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PEER: Professional-development Experiences for Education Researchers

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Professional Development for Emerging Education Researchers: Two Models for Field Schools

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Abstract

To help foster the next generation of STEM education researchers, we have developed and conducted a two-part professional development model that combines intensive in-person workshops with long-term remote activities. Participants include emerging researchers at all career stages, including undergraduates, graduate students, postdoctoral researchers, junior faculty, and more senior faculty considering a change in research focus. In this paper, we outline two versions of the model: a distributed workshop where participants gather from all over the world for two weeks in-person, then disperse for ongoing remote meetings; and a regional workshop, where we facilitate education research among participants who live near each other. In both versions, emerging and established education researchers work closely together to develop research questions, learn appropriate analytic techniques, and, when possible, explore data. Workshops attract participants from a variety of STEM education research communities and have taken place in multiple countries, including Rwanda, Germany, Mexico and the United States. In this paper, we lay out the model for professional development, describe the different contexts we have explored, and discuss various results from the different manifestations.

Introduction

The path to becoming a researcher is, in the United States, seemingly well-established. Graduate students work under the mentorship of faculty experts in a research area, gradually acquiring the technical skills, theoretical knowledge, and insight required to conduct research. Particularly in science, technology, engineering and mathematics (STEM) fields, the researcher frequently undergoes subsequent development as a post-doctoral researcher. This position ideally gives the researcher more agency over project choice and methodologies, an independence that they will need as a faculty member. More limited options exist for future redirections in a research area. Among more experienced faculty, sabbaticals may provide the opportunity to relocate and learn a different subject, while workshops of various lengths can offer instruction in specific techniques that may lie outside the original area of expertise.

The field of education research presents unique challenges to these models. The connection with student learning and pedagogy draws a significant number of "boundary crossers," faculty who, unsatisfied with their effectiveness as teachers, become aware of the existing research and gradually transfer more of their time to systematic exploration in the area. The field is explicitly interdisciplinary, combining disciplinary expertise with formal education research theory and methodology. These methods are often quite distinct from more traditional STEM research areas including, for example, qualitative inquiry or analysis of videotaped classrooms or other student interactions.

We have developed a model for emerging researchers to learn about the nuances of education research. The model is flexible, with both on-site and remote forms, and capable of responding to the particular motivations and circumstances surrounding individual faculty and institutions. Currently in its fifth year, PEER (Professional-development for Emerging Education Researchers) has demonstrated its effectiveness across a wide range of contexts, countries and participant experience. In this paper we present the driving philosophy behind PEER, evidence for both its need and value across a broad community of researchers, and evidence for its success at fostering new research in discipline-based education.

Existing models for faculty professional development

There are a variety of existing models for faculty professional development. Here we briefly review models that pertain to teaching and, separately, research. One nuance of education research is its interplay with faculty teaching responsibilities, and professional development activities that explicitly separate the two can miss an opportunity to foster productive growth in both areas. Additionally, few existing models address post-intervention collaboration outside of a single institution.

Professional development of teaching The most common sponsors of faculty professional development activities surrounding teaching are institute Centers of Teaching and Learning. Currently there are more than 200 centers that participate in the Network of STEM Education Centers (NSEC)[1], an organization of campus-based centers that seek to catalyze broad education transformation. The vast majority of these workshops, or similar on-campus programs, aim to transform faculty practice in the classroom. These workshops tend to be limited to faculty at the particular institution and reside in an administrative unit (the center) rather than an academic department. A consequence of this placement is that these efforts are most commonly interpreted by departments and administration as pertaining exclusively to an individual's teaching responsibilities rather than their scholarship. Teaching workshops may also be seen pejoratively, associated with the remediation of "bad" teachers, or with a "quick fix of the week" attitude.

There are also a number of professional organization-sponsored workshops (e.g. the American Association of Physics Teachers' New Faculty Workshop[2]). These off-campus experiences give faculty the opportunity to immerse themselves fully in professional development while also making connections with like-minded peers. The AAPT New Faculty Workshop, for example,

hosts interactive sessions on research-based instructional materials [3, 4] and methods (e.g. Think/Pair/Share and "clicker questions"), current questions in physics education research, and other resources for improving teaching (e.g. PhysPort[5]). Post-workshop assessment[6] finds these workshops extremely effective at raising awareness of research-based pedagogical practices. The long-term adoption of methods, however, is significantly affected by local culture, with time and resource constraints limiting adoption of research-based methods.

Professional development of research Professional development for research methods are typically off-campus, in either disciplinary field schools or extended workshops (like the Gordon Research Conferences). These allow the researcher to learn about new methods and techniques to a depth unavailable at traditional conferences, and to make connections with experts to whom questions can be addressed. Gordon conferences in particular are designed to foster collaboration, and the week long experience is deeply interactive. Post-meeting communications, however, are largely left up to individual participants, with no formal follow up. Because participants generally attend these in-depth experiences individually, a natural cohort may not exist at their home institution, and participants from smaller institutions are less likely to find collaborators nearby.

Models for Field School

We have developed a field school experience that allows for an extended, in-depth experience with education research methodology while promoting the formation of a collaborative cohort. These field schools have two different "flavors:" a distributed model that forms a geographically dispersed cohort and a regional model that centers on an existing critical mass of local participants, possibly drawn from multiple institutions in the same region. Both allow participants to develop and pursue research questions of their choosing, subject to some methodology constraints, giving the researchers important agency over their scholarship.

Distributed Model The distributed model has two components: an extended (typically two-week) in-person experience during the summer and a series of virtual meetings throughout the subsequent academic year. Participants form (or join previously formed) working groups that focus on specific research projects. During the in-person experience, the schedule includes modular workshops on a variety of topics and builds in both structured and unstructured time for working groups to focus on relevant aspects of data collection, analysis, and/or publication. Recognizing that a strong sense of community is necessary to the groups' sustainability, the experience pays close attention to fostering a sense of togetherness, with communal meals and social outings. After the in-person experience ends, the entire cohort meets virtually on a bi-weekly basis. In addition, individual working groups meet virtually on an as-needed basis to continue the work of data analysis and paper preparation, usually with one PEER co-organizer joining to provide any needed support.

The distributed field school drew inspiration from Seattle Pacific University's Interdisciplinary Research Institute in STEM Education, I-RISE[7]. I-RISE brought together graduate students,

postdoctoral researchers and junior faculty for an extended, collaborative research project centering on a separate high school teacher professional development project. Participants would spend the morning observing the teachers, taking field notes and organizing video recording. Afternoons were spent analyzing the data, forming and discussing research questions and developing the broader project. Inspired by I-RISE, our experience initially formed around a program, Integrating Metacognitive Practice and Research to Ensure Student Success (IMPRESS), that supports the persistence of first generation (FG) and d/Deaf or hard-of-hearing (DHH) STEM majors through explicit metacognitive activities. Students in IMPRESS spend the morning engaged in authentic scientific investigations, developing models, designing and conducting experiments, and synthesizing results into a theory for climate change. Afternoons are spent in explicit metacognitive reflection, learning about a variety of affective and metacognitive concepts that affect learning. By hosting the field school concurrently with the IMPRESS summer experience, participants could engage in a hands-on experience with logistical and ethical aspects of classroom video data collection and management, as they pursued research questions of interest.

Given the distributed nature of the ongoing research after the field school, participation in this model is targeted at high autonomy individuals and groups, who are often somewhat isolated at their home institutions. Over four years, the number of participants has grown each year from six in 2014 to nineteen in 2017. Each year, we have a mix of returning and new participants. In our four years, we have had participants from 23 institutions and five countries, including faculty, postdocs, graduate and undergraduate students. We have produced seven peer-reviewed publications and over twenty presentations. We have also received several small grants through the American Association of Physics Teachers PER Topical Group that have allowed us to provide some housing support to PEER participants during the summer workshop.

Regional Models Our regional field schools are designed primarily to help nucleate/facilitate a local community of emerging education researchers. Unlike the distributed model, these experiences target local communities of faculty and their mentees (undergrads and grads). These schools vary in length (2-day, 3-day, 5-day) and we work with the local organizers ahead of time to identify which modular workshops best fit the specific needs of the participants. Each school therefore has a distinct focus generated by the participants, although there are elements that are common among all of the schools. For example, in every field school, we have at least one workshop on identifying research interests and how to turn those interests into viable research questions. However, even these common workshops are adjusted to target the particular needs of the local community.

The regional field schools have taken place in a variety of international settings, including Kibungo (Rwanda), Monterrey (Mexico), and Cologne (Germany). In Rwanda, faculty were under pressure to develop publishable research projects while working within the constraints of a graduate program in which many students also were full-time teachers and resources were limited. Sessions therefore focused on the types of data available to faculty and students and questions that would resonate most strongly with government interests and other national funding agencies. Some faculty were sponsored by a recent World Bank award, and so discussions continue about international partnerships that can form a community that spans continents. In

Cologne, diverse faculty interests led to workshops on equity in classroom practice from both a research and pedagogical perspective. As with the Rwandan faculty, Cologne participants included both STEM and non-STEM disciplines, and so an expansive view of topics, data and methods was adopted.

Unlike the regional field school model, where participants are geographically distributed, the distributed school does not require an explicit coordination of a post-workshop community. Our efforts are limited to demonstrating various techniques for promoting and maintaining a local community of practice (e.g. e-mail listserves and regular meetings to discuss articles or research findings).

Principles

Theoretical perspectives In designing and conducting our field schools, we draw heavily from two theoretical perspectives: responsive teaching and communities of practice.

Within STEM education, responsive teaching is a pedagogical approach that highlights student ideas, makes disciplinary connections to these ideas, and uses the substance of these ideas to direct a class.[8] While many models of student-centered instruction foreground students' ideas within experiments and topics chosen by an instructor, in a responsively-taught classroom, promoting student agency over choosing topics and conducting investigations is central.

In our case, we recognize that our participants usually have backgrounds that vary widely in terms of exposure to and expertise in the issues, processes, and techniques of educational research; nonetheless, they all have research interests in education. By grounding our schools in responsive teaching, we help participants refine their own interests and grow their agency and confidence in directing research projects. We treat this variety as an asset to be utilized and not a challenge to be overcome.

In our field schools, we are also working to develop a community of practice among participants. Since most of our participants are emerging education researchers, they are still in the process of forming their professional identity, at least in regards to their identity as an education researcher. Research has shown that one's professional identity is intimately linked to community participation.[9, 10]

As a theory of learning, Communities of Practice assumes that the fundamental process by which we learn and develop our identity is through engagement in social practice.[11] While communities of practice take many forms, they all share the same basic structural elements.[12] There is a *domain* of knowledge that ties together a *community* who are interested in this domain. As mentioned above, each field school is composed of a group of people who have research interests in education. The final element of a community of practice is the shared *practice* that the community develops to be effective within their domain. We see the field schools as helping these communities in the process of creating this shared practice.

Guiding Principles Based on the perspectives of responsive teaching and communities of practices, we have used several guiding principles (Table 1) in building our field schools.

First of all, we believe that field schools should be responsive to the needs of the participants and that this responsiveness should be reflected in both the preparation and enactment. Thus, we work with participants and local organizers to understand and anticipate needs ahead of each field school to plan a schedule and topics that would be most appropriate for each environment and group. Then, during each field school, we make space for discussions and topics that reflect the emerging needs of participants as they engage with the research.

Second, not only do we believe that our field school should be responsive, but that research itself is and should be responsive. We address this fluid and generative nature of research by framing research as "play": an enjoyable process by which we generate, try on, and adapt new ideas. As one faculty participant, "Dan", noted in his reflections,

> The other thing to try and tease out here is why I'm feeling positive about [this analysis method] We were feeling kind of negative about it two weeks ago, it seemed like a lot of work for insight that could be got with less work using other methods. Now it feels more useful.

Dan felt that discussing his emergent coding methods with his working group allowed him to feel hopeful about his tentative results and see a path forward to more robust conclusions.

Third, all research should be situated within and responsive to the larger scientific community of which we are a part. Thus, we are strong proponents that research cannot and should not be divorced from writing and dissemination. Issues related to how to share research should be discussed and integrated throughout the entire research process. Thus, we place a strong emphasis on generative writing and discussing one's audience early and often. We also find it is helpful to have participants frame their project in terms of a paper early as this provides a focus and goal, as well as encourages explicit attention to documenting the process and situating the research within the existing community. In addition, for emerging researchers, this focus on writing and producing papers is helpful in setting a precedent for future productivity.

A graduate student participant in the distributed field school, "Amelia", reflected on the *communicative* guiding principle with a long list of the benefits of generative writing, including

> [Generative writing] was very helpful for me to get my ideas out of my head. It helped me offload some of the mental effort required to maintain my thoughts and ideas, as I was able to not only put them somewhere but also process them more easily.

Other participants felt that the field school's emphasis on developing papers for publication was a substantial strength that had been missing in their previous research preparation.

Finally, our grounding in the theoretical framework of communities of practice leads us to place explicit attention and effort on the collaborative nature of research. Thus, several of our modular workshops focus on aspects of operating well within groups from an ethical as well as logical perspective (e.g., authorship, data sharing, etc.). In addition, most/many of our workshops include

activities that provide experiential practice with working in groups (e.g., small group discussion of ethical case studies) and co-mentorship (e.g., forming working groups with mixed levels of expertise).

Table 1: Guiding principles for field schools

Principle	Description
Responsive	Field schools are responsive to participants' needs.
Playful	Researchers play with ideas and data to generate new knowledge.
Communicative	Dissemination and presentation are integral parts of research activities.
Collaborative	People do research together, in communities.

Our guiding principles are manifested differently in the distributed and regional field schools. In the following sections we outline some examples of how these principles are instantiated in particular field schools.

Distributed Field School To demonstrate how our guiding principles influence the distributed field school, we use the 2017 field school as an example. The schedule for this field school is shown in Table 2.

As discussed above, our field schools are *responsive* both in preparation and enactment. As a part of their application for the distributed field school, participants write a cover letter describing their interest, background, and any relevant expertise in discipline-based education research. After they have been accepted, we ask them to write a short statement of research interest, in particular identifying which of the current PEER working groups they are interested in and why (or proposing a new working group). These initial statements, combined with our experiences of previous years, help us to plan for workshops that we think will be needed by the current cohort. For example, in 2017, we had many more new participants joining us with diverse interests than in previous years, so we placed a stronger emphasis on forming working groups at the beginning. In addition, these statements induct participants into the *communicative* guiding principle.

While we do plan a schedule based on these initial interactions with participants, the actual scheduling of particular workshops often depends on the needs of working groups, particularly in the second half of the field school while working groups are actively engaged in research, in accordance with the *responsive* guiding principle. The schedule in Table 2 reflects the schedule as it was actually enacted in 2017, but differs in some significant ways from our initial plan. For example, we originally planned to do workshops in the mornings and have the afternoons for working groups and generative writing (e.g., Day 5). However, we received feedback from participants after week 1 that they preferred to be in working groups in the mornings and do workshops in the afternoons. So, we shifted the schedule to reflect this need (e.g., Day 7). In addition, which day we did a workshop was somewhat dependent on the needs of the working groups. For example, we waited to do the workshop on "Creating/refining central claims" until all of the working groups had progressed far enough in their work for this to be a productive discussion for all groups. While we expect the schedule for the 2018 distributed field school to have similar components to that in Table 2, we also expect it to change based on the background of the participants and the needs of the working groups.

Table 2: Schedule for Distributed Field School in Summer 2017. Each day included communal breakfast and lunch and the first day included a communal dinner.

Day 1	Morning	Overview and Introductions
		Research ethics
		Data Sources and Working Groups
	Afternoon	Identifying research interests
		Generative writing
	Evening	Communal Dinner
Day 2	Morning	Introduction to IMPRESS program
		Logistics of data collection (e.g., camera setup)
		Forming working groups
	Afternoon	Ethical conduct of research
		Generative writing
Day 3	Morning	Working group planning and next steps
		Working group checkin
	Afternoon	Working groups and generative writing
Day 4	Morning	Research design
Day 5	Morning	Analyzing video data
	Afternoon	Working groups and generative writing
Day 6	Morning	Components of paper writing
		Planning for academic year participation
	Afternoon	Working groups and generative writing
Day 7	Morning	Working groups
	Afternoon	Conducting effective literature searches
		Discussion about appropriate work boundaries (spontaneous)
Day 8	Morning	Working groups
	Afternoon	Discussion of working group issues
		Creating/refining central claims
Day 9	Morning	Working group planning for after field school
		Living nature of research
	Afternoon	Communal social activity
Day 10	Morning	Review of what we've done so far
		Scheduling and next steps after field school
		Reflection and debrief of PEER experience
	Afternoon	Documentation of working group status

To highlight the fluid and generative nature of research (the *playful* guiding principle), we build in time for different working groups to bring an issue to the larger group to "play" with. Depending on the issue, we use that time to define terms, clarify questions, broaden perspectives, etc. In many of our workshops, we emphasize the "messy" side of research that is often obscured in final products (e.g. papers) and can give false expectations, particularly for less experienced researchers. We also include a workshop that explicitly addresses the "Living nature of research questions", where we use examples from our own previous research to show how a project can (and should) change over time in response to a variety of factors.

In addition, we place a heavy emphasis on generative writing as a part of the *communicative* guiding principle. On the first day, we do a short workshop on generative writing and each participant creates their own page on a group wiki that they contribute to each day. For the first few days, we provide some explicit prompts to help them start the process, but then fade this throughout the field school as they develop the habit of writing every day. Each participant uses their page slightly differently: some use it like a reflective journal, others like a lab notebook, others as ways to draft parts of papers. For many, their writing varies depending on where they are in the research process.

By highlighting generative writing from the beginning, we establish that writing isn't a summative act, but is and should be integrated throughout the research process. We also reinforce this by asking working groups to establish a clear goal for their project, such as a paper that could be reasonable accomplished while they are a part of PEER. We then support this goal through workshops such as "Components of paper writing", "Conducting effective literature searches", "Creating/refining central claims", etc. Since working groups already have a paper in mind, these workshops are then targeted to their particular paper. This strong emphasis on writing during the field school is also vital to support the longitudinal partnership once participants are back at their home institutions.

For the distributed field school, we are building a community of practice that is geographically dispersed. Working away from one's home institution and living side-by-side with a small group of collaborators during the field school helps to develop intense partnerships that can survive the subsequent academic year. To facilitate this community development (the *collaborative* guiding principle), we help participants form working groups and provide extensive time for these working groups to develop independent from the larger group (see Table 2). Our workshops include collaborative activities and several focus on aspects of collaborative research. For example, the 2017 workshop on "Components of paper writing" provided a framework for thinking about contributions to a project, which was followed up with a breakout session where working groups discussed how their group would decide on authorship. In addition, we build in explicit non-work related time for community building. Every day involves communal breakfast and lunch and in 2017, we shared a communal dinner at the home of one of the directors on Day 1 and went out for ice cream on Day 9. During the evenings and weekend, smaller groups formed to go on outings to Niagara Falls, baseball games, local festivals, etc.

Regional Field Schools As discussed previously, we have developed many modular workshops that can be used and combined to address the needs of each community. In Table 3, we show the

schedule of workshops for one (Cologne) of the regional field schools and discuss here how this school embodied the guiding principles outlined in the previous section.

Table 3: Outline of workshops for Regional Field School

Day	Length	Workshop
1	2 hr	Identifying research interests
	3 hr	Turning interests into projects
2	2.5 hr	Conducting video-based research, refining research questions
	2 hr	Finding creative solutions, community building
3	2 hr	ZuS-STEM Education Research Offspring Project (local initiative)
		(two day break)
4	1.5 hr	Education Research: a personal narrative
5	4 hr	Increasing engagement & equity
	3 hr	Measuring engagement & equity
6	2 hr	Refining a research idea, next steps

This Field School involved a population of graduate students and senior research assistants from a variety of disciplines as well as pre-service teachers interested in bringing a research lens with them when they entered the elementary and high school environment. Preliminary discussions revealed a strong interest in inclusion and equity, with a regional aspect analogous to US discussions on including students from rural environments[13] and avoiding educationalist[14] attitudes. Because participant disciplines included both STEM and non-STEM subjects, initial workshops were developed to elicit research interests and articulate them in ways that could be shared within the group. The second day was then devoted to methodology, in particular qualitative and video-based research, and navigating the particular situational obstacles the researchers anticipated.

The first two days were quite draining, and so days three and four were intentionally less demanding. Participants had time for informal interactions with both PEER leaders and other participants during which ideas were developed in a less demanding environment. The intensity increased again on day 5 with a day-long focus on engagement and equity, which introduced definitions of inclusion and equity amenable to rigorous investigation, and appropriate qualitative and quantitative methods. The week-long workshop concluded with a focus on developing individual and community plans of action.

Whereas the distributed school forms working groups — collaborative teams focusing on a specific project — the regional workshops emphasize the articulations of existing interests, data and projects. Generative writing was used to elicit these articulations, with participants committing their ideas to paper (or computer). These ideas were then shared amongst participants to create a broader knowledge of what colleagues were engaged in. Generative writing prompts followed a similar iteration as in the distributed schools. Initially participants listed their motivations and first questions; subsequent writing tasks prompted them to consider the data they had available (e.g. school records or access to specific classrooms) and the questions they found most intriguing. These writings were then used as the basis for group discussions.

Results and Lessons Learned

Gauging the efficacy of a professional development program is difficult. We measure success quantitatively in two ways: retention of participants in ongoing PEER activities (distributed model only) and number of presentations and publications generated from ideas at field school. Regional workshops have been too recent to accumulate meaningful engagement data (e.g. network analysis of faculty remaining in contact), although we note that there is evidence that regional schools can attract participants to subsequent distributed schools.

Retention numbers from the distributed model are promising. Of the 13 unique graduate students, post-doctoral researchers and faculty that have participated in at least one field school, **70%** (9/13) returned for a subsequent school, indicating they felt part of a valuable community (three of the 12 undergraduate researchers also returned for a second year). Eight of the nine also participated in collaborative research throughout the academic year in between the field schools.

The interaction between the distributed and regional experiences is also promising. As a result of their participation in the distributed school, two separate participants organized regional experiences back at their home institutions (in Cologne and Monterrey). As a result of the Cologne regional school, an additional individual then joined the subsequent summer's distributed school. Two regional experiences were offered in Rwanda over the summer of 2017; as a result, two participants will be attending the distributed school in Rochester, NY in 2018. This synergy demonstrates both the effectiveness of the various implementations and the perceived value to the participants.

To date, field school participants have submitted nine peer-reviewed papers (seven published; two under review) and over twenty presentations both internationally and locally.

In the 2017 distributed field school, we asked participants to write reflections on the following questions:

- What is one thing from PEER that worked well?
- What is one thing from PEER that didn't work well or needs to be improved?
- What is one thing you could have done differently to make this a better experience for you?

and then had a follow-up discussion regarding the participants' experiences. This survey and discussion formalized our feedback processes and discussions which had been more informal and organically generated in prior distributed and regional field schools.

From these discussions, we have learned the importance of community building within the experience, and the value of early social events in environments outside the academic campus (e.g. dinner at a director's house). Participants also pushed for an inversion of the programming. The initial schedule had programming in the morning and group-work time in the afternoon. After a few days, however, the participants expressed a strong preference to work together in the morning on their project, while they were still fresh. The ebb in energy in the afternoon also led us to schedule 1-2 afternoons of free-time, with explicit instructions to not work. This was similar to the scheduling of the Cologne regional school, where a 2 day break provided an important

opportunity for participants to rest and gather energy. Future schools will see us build more explicit downtime into both experiences.

An important observation from both regional and distributed schools is the importance of setting expectations. This is actually quite difficult given the emergent nature of the workshop topics, which follow the participant interests. As a result, participants felt that they brought their own expectations to the experience with little external guidance. A participant suggested that the organizers summarize the different ways that people had participated in the past so that new participants would have a better idea of the the intended experience. It also became apparent that the facilitators spent a great deal of time assessing the different working groups' dynamics and progress, but did not communicate those assessments to the groups. As a result, the flexibility that the school developed also created some anxiety in that groups felt unable to plan. In the future we will be more transparent to participants.

Despite these limitations, distributed field school participants showed clear growth in their approach to research over the course of the field school. One undergraduate participant, "George", echoed the *collaborative* guiding principle in reflecting on his growth, writing:

> I think that . . . I will be successful in completing my tasks after we leave because I will actually have practical components of research to conduct on my own time. . . . [Today's discussions] allowed me to think critically about research topics that I would otherwise have never contributed to.

Other participants echoed George's sentiment that participating in field school allowed them access to research topics, methods, and community that they otherwise could not have participated in.

Conclusions

We have shown the development of a flexible model of professional development for emerging education researchers (PEER) that are built on principles derived from the theoretical frameworks of responsive teaching and communities of practice. Our field schools are built around the ideas that research is fluid and generative, should be situated within and responsive to the larger scientific community, and is collaborative in nature. These field schools are also responsive to the needs of participants and so these principles are enacted differently in the different schools. The ability to successfully adapt the principles to two different environments, one situated at participants' home institutions and the other at a remote location, indicates a general value in the workshop modules that transcends the implementation specifics. While the models will continue to develop and evolve, we believe the success of our emerging education researchers in seeing their research through to dissemination at national conferences and peer-reviewed publications establishes the promise of PEER for a different kind of professional development.

References

[1] "Network of STEM Education Centers," https://serc.carleton.edu/StemEdCenters/index.html.

[2] "American association of physics teachers new physics and astronomy faculty workshop," https://www.aapt.org/Conferences/newfaculty/nfw.cfm.

[3] D. R. Sokoloff and R. K. Thornton, *Interactive Lecture Demonstrations*. John Wiley & Sons, 2001.

[4] K. Perkins, W. Adams, M. Dubson, N. Finkelstein, S. Reid, C. Wieman, and R. LeMaster, *PhET: Interactive Simulations for Teaching and Learning Physics*. WORLD SCIENTIFIC, 2012, pp. 702–709.

[5] "PhysPort: Supporting physics teaching with research-based resources," https://www.physport.org.

[6] M. Dancy and C. Henderson, "Pedagogical Practices and Instructional Change of Physics Faculty ," *American Journal of Physics*, vol. 78, pp. 1056–1063, 2010.

[7] "Interdisciplinary Research Institute in STEM Education," https://www.facebook.com/interdisciplinaryresearchinstituteinstemeducation/.

[8] A. D. Robertson, L. J. Atkins, D. M. Levin, and J. Richards, "What is Responsive Teaching?" in *Responsive Teaching in Science and Mathematics*, A. D. Roberton, R. E. Scherr, and D. Hammer, Eds. Routledge, 2016, pp. 1–35.

[9] E. Wenger and J. Lave, *Situated Learning: Legitimate peripheral participation*. New York: Cambridge University Press, 1991.

[10] P. W. Irving and E. C. Sayre, "Conditions for building a community of practice in an advanced physics laboratory," *Physical Review Special Topics - Physics Education Research*, vol. 10, no. 1, p. 010109, 2014.

[11] E. Wenger, *Communities of Practice: Learning, Meaning, and Identity*. New York: Cambridge University Press, 1998.

[12] E. Wenger, R. McDermott, and W. M. Snyder, *Cultivating Communities of Practice*. Boston, MA: Harvard Business School Press, 2002.

[13] S. R. Ali and J. L. Saunders, "The career aspirations of rural appalachian high school students," *Journal of Career Assessment*, vol. 17, no. 2, pp. 172–188, 2009. [Online]. Available: https://doi.org/10.1177/1069072708328897

[14] T. Kuppens, R. Spears, A. S. Manstead, B. Spruyt, and M. J. Easterbrook, "Educationism and the irony of meritocracy: Negative attitudes of higher educated people towards the less educated," *Journal of Experimental Social Psychology*, 2017. [Online]. Available: http://www.sciencedirect.com/science/article/pii/S0022103116305509