The Sciences" (FACETS) that offers ideas on how scientific conferences can integrate lessons learned from retooling in-person meetings to virtual formats. The meetings of the future will look different from those of the past, but it is still unclear exactly how. The focus of the Council for the next year will be on how all APS activities, not just meetings, should look in the post-pandemic era.

On the education and outreach front, the first seven sections of Effective Practices for Physics Programs (EP3) have been released; all 35 sections will be complete by early 2022. EP3, produced in concert with AAPT, provides guidance for implementing effective departmental change in areas such as recruitment and retention, advising and mentoring, career preparation, community engagement and outreach, instruction, departmental culture and climate, and much more. APS has also established two new positions in support of education. Michael Wittmann of the Univ. of Maine, a Fellow of the APS from GPER, has been appointed Head of Education at APS effective 1 June. And of particular interest to members of FEd, Geraldine Cochrane will take a sabbatical from Rutgers to serve as the Acting Head of Diversity at APS. Geraldine was elected a Fellow of the APS last year upon nomination by FEd "for scholarly advocacy around equitable access that pushes the boundaries of physics education." I am sure that both of these distinguished physicists will be very effective inaugural holders of these important staff positions.

Throughout the rest of my term (which continues through 2024) I will continue to report on Council activities of interest to FEd, FOEP, and GPER. Feel free to contact me at mcneil@physics.unc.edu if you want to discuss how I can best represent these units in APS governance. I look forward to hearing from you!

From the Editor

Jennifer Docktor, *University of Wisconsin – La Crosse*

Summer is here, and hopefully it brings a break from pandemic teaching for some of you! There are some staffing updates to report which are relevant to the Forum on Education. First I would like to welcome Michael Wittmann as Head of Education at APS. As part of this new position he will be a liaison to FEd. You can read more about him in the June issue of APS News. Secondly, Carl Mungan has decided to retire from his newsletter columns on Browsing the Journals and Web Watch. He has been writing these articles since Summer 2009 and we are very grateful for his long-time service to the FEd newsletter. Please join me in thanking Carl! (mungan@usna.edu)

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 newsletter is October 1.

Implementing Active Learning in Physics Departments

Liz Gire, *Oregon State University* | ***Randy Knight,*** *California Polytechnic State University* |
Marta McNeese, *Spelman College* | ***David Meltzer,*** *Arizona State University* | ***Andy Rundquist,*** *Hamline University*
Jennifer Docktor, *University of Wisconsin - La Crosse*

The APS Physics Department Chairs Conference was held virtually on June 3-4, 2021 (https://www.aps.org/programs/education/conferences/chairs/2021.cfm). One of the parallel sessions focused on Implementing Active Learning in Physics Departments with the session facilitators listed above. This article summarizes the questions raised by participants who attended the session along with notes summarizing responses from the facilitators.

What are the "nuts and bolts" of active learning?

The session began with a brief overview of active learning from David Meltzer with the following key points [1]:

- Active learning instruction is based on research about student thinking and difficulties learning physics.
- Students should engage with each other during class, such as working on some kind of problem solving activity.
- Students have opportunities to express their thinking.
- Students receive rapid feedback.
- See Physport https://www.physport.org/ for research-based resources. Additional key articles and texts are listed in references [1-5].

What are some of your experiences with implementing active learning at your institution?

Roughly two-thirds of participants attending the session indicated they currently use active learning in their physics department. Participants and facilitators shared some of their experiences, including the following:

- Whiteboards can be a useful tool for students to make their thinking visible. It is sometimes viewed as a "temporary" work space and students are more willing to make mistakes. The size of the whiteboard can be varied depending on the type of student interactions you are interested in.
- Students can solve problems at the board in front of the class. Everybody takes a turn and then nobody can hide.
- When using whiteboards for group work, allowing only one marker per group can encourage collaboration. If they each have a marker, they sometimes work individually in their corner of the board. If students are assigned specific roles in their group, it's good to rotate the roles.
- Smaller whiteboards can be used for students to provide individual responses to a question or task. The instructor can collect the whiteboards from students and select some to display anonymously and discuss as a class. See examples in the Paradigms in Physics curricular materials in ref. [6]
- Some students might express concerns about balancing time to participate in activities during class and write notes in their notebook. You can give them additional time to record notes or have them take pictures of group work with a device.
- Performance-based assessments such as a final project can be used in place of traditional exams. If the project is made publicly available online then students will become invested in their work.
- Randy noted that at Cal Poly a supportive dean provided funding and got the studio classrooms off the ground – and helped persuade chemistry to do the same – in spite of a physics chair who was not at all supportive.

How can you get students to "buy in" to using active learning in upper division courses?

Sometimes active learning techniques are seen as "elementary," so even if students have used active learning in their introductory courses they may hold different expectations for upper division physics courses. These are some strategies to enhance student buy-in:

- At the start of their junior year, teach students about how active learning works and the rationale. Highlight that real physics gets done as part of a team.
- Use hard problems, something students can't solve on their own so they see the value of collaboration.
- Emphasize that physics is something you do, an action. Incorporate kinesthetic activities early in the course.
- Provide opportunities for scientific communication.
- Survey students part-way through a course about what aspects most help their learning, and then discuss how you are responding to their feedback.

How can you get faculty to "buy in" to using active learning in upper division courses?

Physics faculty members may express concerns about active learning, such as that they won't be able to cover as much content or that if they don't explicitly show something to students they won't learn it. These are some strategies used in the Paradigms in Physics curricular materials [6].

- Reassure faculty that lectures are still needed in upper division courses but they can be shorter.
- Oftentimes students already have some knowledge they can leverage, so faculty can build on things students learned in introductory courses.
- Even if you start slower at the beginning of the course, active learning makes it possible to accelerate the course over time and still address the same topics as traditional instruction.
- Make active learning part of the culture of the physics department, so faculty see that this is how we teach physics at this institution. Chairs can help set that culture.
- Administer pre- and post-instruction learning diagnostics to provide ongoing assessments of student learning in various courses using various instructional methods. In some departments, this kind of evidence of improved student learning has proven to be a powerful persuasive tool and has significantly increased faculty buy-in.
- When there are multiple instructors of a course it's important to ensure faculty are not working at cross purposes. Watch for the possibility of covert resistance from senior faculty. Some institutions have faculty "shadow" other faculty members teaching active learning courses before they cycle into teaching that course, to become familiar with the lab activities and pedagogical approaches.
- Teaching Assistant (TA) training can be important if graduate and /or undergraduate students are teaching portions of a course, such as labs, recitations, or discussion sessions. See sample orientation resources from the University of Minnesota [7]

How will implementing active learning impact student evaluations of instruction?

Students might perceive that they learn more from lectures when they actually learn less [8], or they might have a preference for traditional (passive) instructional techniques which can influence their ratings of an instructor. These are some things to keep in mind about active learning and student evaluations:

- When applying for promotion, retention, and tenure it's important to have multiple sources of evidence for teaching effectiveness. Include direct measures (such as pre-post assessments of student learning) as well as indirect measures such as course surveys. A student assessment of learning gains (SALG) is one example, see http://salgsite.org/
- It can take a couple of years for active learning to become accepted at an institution. MIT is one example.
- Having active learning in all sections of a course is preferable. If students hear that they have to learn and think in the studio format of the class, it can get a bad reputation and students "prefer" to be in the lecture section where they can be passive.
- Be mindful that there are equity issues with student evaluations of instruction. Students may be less receptive to active learning when it is implemented by women and underrepresented minorities.
- Determine what is most valued by the administrators at your institution. Does the dean want to read students' comments about neat activities they did in a course or do they just want to see high evaluation scores (keep the students happy)?
- Be aware that research indicates student evaluations of instruction are not correlated with student learning.
- Learning outcomes assessments are big in higher ed if your institution is going up for accreditation. See examples of content-based assessments and non-content assessments on Physport. Some institutions use senior exit interviews to assess the impact of active learning instruction.

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Inclusive Mentoring: The Mindset of an Effective Mentor

Chandralekha Singh, *University of Pittsburgh*

Mentoring is the process of forming, cultivating and maintaining relationship that supports and advances the mentees in their pursuits [1-2]. As physicists, we mentor undergraduate and graduate students in diverse settings, e.g., when we teach them in various courses, when we advise students in their research or when we advise them about academic and non-academic issues. We give advice on what courses to take, whom to do research with, how to live a balanced life and manage academic and non-academic responsibilities, how to apply for financial supports, scholarships and jobs.

While effective mentoring can improve the outcome for all students in research and education, appropriate mentoring of students plays a critical role in ensuring that students from underrepresented groups thrive since physics is one of the least diverse STEM disciplines with stereotypes related to who can excel in it [3-11].

Research suggests that there is no single mentoring style that impacts effectiveness [2]. However, genuine concern for the mentee, boosting their sense-of-belonging and self-efficacy [4-6], inculcating growth mindset (intelligence in not immutable since your brain is like a muscle and can grow with hard work) [7,11], supporting students in learning to use effective strategies for growth that build on their current knowlege meaningfully, encouraging them to take advantage of their peers and mentors while helping them embrace their struggles as stepping stones to learning, are critical aspects of successful mentoring. It is important for mentors to convey to students that they have high expectations of them, they know that they have what it takes to excel if they work hard and work smart (which entails using effective approaches) and they are there to support them as needed. Observed outcomes of good mentoring are mentees more likely to succeed in their course work, research, be visible compared to others at a particular stage of their career, have a career plan in addition to being happy with their work because mentoring helps shape the outlook and attitudes of the mentee positively [1,2]. Mentoring can support growth in physics knowledge and skills as well as development of leadership skills while creating a climate of positivity, sense of competence and "you can do it" attitude [1,2].

Keeping in mind the role of mentors, a crucial characteristic of effective mentoring relationships in both teaching and advising contexts is that the mentors themselves have a "growth" mindset in order to help their mentees embrace struggles with physics and learn how to react to challenges and adversity. A research study involving the fixed vs. growth mindset of STEM instructors of undergraduate students was carried out at a large research university in the US in which 150 instructors from 13 different science disciplines including physics participated [11]. Instructors were asked to respond to the following two questions on a Likert scale (strongly agree, agree, disagree, strongly disagree etc.): "To be honest, students have a certain amount of intelligence, and they really can't do much to change it" and "Your intelligence is something about you that you can't change very much". Instructors who agree with these statements have a "fixed" mindset about their students' ability and those who disagree with these statements have a "growth" mindset about their students' ability. It was found that STEM instructors who had fixed mindset about students' ability in that they believed that students in their courses came with fixed abilities had larger achievement and motivation gaps. In particular, the achievement gaps between the racial and ethnic minority students and white students were twice as large and underrepresented students had worse motivational beliefs in the classes taught by instructors with a fixed mindset compared to instructors with a growth mindset.

It is not surprising that those in mentoring roles, e.g., instructors and research advisors, who have a fixed mindset about their students' ability are unlikely to inculcate growth mindset amongst their students, i.e., have students realize that intelligence is not fixed but can grow when one works hard and works smart and inspire them to use effective strategies to grow [7,10]. On the other hand, good mentors can shape the way that mentees react to challenges and ensure that the mentees embrace struggles while solving physics problems or conducting physics research as normal, unavoidable and an opportunity for developing expertise using deliberate strategies and build on their prior knowledge and skills [7]. A good mentor can disambiguate student experiences in challenging situations and promote growth mindset and the importance of struggling in learning and excelling [7]. In particular, only when we as mentors have a growth mindset and truly believe that the students we are mentoring in instructional or research contexts can overcome challenges and excel by working hard and using effective strategies while we continue to support them, will students develop a mindset that challenges are not unique to them or permanent but universal and temporary [7]. As mentors, we should set high expectations for students but also provide assurances that students can reach those expectations by working hard and using effective approaches, struggling at the task and using their struggles as a learning opportunity while we continue to support them. Also, we should simultaneously help students learn effective cognitive and meta-cognitive strategies to scaffold their knowledge and skill development. What is important to recognize is that setting high standards without providing assurance that all students in a physics course or in a physics research lab can achieve them by working hard while using effective strategies can hurt those from the underrepresented groups (e.g., women and racial and ethnic minority students) the most. Due to the stereotypes associated with physics, without assurance from the mentor, those students are more likely to attribute their struggle to their lack of ability as opposed to a normal part of developing expertise [7].

Mentors should also positively recognize and praise students for making progress even if the mentor perceives them to be small steps, otherwise, lack of recognition is more likely to negatively impact those who are underrepresented in physics. Since physics is a field with strong stereotypes about who can succeed in it, these micro-affirmations are particularly important. Lack of positive recognition is known to negatively impacted the entry and retention of underrepresented students, e.g., women and racial and ethnic minority students in physics related disciplines for decades [3-7].

Eileen Pollock, the first woman to get a BS degree in physics at Yale University, decided to pursue graduate work in English and became an English professor at the University of Michigan despite finishing her physics undergraduate degree summa cum laude. In her memoir [12], she recounts the negative impact of lack of positive recognition from her thesis advisor, "Not even the math professor who supervised my senior thesis urged me to go on for a Ph.D. I had spent nine months missing parties, skipping dinners and losing sleep, trying to figure out why waves — of sound, of light, of anything — travel in a spherical shell, like the skin of a balloon, in any odd-dimensional space, but like a solid bowling ball in any space of even dimension. When at last I found the answer, I knocked triumphantly at my adviser's door. Yet I don't remember him praising me in any way. I was dying to ask if my ability to solve the problem meant that I was good enough to make it as a theoretical physicist. But I knew that if I needed to ask, I wasn't." She adds, "[I was] certain this meant I wasn't talented enough to succeed in physics, I left the rough draft of my senior thesis outside my adviser's door and slunk away in shame. Pained by the dream I had failed to achieve, I locked my textbooks, lab reports and problem sets in my father's army footlocker and turned my back on physics and math forever." This example illustrates a missed opportunity in which an undergraduate thesis mentor failed to positively recognize the accomplishment of a woman in physics and she went from feeling "triumphant" to feeling she wasn't talented enough to succeed in physics, otherwise her advisor would have praised her for her successful solving of the problem. What is also worth reflecting upon is that decades later while writing her book, when Pollock asked her thesis advisor what he thought of her thesis, he noted, "It's very unusual for any undergraduate to do an independent project in mathematics. By that measure, I would have to say that what you did was exceptional." She then asked if he ever specifically encouraged any undergraduates to go on for Ph.D.'s; after all, he was then the director of undergraduate studies. He said he never encouraged anyone. This type of lack of encouragement is likely to be particularly detrimental to underrepresented students.

Due to the pervasive societal stereotypes associated with who belongs in physics and can excel in physics, many students from the underrepresented groups question whether they have what it takes to be a successful physicist [13-20]. Depending upon students' background and privilege, students may come to our classes and in our research labs with different motivational beliefs and prior preparations. Mentoring plays a critical role in ensuring that all students and especially those from the underrepresented groups receive adequate guidance, support, recognition and assurance to participate and excel in physics. Developing the mindset of an effective mentor requires us to be reflective and introspective and is crucial for ensuring that our students develop a growth mindset, embrace their struggles in physics and use effective approaches to overcome the struggles and excel in physics [10,21].

Chandralekha Singh is a professor in the Department of Physics and Astronomy at the University of Pittsburgh. She is a former chair of the APS Forum on Education and is currently the Past President of the American Association of Physics Teachers.

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Physics Teacher Education Coalition

Section on Teacher Preparation

Alma Robinson, *Virginia Tech*

Josh Grossman & Angela Johnson of St. Mary's College of Maryland begin the Teacher Preparation Section by describing how their pandemic-necessitated remote recruiting efforts led to effective, scalable, asynchronous web-based activities that will persist in future semesters. Their activities reached both St. Mary's students, as well as prospective high school and community college students.

Doug Petkie and Shari Weaver discuss the successful strategies that Worcester Polytechnic Institute (WPI) has implemented to their physics teacher preparation program. With the guidance from the PhysTEC community and the Physics Teacher Education Program Analysis (PTEPRA) rubric, WPI has created a Learning Assistant program, utilized a Teacher in Residence, recruited teachers with Get the Facts Out resources, and partnered with a range of campus programs and administrators.

Adapting and Learning from Teacher Recruitment during the Pandemic

Josh Grossman & Angela Johnson, *St. Mary's College of Maryland*

The pandemic caused all kinds of terrible challenges, but there are also opportunities to learn from some of the changes we were forced to make. Pandemic-motivated alterations to our teacher recruiting activities also provide opportunities that will persist.

St. Mary's College of Maryland (SMCM) is a small, public, liberal arts college with an independent charter, located in historic St. Mary's City. In 2019, we were selected for a PhysTEC Recruiting Site grant, which began in 2020. Prior to the grant, a pathway to becoming a physics teacher existed through our physics BS and our master's of teaching (MAT) programs. However, it was not a highly visible program, nor did it have focused mentoring, physics pedagogy courses, or early physics teaching opportunities. Formalizing the program and its supports were the first components of our Recruiting Site grant work.

Direct recruiting of candidate physics teachers is another major component. We recruit from two populations: matriculated SMCM physics students who may not have considered teaching as a career, as well as students who have not yet matriculated. The latter include high school students and students transferring from two-year colleges. We had planned in-person presentations and conversations, but the pandemic intervened. For over a year, SMCM has had no in-person gatherings outside of class. Likewise, other institutions are not permitting outside visitors. We have also found it difficult to drum up a lot of participation in virtual events that are not part of class. Meanwhile, synchronous class time became all the more precious. As a result, we concentrated on creating interactive, asynchronous activities that could be assigned as part of a course. The interactivity promotes students' engagement with the information. Get the Facts Out (getthefactsout.org) has lots of well-researched material on the attractiveness of teacher salaries, benefits, quality of life, etc. The folks working on GFO were wonderfully helpful in providing feedback and data. We also drew ideas from an interactive teacher-recruitment website by Sarah Formica at the University of North Georgia.

In our web-based activity, each student responds to questions about teaching careers. After the student responds to each question, the aggregated responses are revealed from other students who have completed that version of the activity. By and large, this tends to confirm that most of the other students have similarly mistaken beliefs about teaching careers, and by extension so does much of society. The activity then provides the correct information, emphasizing that teaching is better (often considerably better) than what the bulk of students believe. It points out that negative messages about teaching from broader society may not be based on the facts. After the sequence of questions and reveals, the students report on changes in their knowledge and attitudes about teaching careers. They also have an opportunity to request a follow-up advising session on SMCM's pathways to teaching careers.

While we started creating the interactive, asynchronous activities out of necessity, they have additional benefits. Because they are online and asynchronous, no extra time is needed to present them to multiple groups; they're scalable. Certainly, in-person presentations and discussions provide higher quality interactions to a small number of students, but this approach enables us to cast a much larger net. It is also easier to collect data from the online activities than it is to do for in-person presentations.

We copied and pasted from the physics teaching activity website to make separate activity websites for multiple disciplines -- all of the College's STEM programs, plus educational studies. We embed the teaching career data in the websites from a common file (using iframe objects); this allows us to push updates to all websites at once. Several programs recognized right away that teacher recruitment activities went beyond providing a general societal benefit; they fit with SMCM's professional skills curriculum, and they help with recruitment and retention. For the same reasons, our dean pushed reluctant programs and thanked adopters. We can now present a unified message for the institution in recruiting STEM teachers. Many of the introductory and second-year courses where the activities are assigned have students from multiple majors. The students can select the teacher recruitment activity that best fits their interests. Instructors assign the activity, and the website records their ID upon completion, usually for a participation grade. Some instructors also assign a brief reflective paragraph. We drafted the activities, providing the framework, the broad questions, general information on teaching, and institution-wide advising information. The programs can edit the activities, add discipline-specific information, and control when they are deployed, but we retain access for updates and data collection. The other disciplinary programs are grateful that the arrangement saves them from most of the work of creating their own activities.

In our preliminary data, students' self-reports indicate that many learned about teaching and many increased their interest in it at least to some extent. The first semester of activities have been directly responsible for identifying two prospective physics teachers from a physics section, three prospective teachers from a calculus section, and half a dozen prospective biology teachers from a chemistry course.

At this point, the reader may be questioning the benefit to the physics program in doing all of this work for other programs. In institutions that are not particularly large, physics teaching students likely share at least some of their pedagogy courses with teaching students from other STEM disciplines, so recruiting STEM teaching students benefits all of them. At small institutions, there is even less differentiation in courses or sections for teaching students. Broadly supporting enrollment in the educational studies department (at SMCM we do not have a separate school of education) supports the physics teaching program and vice versa.

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Successful Strategies from the WPI PhysTEC Comprehensive Site

Doug Petkie and Shari Weaver, *Worcester Polytechnic Institute*

We would like to take this opportunity to share some of our successful strategies in the development of our Physics Teacher Preparation Program in the context of a polytechnic institute. Our journey started with the PhysTEC Fellows Program in 2018 and is continuing as a funded PhysTEC Comprehensive Site currently at the end of the second year of the three year award. It often takes about three years to see significant changes in a program and these changes are continuing to emerge as we transform our program. We owe our success to the adaption of effective practices others have developed and through mentorship from a strong PhysTEC community.

Worcester Polytechnic Institute (WPI) in Worcester, MA, is a private STEAHM (Science, Technology, Engineering, Arts, Humanities, and Mathematics) university with an undergraduate student population close to 5,000 students and a graduate population of 2,000 students, with BS, MS, and PhD degree programs in most departments and programs, including physics. A Project-Based-Learning (PBL) curriculum was implemented in 1971 that offers a powerful experiential learning platform that we utilize in our program which allows teaching practicums and field experiences to be part of a student's curriculum for their major. WPI does not have a formal department or college of education, and the teacher preparation program [1] is housed in the STEM Education Center, along with many other programs that engage K-12 teachers. Coordination and support for the teacher preparation program come from departments that house majors, so teaming with the STEM Education Center is essential and a key element to a thriving program.

Many of the elements we highlight here are found in thriving teacher preparation programs. Each institute has a different environment that can support a thriving program, and the Physics Teacher Education Program Analysis (PTEPA) Rubric is a valuable multi-dimensional tool for a program's reflection, strategic planning, and assessment [2]. Available in an interactive Excel workbook, it has features that allow you to track your program as it evolves, and the PTEPA rubric provides insights to potential blind spots and hidden opportunities not previously considered. The elements we describe here are found in the PTEPA rubric, and it is well worth the time to implement the rubric and study characteristics of thriving programs since institutional strengths vary from program to program. Approximately every 3-6 months, we discuss and update our rubric as we assess our progress and plan new activities and initiatives.

Another key element in our program was the creation of a physics Learning Assistants (LA) program [3] that has undergraduate students assist in teaching the laboratory sections, with graduate Teaching Assistants (TA), in the introductory physics course sequence. The LAs and TAs attend a weekly one-hour pedagogy session that focuses on pedagogical content knowledge (PCK) and utilizes resources such as the Periscope Video Lessons found on PhysPort [4]. Experienced TAs and LAs become mentors and co-leads in these sessions that promote an inclusive environment and the development of a physics identity, as pointed out in an article in the Summer 2020 FEd Newsletter on "Cultivating an Inclusive Culture in the Physics Department through a Learning Assistant Program" by Eleanor Close and Xandria Quichocho [5]. While we intend to transition the pedagogy session to a credited course, we currently offer the pedagogy sessions as part of being a TA or LA in the department, which has been run during the fall semester for the past three years. The key to the successful LA program is the weekly pedagogy sessions that create a community of teachers. This experience as an LA, coupled with the PCK sessions, have not only drawn students into our physics teacher preparation program, but this past year, has drawn two students to shift their career plans toward attending graduate school and joining a Physics Education Research (PER) group.

The Teacher-in-Residence (TIR) is another key element enabled by the PhysTEC Comprehensive Site award. Thomas Noviello (Leominster High School physics teacher) is the WPI TIR and plays many roles in our program that include teaching a section of the pedagogy sessions for the TAs and LAs, teaching an introductory course with LAs, individually meeting with current students in our program and students considering the program (retention and recruitment), holding informational sessions about the program for students in introductory physics courses about careers in teaching high school physics, organizing the regional high school physics teacher advisory group, and he also is the supervising practitioner for the students' teaching practicum and field experiences. These are all essential roles that would be difficult for a faculty member to fill who has not been a high school teacher. Thomas serves as a role model and inspiration to students in the program and the glue that creates a highly coherent program. The Physics Department and STEM Education Center are requesting to have the TIR position based budgeted between the two departments once the PhysTEC grant is completed.

Recruitment and university buy-in are other key elements we have focused on. In this case, Get the Facts Out (GFO) resources and the GFO team have been essential in our efforts [6]. We have adopted PowerPoint materials from the GFO Recruitment Resources and followed the Tested Messaging advice to best modify and utilize these resources. These have been used in several venues from open houses and accepted student days for high school seniors (and their parents) to fall academic and career advising sessions for first-year WPI students. During many of these sessions, we have current students in the physics teacher preparation program participate and describe their experiences, as student promotion of the program sends a very powerful message. We have also used the materials to present at the WPI Provost's meeting that includes all upper academic administrators, department heads, and academic program directors. This presentation yielded new partnerships, such as with the athletic program director, as many student athletes look toward coaching high school sports and have not considered a teaching career. For the Provost's meeting, we utilized the pre- and post- Perceptions of Teaching as a Profession (PTaP.HE) survey (using SurveyMonkey) that was analyzed by the GFO team to provide feedback on the impact of the presentation, which did result in improving academic leaders' perceptions of teaching as a career pathway for WPI students.

Moving forward, other significant elements that have aligned with supporting our program is the recent NSF Robert Noyce Teacher Scholarship Program award, the hiring of PER faculty member for this coming fall, and the allocation of a dedicated laboratory room for the physics teacher preparation and LA programs. As an aspirational PhysTEC 5+ member, we look forward to continuing to learn from, and contribute to, the PhysTEC community.

We like to thank the PhysTEC and broader physics community (and their funding sources) for creating and disseminating such a powerful set of resources for the teacher preparation community. We also thank other members of our core WPI team, Associate Teaching Professors of Physics Rudra Kafle and Izabela Stroe, Dana the Physics Laboratory Manager, and Thomas Noviello, the TIR.

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Executive Committee of the FEd

Upcoming newsletter deadlines:

Fall 2021: October 1, 2021

Spring 2022: January 15, 2022