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The Living Physics Portal: Reimagining College Physics Teaching by Recognizing Faculty Expertise and Providing Opportunities for Influence

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Abstract. The Living Physics Portal (the Portal), an online, open-source environment, was developed by a user-centered design process to support physics faculty in finding, sharing and adapting curricular materials for interdisciplinary college physics courses. Unlike other digital libraries, community-building activities are central to the design and functioning of the Portal, so users have opportunities to engage in discussions and collaborative development of resources. First, Portal design re-envisions college physics teaching as a collaborative and community-oriented endeavor. Second, the Portal design explicitly acknowledges physics faculty's expertise in curriculum development. Third, Portal community activities and artifacts rely on users and participants to move forward with design, creating opportunities for physics faculty to substantially influence the future of the project. We report on details and purposes of the design, as well as empirical evaluation plans around its effectiveness.

INTRODUCING THE LIVING PHYSICS PORTAL

The Living Physics Portal (www.livingphysicsportal.org), or "the Portal," is an online, open-source environment for sharing instructional materials and dialoguing about instruction in introductory physics for life sciences (IPLS) courses and intermediate interdisciplinary physics courses. Visitors to the site who register as educators can browse IPLS curricular materials based on physics topics, life sciences topics, resource type (lecture, homework, exam and others), pedagogical approach and other filters. Each resource on the Portal has a description, preview and comment section so that educators can gain a complete picture of the resource before downloading the files for free. Profile pages of other users facilitate networking. Educators may also upload their own curricular resources following a user-friendly process. We aim for the Portal to be a thriving community working on educational change, not just a repository of curricular materials. Many digital libraries go underutilized because they do not have that thriving community that communicates, supports each other's teaching work, and sustains constructive professional collaborations [1, 2]. To reach our goals of expanding the Portal community of users and supporting faculty's pedagogical learning, we designed face-to-face and synchronous community activities as part of this ecosystem. Faculty can join facilitated, synchronous online working groups to collaborate in small groups around a well-defined task for two to three months. They can also participate in in-person workshops and soon will be able to interact in asynchronous online forums. There are currently over 700 active members and 2000 downloads of curricular materials from the Portal.

USER-CENTERED DESIGN PROCESS TO CREATE THE PORTAL

To meet the needs of faculty in the design of the Portal, we conducted extensive research on the practices of faculty around IPLS courses. We visited faculty at 11 institutions, including three community colleges, and asked about how

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they plan for and teach their courses. Then we watched them plan and teach. We talked to faculty about their role, course and pedagogy, course planning process, use of others' teaching materials, development of teaching materials, involvement in online communities and successful collaborative experiences. Our goal was to gain an in-depth view of teaching work as the foundation for creating an online tool that would meet real needs.

We synthesized our findings to create personas, or constructs, of potential users. The personas were developed based on salient characteristics of the faculty that we talked to. Personas package a large amount of information into a succinct, easily understandable format and give designers something concrete to discuss [3–5]. A persona does not represent any single person, but is very person-like, enabling designers to design for a "person" without designing for the idiosyncratic details of an individual [6].

We developed six personas to represent types of potential Portal users (Table 1). The design team then brainstormed a list of scenarios, which are narratives that describe how and why a persona would interact with the website. Scenarios were written from a persona's perspective, articulated their main goal in coming to the site, and described the steps the persona would likely take. For example, the main goal of a scenario for Pablo might be, "I want to discuss my experience implementing a particular classroom activity." We then grouped related scenarios to create three "design cycles." Next, we created more detailed "work flows" and wireframes, which are clickable prototypes of the website that potential users can interact with. Applying a usability testing process, we tested the wireframes for prioritized scenarios with potential users. Using feedback from a sample of potential users, we revised the wireframes before implementing the designs in the website.

TABLE 1. Personas of users for the Living Physics Portal that guided and shaped the design of the site.

Persona	Key Quote	Description
Nathan the Novice	"I've never written labs from scratch, and I'm worried about doing that."	New faculty with no real connection to IPLS community. Wants to improve course evaluations.
Tanika the Tinkerer	"I'm never not thinking about what could I put into this physics for bio majors."	Has been teaching for a few years, on the fringe of IPLS community. Listens carefully to students' concerns (e.g., readiness for the Medical College Admission Test).
Pablo the Practitioner	"In the past few years, I've started to look into the IPLS community and try to reach my students."	Experienced in active learning pedagogies, connected to IPLS community. Embarking on large course transformations.
Michelle the Master	"I realized that there's a delightful group of students, but the course just wasn't a good fit for them."	Respected IPLS contributor leader in the IPLS community. Thought leader for transforming IPLS courses and greater field.
Anna the American Association of Physics Teachers Regular	"I'm always looking for innovative new pedagogy and materials to bring to my students."	Experienced in active learning pedagogies. Newly aware of IPLS community. Eager to improve relevance and engagement for students.
Benson the Biophysicist	"My department has a big problem, and I'm going to solve it."	Experienced in traditional pedagogies. On the fringe of IPLS community. Sees a general lack of good biology integration in others' teaching.

REIMAGINING THE WORK OF PHYSICS TEACHING THROUGH DELIBERATE DESIGN OF COMMUNITY ACTIVITIES AND ONLINE TOOLS

Our reimagining of the work of physics teaching involved the design of tools in the Portal and community activities. From the teacher professional development (PD) literature, we know that grounding professional development experiences in specific curricular activities or specific classroom moments was particularly generative for educators' learning [7–9]. This finding strongly informed the design of Portal tools and activities that invite faculty to discuss their pedagogical logic.

The design of the Portal pushes the boundaries of physics teaching culture by (1) encouraging collaboration over individualistic teaching work, (2) explicitly valuing the expertise of physics instructors that is relevant to curriculum development but often overlooked by physics education experts, and (3) prioritizing newcomer feedback in multiple direct ways rather than only the powerful, known stances of more senior community members.

Making the Work of Teaching More Collaborative

Many physics faculty tend to work through their day-to-day instructional dilemmas in isolation, without collaborative sense-making [10]. Many science, technology, engineering, and mathematics education leaders

implicitly reinforce these norms by designing PD to engage faculty individually [11]. The Portal design re-envisions college physics teaching as a collaborative and community-oriented endeavor by (a) providing open access for all verified educators to share, download and comment on materials; (b) structuring explicit opportunities for dialogue within the site; (c) running synchronous working groups, such as curriculum swaps, in parallel with other Portal activities; and (d) encouraging adaptation and resharing of materials. Free open-access curricular materials can serve to minimize the financial barriers to access that underserved institutions face. Contributors are encouraged to submit materials in file formats that are easily editable by others. As faculty move their contribution into the Vetted Library, there are greater demands to explicate the pedagogical logic behind their curricular materials. We designed the Portal to elicit community discussion by making this pedagogical logic public and providing commenting features.

Publicly Recognizing Physics Faculty's Expertise as Curriculum Developers

Physics education has a history of externally funded, empirically grounded curriculum development work [12], but as a scholarly community, we tend to forget the innovative work faculty do in adapting and reinventing curricula to fit their local contexts [13]. The Portal design explicitly acknowledges expertise in curriculum development by treating physics faculty as having materials to share, not only as being consumers of others' materials. The Community Library allows any verified educator to contribute curriculum they have developed without fear of externally imposed quality criteria. With this low barrier, one concern might be that the quality of material could decrease and have a negative impact on the likelihood of new contributors sharing their materials [1]. The Portal design walks this line by distinguishing between a Community Library and Vetted Library, with the latter having to pass an editorial review process. The Portal explicitly encourages faculty to reshare adaptations of others' materials, thereby validating and recognizing the innovative work required to adapt. This approach also permeates our community activities. In curriculum swaps, all participants are invited to (a) share an activity and (b) explain their pedagogical logic. One participant, Jessica (a pseudonym), explicitly noted that this was a welcome surprise: "As an instructor with no research expectations, I do not often participate in PD where I actually have something to present." Orienting to physics faculty as generators of curriculum infuses the Portal online tools and community activities.

Inviting Newcomers to Influence the Future of the Community Tools and Activities

A central design aspect of the format of curriculum swap working groups is to identify and solicit participant input about undecided aspects of the Portal. Curriculum swap working group facilitators from the Portal team enacted this goal by soliciting feedback about features, including drafts of Vetted Library submission prompts about pedagogical logic and examples of responses to prompts by early contributors. Participants weighed in about whether the prompts targeted the right key ideas at the right level of detail. Further, Portal team facilitators asked participants what themes they would be interested in for future focused working groups.

Another example of how curriculum swap discussions allow faculty to influence the Portal is in the collaborative design of the digital certificate marking faculty's PD and curriculum development activities. Jessica's comment in the previous section continued in the context of imagining what artifacts from the working group might serve as evidence to her home institution of her accomplishments. Jessica stated, "I think specifying that we presented a lesson or topic or activity to the group would be beneficial. Also, the total time commitment of the meetings." The Portal team designed digital certificates that included all the information requested by the user.

One other way that newcomers to the Portal influence the future of the community tools and activities is through communication between site designers and developers with working group facilitators. Group facilitators convey participants' concerns and any bugs they find on the site to the development team. Curriculum swap facilitators invite feedback about lines of inquiry the design team has, such as challenges with contributing materials to the Portal. In all of the examples presented here, the Portal community activities and artifacts rely on users and participants to move forward with design, creating opportunities for physics faculty to substantially influence the project.

CONCLUSIONS AND ONGOING WORK

The status quo culture of physics teaching has some problematic aspects, such as individualistic approaches to curriculum development, the undervaluation of the curriculum development experience of instructors, and the tendency for senior faculty to hold the most influence in design decisions compared with newcomers to a community. The Portal has innovative features that serve to disrupt some of these aspects, including (a) a streamlined process for

contributing materials to the Community Library, (b) allowing contributors to revise their materials over time with community feedback, (c) encouraging adaptation of curricula and resharing of adaptations, (d) making contributors' pedagogical logic more transparent to others, and (e) inviting discussion of classroom implementation.

Empirical evaluation of the effectiveness of the design of the Living Physics Portal at meeting its goals will build from the foundation of a two-pronged data collection effort. Web analytics of Portal usage by registered beta testers will provide quantitative evidence of the activities and patterns of behaviors on the site. Further qualitative data in the form of video recordings of working group meetings, interviews, and usability testing offer researchers the possibility to map observations to explanations. We anticipate that careful examination of these data streams will reveal new community needs as well as shortcomings in our designs that will demand thoughtful redesign work.

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