PhysPort as professional development to foster creativity in teaching

Linda E. Strubbe, Adrian M. Madsen, and Sarah B. McKagan
American Association of Physics Teachers

Eleanor C. Sayre
Department of Physics, Kansas State University

Instructor professional development in physics often focuses on a linear path towards using research-based teaching methods. However, this does not reflect how instructors frame their teaching. Instead, we propose a professional development focus on supporting physics instructors' creativity in teaching. Creativity is important as instructors teach in diverse contexts and hold diverse educational values. Creativity research indicates that having a well-structured space to explore many ideas can support creativity. We investigate this for the case of PhysPort, a website for physics professional development. We present results from interviews with PhysPort users, to show how they joyfully explore, feel trust in materials on the site because they are research-based, and use ideas from PhysPort creatively. We also discuss how better site organization could support users' creativity more. Through this case study, we encourage designers of instructor professional development to consider supporting instructors' teaching creativity as a key goal.

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I. INTRODUCTION

Instructor professional development in physics teaching often is framed as a linear path: instructors should move towards more extensive and sustained use of research-based teaching methods [1–3] (which are often branded with a specific name; [4]), either with fidelity or adaptation [5–10]. Physics education researchers also often advocate for instructors to assess learning in their courses with concept inventories [2, 11, 12]. However, this linear trajectory does not reflect how instructors frame their own teaching [10]. The space of productive ways to teach and assess learning is very broad and spans many dimensions [e.g., 10–15]. Further, instructors teach in many different contexts, with many different types of students, have many different educational values and goals, and encounter many different day-to-day situations. Because of this diversity, there is no single best way to teach. Instead, *creativity* is a key element in successful teaching [16–19]: Bramwell et al. argue that creativity in teaching *"most often means combining and integrating different educational theories, stances, and models about teaching, learning and instruction in novel ways to address the needs of unique learners. There are no clear-cut, explicit or correct solutions to address learning issues and teaching dilemmas; there are myriad ways to conduct teaching and instruction emergent out of multitudinous frameworks"* [16].

We propose that physics professional development should support instructors in developing creativity as teachers. In this paper, we investigate how supporting creativity works in the case of PhysPort, a website for professional development for physics instructors. Professional development aimed at fostering creativity aligns with an asset-based agentic paradigm we have proposed for physics education research [10]: it supports faculty developing their own new ideas about teaching, and making their own decisions in line with their own educational goals and values.

We draw on creativity research to focus on two factors that foster creativity:

1. Having many ideas to explore and play with [20];
2. Having a well-structured space to explore [21].

We take a parallel to Duckworth's research with children, in which she argues that "the having of wonderful ideas"—i.e., their own creative ideas—is a critical component in children's development [20]. Duckworth [20] and Hawkins [22] both advocate becoming familiar by exploring, and both highlight the curiosity and joy of that exploration. Having familiarity with many ideas prepares children to make new connections between ideas. Extending this picture to instructors learning to teach physics (as did Russ 2018 [23] as part of the theme of PERC 2018), we suggest that instructors' new creative ideas about teaching will build on a foundation of other ideas; that the more ideas instructors are familiar with in physics teaching already, the more new creative ideas they will be ready to come up with; and that instructors may even take joy in the exploration and creative process. Higgins et al. also highlight the importance of teachers experimenting with new ideas [24].

At the same time, it is helpful for the exploration space to have thoughtful structure. Following our parallel with Duckworth's ideas [20], we suggest that professional development can work by providing strategically chosen materials and questions in ways intended to spark instructors' new creative ideas. We also draw on Sagiv et al.'s research on fostering creativity in the context of organizational behavior [21]. They contrast the Freedom approach, in which people have wide-open scope to develop creative ideas, with the Structure approach, in which people have a more restricted space. Sagiv et al. find that the Structure approach fosters more creativity by channeling people to focus on core elements of their task [21]. They find that structure can *"allow individuals to systematically re-organize components of the problem's environment in a way that generates creative solutions."* People also are more creative if they feel a sense of psychological safety [e.g., 25, 26], which for our context, we interpret as feeling trust in the materials they are exploring.

In this paper, we discuss PhysPort, a website that supports physics faculty in incorporating research-based teaching and assessment in their classrooms (www.physport.org; [27]), as a case of professional development in physics. We investigate how PhysPort supports instructors' creativity through five claims, which we connect to these two factors that foster creativity. PhysPort was developed through a process of "user-centered design" [e.g., 28–30], designing and testing the site based on research into user needs. Because the site was designed in pieces over time, we are now embarking on a process of redesigning the entire site. Part of this includes interviewing experienced users of PhysPort, to learn how they use the site and how it impacts their work. In this article, we share results of these interviews as a case study of how professional development can foster instructors' creativity.

II. METHODS

We recruited interview participants via a survey about PhysPort use that we emailed to about 4500 registered PhysPort users and linked to from a banner on the site. About 300 users filled out the survey, of whom about half indicated interest in participating in an interview. We invited 21 of these users to participate in an interview, aiming for users who gave rich survey answers; distribution across which sections of PhysPort they use most (as indicated in the survey); diversity in gender, ethnicity, and institution type; and inclusion of several users from outside the U.S.

Twelve of these users participated in an interview during Winter 2020. Throughout this paper, we refer to users by pseudonyms. Their demographics follow. We did not achieve diversity in ethnicity or institution type, due to who responded to our request for an interview and our decision to cap our number of interviews at twelve.

- 6 women and 6 men;
- 11 working in the U.S. and 1 in the U.K.;

- 1 identified as Latinx, 1 as Asian, and 10 as white;
- 6 from research-focused 4-year institutions, 3 from teaching-focused 4-year institutions, 2 from 2-year colleges, and 2 from high schools (one user teaches both high school and 2-year college, so is double counted).

Two researchers (LS and AM) conducted each interview over Zoom. One researcher primarily asked questions, while the other took field notes and asked occasional follow-up questions. Interviews were semi-structured and lasted about one hour. Our goal was to learn rich stories about how instructors use PhysPort and what impact it has on their work. We asked about instructors' institution and role, how they started using PhysPort, a recent time they used PhysPort, how PhysPort impacts their work, challenges they experience using the site, and their gender and ethnicity identities. We asked users to share their screen while they moved around the site. After the interviews, the two researchers debriefed together to generate short reflections. Audio for all interviews was transcribed using Rev.com.

Analysis for this project focused on transcribed audio data, augmented by our field notes and reflections. We referred to the video with screen share any time participants referred to their screen. For Claims 1 and 2 that involve participants' affect, we also reviewed the video. Our analysis approach follows an adaptation of Engle et al.'s methodology of "progressive refinement of hypotheses" [31]. LS and AM discussed possible claims based on impressions of the interview corpus, then examined our data for evidence to support or refute each tentative claim, and revised our claims. Sharing emerging claims with our larger team stimulated ideas for possible theoretical framings. We considered creativity as a framing and further refined our claims based on this and further examination of our data. LS examined each transcript for evidence of each claim; AM examined a random set of half of the transcripts for evidence of each claim. We agreed on the existence or lack of evidence for the claim in 81% of the cases examined. Most disagreement was related to Claim 2. Through discussion, we refined that claim and resolved all disagreements.

III. RESULTS

We conducted interviews with experienced users of PhysPort—instructors who tend to visit regularly and be enthusiastic about the site. These experienced users enjoy exploring on PhysPort: they like seeing lots of new teaching ideas, and that can spark their own new creative ideas. It's helpful for instructors to have a concrete idea to get them started on exploring; in the case of PhysPort, this is often assessments. The structure of PhysPort also facilitates instructors' exploration: many instructors appreciate that PhysPort restricts the scope of their exploration to materials they can trust, that are based in research; many also appreciate aspects of how ideas on the site are organized. Once instructors have been exploring, they demonstrate their creativity by using what they find on PhysPort in creative ways. Last, PhysPort's organization could be improved to help users explore more productively, and thus foster their creativity further.

CLAIM 1: Experienced users explore and discover new ideas on PhysPort, often joyfully. They value exploring on PhysPort: they talk about *"browsing"*, *"wander[ing] around"*, *"scroll[ing] through"*, *"poking around"* and *"explor[ing]"* the site. Eleven out of 12 participants expressed this type of feeling. For example, some of Emily's activity on PhysPort is curiosity-driven exploration with no specific goal: *"not all that directed towards specific questions...just, I wonder what's out there that might be interesting."*

Instructors like to explore on PhysPort because they find it valuable to see many different ideas for teaching and assessment, that can stimulate their thinking and sometimes spark new ideas. Emily continues, *"Sometimes [PhysPort] just makes me aware that there are other ways to do things than the way I'm doing it now...[which] is really helpful."* For Carmen, PhysPort has *"impacted my teaching [in] that I see new ideas...I can get some food for thought here."* Theo likes to look at Expert Recommendations *"just to kind of see if there's something that sparks some sort of inspiration in me...It's nice to hear somebody else's perspective...and that will sometimes spark a new idea of what I'm going to try in my classes."* Thus, discovering a variety of new ideas through exploration on PhysPort can seed instructors' creativity. And for some instructors, their exploration is even a joyful experience: Mark *"just browse[s] the whole lot [of assessments on PhysPort] for fun because this is just like a candy box for me."* In this way, instructors interacting with PhysPort parallels the joyful exploration and discovery that Duckworth [20] describes as a key phase in stimulating new creative ideas.

CLAIM 2: Research-based assessments often serve as the concrete idea that stimulates experienced users to start exploring on PhysPort. For Hawkins [22] and Duckworth [20], there is often an object (e.g., a coupled pendulum, a set of cut drinking straws) that starts children on their path of exploration, by having enough different facets and behaviors to grab their interest and start their questioning and experimenting. In professional development, it can also be helpful to have a concrete idea that pulls instructors in, to stimulate their exploration. In the case of PhysPort, that concrete idea is often research-based assessments. Nine out of 12 interview participants first came to PhysPort looking for resources around assessments. Nine participants, after looking for assessments, found resources on PhysPort beyond what they were initially looking for—either other assessments, or resources from other parts of the site. Only two participants described an exploration triggered by another site section.

For example, when João first visited PhysPort, he *"was looking for information on concept inventories...But immediately right when I looked at PhysPort, I saw the wealth of information on how to analyze them, and that became my primary interest."* Priya started out looking for a mechanics assessment *"and then I just got generally interested...I was surprised by how many different assessments there are."*

Mark and Theo both describe coming to learn about some aspect of assessments, something grabbing their attention, and then diving deep. Mark's initial *"main hunt"* was to find concept inventories and related papers, but, *"what I did discover here [was]...physics-specific affective domain-type surveys. That was a whole, extra world...Then it kind of spiraled off into that."* Theo *"had not seen a couple of the lab assessments prior to coming here over the past two weeks, so that kind of took me down a rabbit hole...trying to find interesting things."* In this way, assessments on PhysPort are serving as a concrete idea that draws many instructors in to the site, then gets them started on their path of exploration. We speculate that assessments draw users in particularly because they are concrete things to search for, seem to instructors like they should come from an "official" source (more than, e.g., teaching materials), and are amenable to a wide variety of teaching contexts. The assessments section on PhysPort is highly structured, supporting searching but not directly addressing pedagogies, welcoming instructors to be creative about the situations in which they might apply these assessments.

CLAIM 3: Experienced users feel trust and confidence in the ideas and materials on PhysPort because they are based in physics education research. While instructors value exploring widely on PhysPort, they also appreciate that the site does not contain all possible teaching ideas. Research on creativity indicates that restricting the scope of a task and giving that task structure support people in being creative, by focusing on and defining which elements of the task are core. A key feature of PhyPort's structure is that all teaching materials and assessments on PhysPort are based in physics education research, which restricts the set of ideas for instructors to explore. Eleven out of 12 interview participants expressed the importance of materials on PhysPort being research-based. It gives them trust and confidence in the quality of the materials, which enhances their psychological safety in exploration—in contrast to finding something randomly on the internet.

For example, finding the Force Concept Inventory on PhysPort gave Carmen *"confidence in presenting this to my tenure committee, saying, 'This is an assessment, it's used nationwide, it's been research validated."'* Theo and Mark both draw a contrast between research-based materials (suggesting that these feel safe and worthwhile to explore), and ideas that people simply thought were cool (suggesting that these feel less so): Theo has *"confidence that what I'm finding here has some basis in the research and isn't just a collection of things that people have tried, thought are cool, and want to share."* Similarly, Mark wants his pre-service teachers to know that assessments on PhysPort are *"not just some questionnaires that someone's made up on the back of a Friday afternoon...It's proper stuff."* Benjamin feels *"like I can trust [Teaching Methods with a research rating] a little better than things with no rankings...When you're getting started [with active learning], I think you want to go with the proven stuff initially."* Thus, instructors feel trust in materials they find on PhysPort because they know the materials are research-based.

Several users also want to see more materials that others have tried but that may not be research-based. Abraham feels that *"there's so many people doing so many amazing things, but they're not necessarily people who have a research grant behind them [so their materials won't be on PhysPort]...I feel like there's a lot to be contributed from just regular teachers."*

In this way, most interview participants appreciate that PhysPort focuses their exploration on research-based materials they can trust. A few instructors also want to see materials that other instructors have developed and tried, with fewer requirements for a research basis.

CLAIM 4: Experienced users often use resources on PhysPort in creative ways. Rather than always using teaching materials and assessments on PhysPort exactly as described or intended by the resource developers, instructors demonstrate their creativity by often modifying materials for their contexts, or using them as inspiration for creating their own. Eleven out 12 interview participants expressed this way of using materials.

First we discuss how instructors use teaching materials, which PhysPort intends to encourage users to adapt if they wish. For example, Priya likes to *"mix and match [questions she finds]...or design something of my own."* Benjamin looks for *"example [clicker] questions...just to even get ideas of what sort of question formats were interesting and useful...And then you sort of play...and eventually...you make up your own questions with your own spin on things."* Abraham mostly used the lab curricula he downloaded *"as inspiration. I didn't actually use them verbatim, but I just downloaded some of them, just to get ideas of the kinds of things that they were doing...I do that with a lot of activities that I download."* And Tiffany feels she has *"taken something away from [each teaching method] and brought it into my own teaching."* Past research has also found that faculty often modify or invent their own teaching materials [9]. Thus instructors often use teaching materials in their own creative ways (in contrast to using them with fidelity; see Discussion).

Second we discuss how instructors use assessments on PhysPort, which give explicit directions about how they are to be used (e.g., not shared with students, only used in their entirety). Several instructors do not use assessments as directed—which is one way of demonstrating their creativity and agency to make decisions about how to use the materials [10], even as those decisions are not in alignment with assessment developers' goals for their assessments. Naomi and Mark describe *"picking and choosing"* questions from assessments to suit their specific needs and contexts. (Priya and Emily would also like to do this but think they are not supposed to.) Yusuf creatively draws from assessments to scaffold his students' learning: *"part by part I am giving to students the [assessment] questions [printed out or on the board], then they are solving them and I am reviewing [each] question."* And Mirjana found it useful to look at an assessment on PhysPort as *"one indication of what students should know about energy, just to help us write our own assessments and decide what to shoot for in our curriculum."*

Thus instructors demonstrate how they use materials on

PhysPort in creative ways (not necessarily as intended by the resource developers) to support their own teaching goals.

CLAIM 5: The current organization of ideas on PhysPort is not enabling productive exploration as much as it could. We have already shown that structure focusing on core elements of a task supports people's creativity, and that experienced users value PhysPort's structure of restricting materials to those which are based in research. However, some of PhysPort's site organization is not working well for experienced users, making it harder for them to explore productively to find new relevant ideas, and thus is not as supportive of their creativity in teaching as it could be.

Eight out of 12 interview participants mention confusion related to two site sections, "Teaching Methods" and "Expert Recommendations." For example, Emily is unsure *"if I want to know something, should I start out in the Expert Recommendations tab or should I start out in the Teaching tab?"* Similarly, Mark wonders, *"What's the difference between Expert Recommendations and Teaching?...I'm a bit confused as to where to go."* Mirjana finds each of Teaching Methods and Expert Recommendations to be too broad to be helpful: *"I'd struggle to come up with a situation where...searching through [Teaching Methods] would be my go-to approach for trying to find [something]."* Most interview participants did not comment on the Curriculum page because they did not realize it existed. Abraham, one of the two who does use that page, is *"not entirely clear on the difference between Teaching Methods and Curriculum materials;"* he *"feel[s] like I could've gotten lost trying to find"* the lab materials he was looking for under Teaching Methods. This confusion hinders users' creativity, as it holds them back from exploring site sections they'd likely find interesting.

We interpret that a major source of this confusion is that the current site organization centers teaching methods—but recent research [10] has shown that instructors do not frame their teaching development in terms of teaching methods. Thus this organization does not align well with instructors' own mental organization of teaching ideas. Further, there are various other parts of the site that most (or all) interview participants had never found. Thus, while instructors value exploring the wide variety of ideas on PhysPort, which often sparks their own new creative ideas, the way those ideas are organized is not as meaningful for them as it could be.

IV. DISCUSSION

A key goal of physics instructor professional development can be fostering creativity in teaching—in contrast to training instructors to use teaching methods with fidelity or adaptation [e.g., 5–9]. In the picture of professional development that we advocate here, when instructors use teaching methods not with fidelity but rather to spark their own new ideas, this is a positive demonstration of their creativity and agency. See Strubbe et al. for further discussion and critique of the teaching-method-centered paradigm [10]. Chasteen & Chattergoon also critique linear models of professional development [32].

Good teaching needs to be a creative act [16]; thus professional development should help instructors to build their skills at developing their own creative ideas for their own situations and values. Research on creativity shows that (1) supporting people to explore [20], and (2) structuring the exploration space in a meaningful way [21], are important features for supporting creativity. Our interviews show that these two factors can work well for physics instructor professional development: Instructors value exploring a well-structured space, and their exploration often sparks creative ideas. PhysPort is doing these things relatively well and can also do better—in particular, the site could organize ideas in ways more aligned with how instructors think about their teaching (rather than centering teaching methods), and could offer ways for instructors to share teaching ideas that are not necessarily research-based. We will incorporate these into our upcoming site redesign, of which this research is part. Further, our interview participants are all experienced users of PhysPort—thus likely not typical of all instructors or even all PhysPort users. This study shows how professional development can support creativity for instructors who are already highly enthusiastic about a platform or program; future research will investigate how this can work among a more diverse group of instructors.

Working in a community of colleagues can also promote creativity, by helping instructors feel safe to experiment with new ideas and that their ideas are valuable, offering new ideas and collaboration, and supporting their continued motivation and self-confidence to keep exploring and developing ideas [e.g., 16, 20, 25, 26]. We saw evidence in our interviews that PhysPort helps some users feel community. For example, Tiffany finds that PhysPort offers *"virtual moral support"*; similarly, PhysPort helps Yusuf feel that *"I'm not alone...It gives me self-esteem."* Several other users would like PhysPort to offer *more* community, especially opportunities to exchange ideas and collaborate with other physics instructors. This will be an interesting avenue for future research: understanding how PhysPort already helps some users to feel community, and what we can do to strengthen this.

In conclusion, we encourage designers of professional development for physics instructors to think about supporting instructors' teaching creativity as a key goal, and that supporting exploration of ideas in a well-structured space is a key feature towards this goal.

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