

# ToUCH Virtual Faculty Development Workshops: Going Beyond a Webinar\*

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**Abstract**—As the parallel computing education movement attempts to increase the coverage of Parallel and Distributed Computing (PDC) material in worldwide CS curricula, a major challenge is propagation: getting others to adopt PDC-related curricular materials. This paper reports on a series of faculty development workshops for the ToUCH project, held with the goal of propagating modules on heterogeneous parallel computing. Due to the COVID-19 pandemic, these workshops were held in a new virtual format that split the meeting over multiple days and included explicit expectations for followup work to increase adoption. Subsequent evaluation show that the participants appreciated the format and that many of them adopted one or more of the modules.

**Index Terms**—Parallel computing education, CS education, virtual workshops, propagating educational innovations, faculty development

## I. INTRODUCTION

At this point, essentially all computing devices run in parallel, both because they have multicore processors and because individual devices often operate as part of a distributed system, interacting with remote servers and cloud services. Despite this, the focus of Computer Science education remains on sequential computing, with Parallel and Distributed Computing (PDC) treated as a complication. PDC is not necessarily restricted only to upper-level electives as much as it once was, but we believe more work needs to be done to spread this material throughout the CS curriculum. This has been a long-term project for many people; it has been over 10 years since the first version of the CDER curricular recommendations on PDC topics for undergraduates [5] was released.

A key challenge in creating widespread curricular change is getting others to adopt new materials and ideas. It is not enough to create good materials and write papers about them; this leads to virtually no adoption [22]. A better approach is faculty development workshops, which have been shown to be a significant factor in effecting pedagogical changes [12]. Faculty development workshops allow participating instructors to spend significant time learning about the materials and planning how to incorporate them into courses.

Traditional workshops have met in-person, often at the material creator’s home institution but sometimes co-located with

a conference. Participating instructors travel to the workshop location and stay for between a couple of days and a week. The duration of the workshop is often busy with material-related activities, though breaks and social activities are also included. Participating instructors are given stipends to cover their travel costs and to compensate for their time, both for attending the workshop itself and for subsequent work adopting the materials.

In this paper, we report on workshops designed to propagate modules for teaching heterogeneous parallel computing created as part of our ToUCH project [2], [3], [16], [18]–[20]. This project developed 9 modules, each with materials for a couple of days of class time and covering concepts or approaches to heterogeneous parallel computing. The modules themselves are available thru the project github repository [17]

When we proposed the ToUCH project, the plan was to hold two in-person workshops, one each during summer 2020 and summer 2021. This plan was a casualty of the COVID pandemic so the workshops became virtual events and were delayed a year, finally taking place in summer 2021 and summer 2022 respectively. By that point in the pandemic, we had acquired extensive experience with virtual events, both our own classes and professional conferences. Using these experiences, we designed our workshops to fit the different characteristics of virtual meetings. In particular, we spread the workshops out over more days to exploit the flexibility of being remote and to avoid “Zoom fatigue” from long sessions sitting in a virtual event. We also added a debrief session held after participants had adopted modules, allowing us to collect feedback on the modules and providing a clear deadline for adoption. Furthermore, we tried to design the events to encourage participation, avoiding the webinar format, where one person presents information to mostly-passive participants.

The contribution of this paper is the description and justification of our virtual workshop format, plus an evaluation of its effectiveness. The results are promising so we believe that virtual workshops have a place in strategies for propagating educational innovations even post-pandemic, without the pressures that led us to adopt the format.

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## II. RELATED WORK

### A. Faculty Training Workshops

Bunde et al. [4] discuss the ToUCH virtual workshop from summer 2021. They describe the virtual workshop format and discuss the results of module adoption for 9 workshop participants. As such, that paper somewhat overlaps with the content of our Section IV, but their focus is on the modules themselves and the lessons learned from the adoption effort about creating curricular modules. Thus, that paper complements but does not subsume this one, whose focus is on the effectiveness of the virtual workshop format itself.

Ghafoor et al. [8] report on faculty development workshops to help faculty adopt PDC educational materials. They report on five workshops, three week-long workshops held in-person (2018–2019), one workshop held virtually via two-hour daily meetings over a two-week period (2021), and one workshop run in a hybrid format, with one week of 2-hour daily virtual meetings and 3 days meeting in-person (2022). These workshops involve significantly more contact hours than those reported in this paper and were explicitly aimed at newcomers to PDC, with lack of PDC background and teaching experience as one of the selection criteria and the workshops covering more introductory material than ours. Ghafoor et al. [8] do not distinguish between the outcomes of the various workshop formats.

Ni [13] surveyed CS instructors after a faculty development workshop promoting teaching CS concepts within in a practical context to make the material more appealing to students. (This approach is discussed by Guzdial [9].) Ni [13] found that the best predictor for whether instructors adopted the approach was their enthusiasm for the idea and that being convinced of its effectiveness was not a significant predictor of adoption. Ni et al. [14] further explored factors leading to adoption (or non-adoption) with interviews of workshop participants. They found a variety of barriers that prevented faculty from adopting curricular changes, particularly needing to convince other faculty to accept the change, having to change course learning outcomes, and fearing ripple effects to subsequent courses. They also discovered that having a sense of urgency to make a change, the perceived benefit to students, and prior success implementing a change were factors that helped overcome these barriers at some institutions. We have heard about these barriers from those attempting to increase coverage of PDC concepts in their departments and we certainly tried to impress the urgency and benefits to students of teaching about heterogeneous computing in our workshops.

### B. Propagation of Teaching Material

Beyond workshop-specific reports, there is a large literature on getting others to adopt educational materials, a process called *propagation*. Much of this literature is by science education researchers rather than computer scientists specifically. A common focus is promoting the adoption of pedagogies for active learning. Taylor et al. [23] give a CS-focused survey of this work. Henderson et al. [10] give a propagator-centered discussion of best practices. Hovey et al. [11] discuss

best practices as revealed by people who have successfully propagated materials in CS education.

### C. Distance Education

There is also work on distance education. This differs from our work because it is concerned with teaching content to students using a virtual format while our goal is to teach instructors about our materials so that *they* can use the materials to teach students. A recent example of work on distance education is by Rossi et al. [21], who describe a project using virtual instruction to teach PDC material.

## III. VIRTUAL WORKSHOPS

In this section, we discuss the process of running a workshop in our virtual format, from initially recruiting the participants, to the organization of the workshop and our debriefing activities. The timeline and organization of the workshop is shown in Fig. 1.

### A. Recruiting

To recruit workshop participants, we used mailing lists focused on CS education and parallel computing. The email included a link to the module repository so that interested instructors could see the materials before applying. They were asked to complete a short online application asking for their name and affiliation, which modules were of most interest (so far), the class to which they were interested in adding coverage of heterogeneous parallel computing, and a brief description of their interest in the workshop. This information allowed us to gauge applicant interest and to select workshop participants interested in using the modules in a variety of courses. The number of applications was low enough that we were not forced to reject many applicants; those rejected mainly gave very cursory applications that failed to demonstrate a strong interest in the material.

This recruiting strategy is appropriate for in-person workshops as well; we modeled it after what we and others had done previously for in-person workshops. After the applications had been collected for the first workshop, however, we discovered that recruiting for a virtual workshop changed the pool of applicants. We had applications from Portugal, the Netherlands, Chile, India, South Korea, New Zealand, Kenya, and Brazil. In fact, half of the applicants were from outside the United States. These instructors would not have applied for an in-person event because the cost of travel would make their participation infeasible. We had not expected so many applicants from outside the US, but the outcome is not unreasonable in retrospect since we were advertising on mailing lists for an international research community and everyone had grown accustomed to virtual events because of the pandemic.

On one hand, we were flattered that instructors from around the world were interested in learning about our work. On the other hand, it caused a bit of embarrassment since the stipends we advertised for the event were funded by the US National Science Foundation and thus could only be paid to instructors

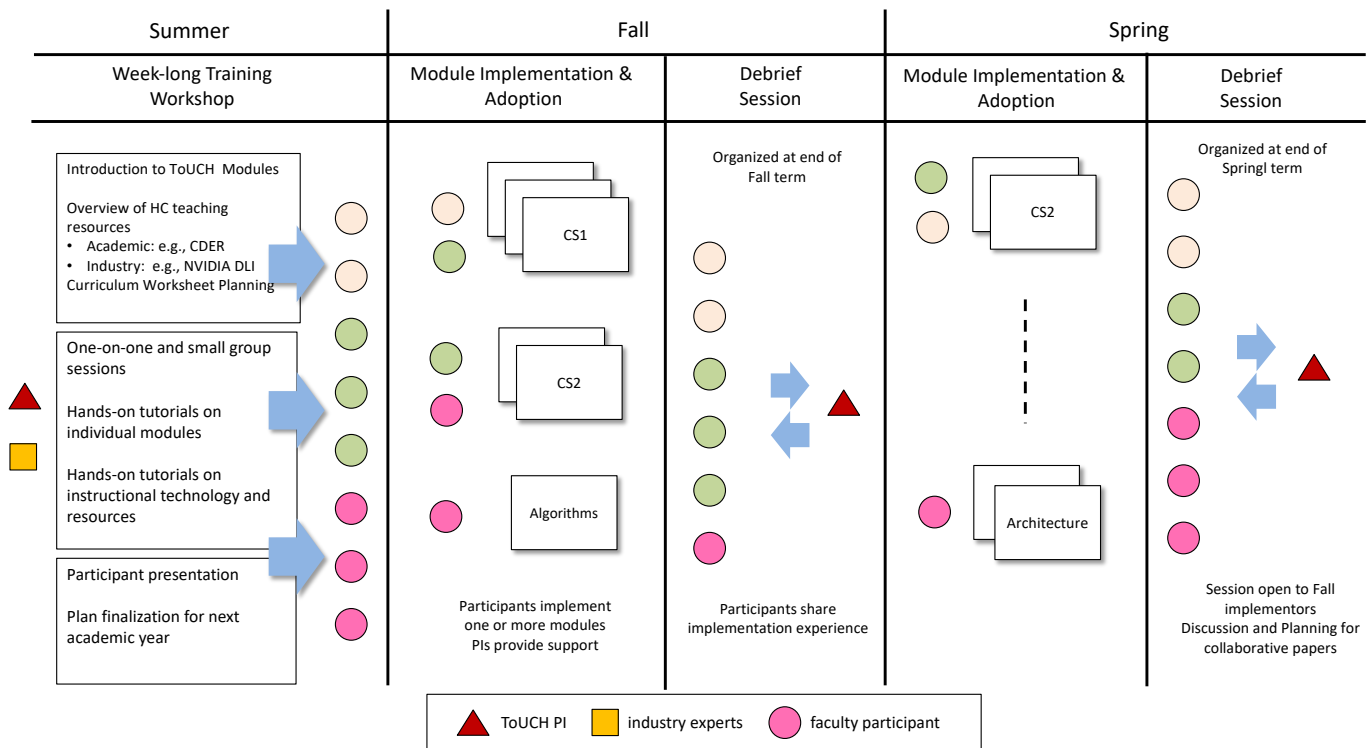


Fig. 1. Organization of a ToUCH workshop. Activities span over an entire academic year which includes (i) participant training (ii) implementation and (iii) de-brief and reflection sessions.

at institutions in the US. We asked applicants from outside the US if they were still interested and nearly all participated without the stipend. When recruiting for the second year’s workshop, we added language to the announcement indicating that we could only provide stipends to instructors at US-based institutions. Several instructors from outside the US still applied and participated in the workshop, though fewer than the first year.

### B. Workshop organization

The faculty development workshops themselves were scheduled over a week during summer 2021 and summer 2022. All training sessions were conducted virtually. At first, we contemplated simply moving the workshop online and scheduling it over 2 full days as originally planned, but we quickly realized that this would be tiring for attendees and organizers alike.

Upon further consideration, we realized that the lack of travel meant that the workshop schedule could have gaps. These would allow participants flexibility to manage other commitments while still having time to complete “homework” before each meeting. In addition, we could meet with subsets of the participants as appropriate without having to provide activities for other participants. With these insights, we decided to schedule the workshop as several meetings spread out over a week, with each meeting no longer than a half day and with gaps between meetings.

The workshop split into three parts. During the first part, the workshop organizers presented an overview of the ToUCH

modules. We also invited industry professionals from IBM, Intel, and AMD to present instructional material developed at their respective companies. Participants were given time to review the modules and ask questions in breakout rooms. At the end of the first day, the organizers and participants worked together to schedule meetings for the next part of the workshop. A sample agenda for the first day of the workshop is shown in Fig. 2.

During the second part of the workshop, each meeting was a deep-dive session into an individual module and its instructional material. These meetings were conducted one-on-one or in small groups. Participants only attended meetings on modules in which they were interested. The organizers met with everyone at least once to help them understand and adapt these modules. We also specifically worked with the participants to develop an assessment plan.

During the workshop’s third part, we met as a large group again. The bulk of this meeting was devoted to participants presenting their plans for adopting modules during the upcoming academic year. Participants had the option to adopt one or more modules in Fall and/or Spring. Knowing their intentions enabled us to plan follow-up emails during the term in which they were adopting and also to schedule participants into a debrief session to talk about their experience. (These sessions are described in Section III-C)

To schedule the relatively large number of people participating in the workshop each year, we actually offered two meeting times for the first and last meetings. For example,



 Faculty Training Workshop Teaching Heterogeneous Computing July 15-22, 2022 Virtual Event 	
Session 1 Friday, July 15, 8 AM - 12 PM CST Organizers: David Bunde, Apan Qasem Zoom: [zoom link]	
8:00-8:10.	Welcome [David]
8:10-8:30.	Introductions [David]
8:30-9:30.	ToUCH Overview [Apan] <ul style="list-style-type: none"> <li>• Why Heterogeneous Computing? [Apan]</li> <li>• Overview of ToUCH modules</li> <li>• Mapping modules to CS curriculum [David]</li> </ul>
9:30-9:40.	Break
9:40-10:20.	Non-ToUCH Resources 30 mins [Apan] <ul style="list-style-type: none"> <li>• Intel DevCloud for oneAPI [Henry Gabb, Intel]</li> <li>• NVIDIA DLI: Accelerated Computing [Joe Bungo, NVIDIA]</li> <li>• CSinParallel [Joel Adams, Calvin College]</li> <li>• CDER [David Bunde]</li> </ul>
10:20-11:10.	Worktime: Explore Modules [David] <ul style="list-style-type: none"> <li>• Plan (5 min)</li> <li>• Explore ToUCH Modules</li> </ul>
11:10-11:40.	Participant Presentations (3 mins each)
11:40-11:55.	Discussion [Apan]
11:55-12:00.	Conclusion [David] <ul style="list-style-type: none"> <li>• Scheduling of one-on-one sessions</li> <li>• Next week's session</li> </ul>

Fig. 2. Sample agenda for the first day of the ToUCH workshop

in summer 2021, the first meeting was offered on a Friday afternoon and then again on Saturday morning. The final meeting (third part of the workshop) was then offered at these same times the next week. Participants were offered both times both weeks, but most of them attended at the same time each week. In some ways, this means that we offered the workshop twice simultaneously except that the participants in each large meeting time interacted during the small-group meetings in the middle, which were only offered once each. For the organizers, having half-day meetings scheduled close together was tiring, but the participants did not have this issue and it seemed worthwhile since having two meetings kept each meeting relatively small and allowed us to accommodate participants in different time zones.

Since all our meetings were held virtually, it was easy to record content for later viewing and sharing. We recorded all the meetings (with permission). We don't think that these were heavily used except that we reused the session with industry representatives so they only had to participate once.

### C. Debrief session

After attending a virtual faculty development workshop in the summer, attendees were expected to implement and assess at least one of the modules during the following Fall or Spring semester. We held debrief meetings after each of these terms,

again exploiting the fact that virtual meetings are easy to convene. Module adoption and participation in these meetings was required to earn the final part of the workshop stipend, part of which was paid for participating in the main workshop and the rest paid for the debrief session. Splitting the stipend in this way was not a new idea, though our impression is that it was not very common at the time. Quite simply, for an in-person workshop, the prerequisite for receiving the second part of a stipend could not be attending another meeting; again, the virtual format gives us additional flexibility.

The bulk of each debrief session was presentations by each attendee about their use of the ToUCH modules, followed by questions and discussion. At the end of the debrief session, the entire group had a "big picture" discussion during which we sought overall feedback on the modules.

During the debrief meeting, one of our goals was also to foster collaborations between workshop participants, specifically with the goal of publishing papers about the modules and adoptions of them. There are several motivations behind this goal. First of all, additional publications are more publicity for the materials and can help draw the interest of other potential adopters. Secondly, being able to publish about teaching PDC provides additional incentive for faculty to continue teaching it, particularly for pre-tenure faculty, who are under explicit pressure to publish.

Philosophically, we view having participants present and publish on their module adoptions as a recruiting effort for the PDC education movement. All of us have a professional identity, an internal view of ourselves that directs us toward the actions that we value as professionals [1]. Publishing in PDC education, presenting our work in this field, and being rewarded for it are steps toward integrating PDC education into this professional identity, just as these same steps create a research identity in graduate students. Expanding a participant's professional identity is a lot of ask from a couple of presentations and publishing a single paper, but the potential benefit is great; workshop participants who come to see themselves as PDC educators will be self-motivated not just to continue using our modules, but to make their own contributions as well.

## IV. EVALUATION

To evaluate our virtual workshops, we bring together a number of sources. We already knew a lot about the initial impressions of participants and when they first adopted a module through their workshop and debrief session. In addition, in Fall 2023, we sent a brief survey to all instructors who had participated in the second group meeting of their workshop. This collected additional information, particularly about adoption after the debrief meeting. We asked participants about the following:

- 1) During which academic years they used or planned to use any of the modules. (Choices were checkboxes for the academic years and also one for "in the future".)
- 2) The support and resources we could provide that would help them adopt or continue using the modules.

	2021 workshop	2022 workshop
Started workshop	17	17
Finished workshop	13 (76%)	15 (88%)
Adopted in 6 months	9 (53%)	7 (41%)
Adopted within 1 yr	10 (59%)	11 (65%)

Fig. 3. Workshop participants reaching each stage of the virtual workshop

- 3) How we should hold future workshops. They were asked to select among in-person, virtual, both in-person and virtual, and no opinion. Then there was an open-ended question asking for an explanation.

This was a minimalist survey, but we wanted it to be short to encourage responses, particularly for the checkbox question about adoption and how we should hold future workshops. Our response rate was  $22/28=79\%$ , which we were happy with.

#### A. Persistence and Adoption

The most important measure of our workshops' success is the adoption of our modules by attendees. Figure 3 shows how the participants in each year's workshop persisted through the process and whether they adopted any modules during the first year after the workshop. In both years, the workshop started with 17 instructors at the first meeting; this is a coincidence based on the number of applications each year. Both workshops lost a couple of participants in the first week, before the second group meeting. Most of these simply failed to attend, but one expressed that the modules were more elementary than they were looking for and some bowed out because of other commitments.

Next, we see that 41% and 53% of the original population adopted at least one module in the next semester following the workshop (3rd line) and around 60% of them adopt at least one module within one academic year of the workshop (4th line; note that all members of the "next semester" group are counted here as well). Seen another way, 75% of those finishing the workshop (i.e. participating in the second group meeting) adopted at least one module during the first year. In the survey, 2 respondents who had not adopted a module in the first year reported adopting one in their second year and 5 of the remainder expressed interest in adopting a module "in the future" but without specifying a year. We are less confident that the adoptions in the last group will happen, but at least those participants are interested in principle.

In addition to getting participants to try our modules in their classes, it is important that they continue using the modules; our goal is lasting impact rather than just a temporary change while participants are being compensated to use the modules. To assess this, we again use the survey data. This data gives an encouraging sign and also raises a question. First of all,  $16/22$  (73%) of the respondents expressed a plan to use the modules in the future, with  $10/22=45\%$  of respondents having already adopted and also expressing a plan to continue using the modules. This is a good sign of persistent success for the virtual workshop format.

The question raised by the survey data has to do with a difference in behavior between the cohorts. Of the 16 participants planning to use ToUCH modules in the future, 11 are from the 2022 workshop; this is all but one of the respondents from that workshop. In the other cohort, only 5 respondents indicated that they planned to use the modules in the future, which is only half the respondents in this category. Even allowing for one respondent in the second cohort who left academia, this suggests that the first workshop was much less successful. We cannot shed light on this difference other than pointing out the 2021 workshop was our first time using the virtual format.

#### B. Publications

As mentioned in Section III-C, one of our goals for the workshops was that participants would publish and present their experiences. In a sense, this goal was met beyond our expectations. One participant, Fuentes, and several colleagues who did not attend the workshop wrote about a heterogeneous computing course that they taught using several of our modules [7]. He also gave presentations about this course in a webinar distributed as part of Intel Academic Day in July 2022. Xu [24] expanded on some of the ToUCH modules and wrote about the resulting course. Another instructor wrote about using our modules in lessons he gave as part of the Carpentries project [15]; to our knowledge, the paper has not been published yet, but we have seen a full draft. These instructors have clearly invested significant effort thinking about the material and have associated it with their professional identities.

Although these publications are a good sign, we also need to not take too much credit for them. The authors used our materials, but their applications to the workshop showed that they were already thinking about the courses on which they published. Thus, their publications represent effective propagation of our work, but not necessarily success in bringing new instructors into the PDC education community.

Our efforts were more important for a joint paper we wrote with 9 workshop participants after their debrief meeting [4]. These 9 were most of the participants attending that particular debrief meeting. Each had adopted one or more modules, resulting in some assessment data and some suggestions for improving the modules. None of these contributions was itself enough for a paper, but together they were sufficient when combined around a theme of the lessons learned during adoption.

The verdict is still out on how strongly contributors to this paper feel themselves to be PDC educators. Their contribution was smaller because of the large number of authors and most of them were unable to attend the workshop where this paper was presented, but several of them have expressed interest in working together again. For now, we take this as a promising sign and we hope to see more of these instructors in future.

#### C. Preferences for future workshops

Our most direct comparison metric between in-person and virtual workshops is the survey question asking about future

workshops. This question got 21 responses, with 11 (52%) preferring virtual workshops and another 7 (33%) advocating for using both formats. Only 2 (10%) preferred in-person workshops and 1 expressed no preference. On the open-ended question asking for an explanation, the most common reason given was that the virtual format is more convenient, with comments such as that it is hard to block out a lot of time for an in-person event, that a virtual event allows meetings to be more spread out, and that the respondent's location makes it hard to travel to in-person events. Three people explicitly said that they were unable to travel to in-person events and another comment said that some people (but not the respondent) have this problem. We did not explicitly ask about workshop effectiveness, but five participants felt that in-person events were preferable due to factors like more/better interaction among participants or it being easier to see the modules in action, but another felt that virtual events could be just as effective. Several commented on lower cost being an advantage of virtual events.

Overall, it is not too surprising that our participants generally favored virtual workshops for faculty development since they had already chosen to attend one. That said, their responses suggest that the convenience of virtual workshops is highly valued by at least a segment of instructors.

#### *D. Desired support*

In terms of desired support, our survey and the feedback we got during the debrief meetings were fairly consistent. Several participants seemed happy with our current materials. Others requested various improvements such as sample exam/quiz questions, updated slides, and more examples. The lack of focus makes it hard to prioritize specific improvements, but these comments do highlight the fact that materials can always be improved. Part of propagating educational materials is supporting adopters, which includes significant time and effort devoted to improving materials.

### V. DISCUSSION

We have shown that virtual faculty development workshops can propagate new educational materials, including to instructors who would find it difficult to participate in traditional in-person workshops.

Virtual workshops are also cheaper to run, though the amount of money saved is a bit unclear. Virtual meetings definitely save on travel time and cost. For workshop organizers, it also greatly reduces the time needed to manage logistics: answering questions about travel, giving directions, and arranging for food and lodging.

In addition, it may be possible to slightly reduce compensation for workshop attendees and organizers to reflect both the reduction in time spent and also the greater convenience, though we are not sure about the magnitude of this reduction. On one hand, many of the meetings in our virtual workshop format can be scheduled around family and professional commitments, making them less disruptive for participants and organizers alike. On the other hand, virtual workshops do

still represent a significant time commitment. In addition to the group sessions, our attendees were expected to participate in one or more meetings during the week of the workshop, to prepare for their adoption, and to create a presentation about their plans. As organizers, we had to convene all the meetings and help all the attendees with their planning and adoption efforts. For both parties, the bulk of the work is outside the workshop week, either creating the materials and workshop (organizers) or adapting and adopting the materials (participants).

Despite a generally positive position, we have a hard-to-quantify concern that virtual workshops provide less opportunity for community building. In-person workshops include significant interactions between all the people involved during breaks, meals, and other "down time". By reducing or eliminating such interactions, virtual workshops provide less opportunity for organizers and participants to learn about each other and to casually discuss both workshop content and other aspects of their work. Since having a supportive community around an innovation has been shown to facilitate its adoption [6], virtual workshops may be less effective as a propagation strategy. They may also spawn fewer other collaborations since participants learn less about each other's work and interests.

Certainly, our virtual meetings were less interactive than we had hoped. We had tried to organize them to promote interactivity by (i) giving participants time to examine the modules and ask questions during the first meeting, (ii) having them present their adoption plans in the third part, and (iii) having them present the results of their adoption in the debrief meeting. This planning prevented anyone from just watching, but we did not achieve the desired level of interaction between participants. The organizers answered the questions during (i) and asked most of them during (ii) and (iii). It may be possible to do better (our colleagues in the humanities led discussion classes over Zoom after all), but we still worry that there will be less mixing of ideas in virtual workshops.

Overall, we think that both in-person and virtual faculty development workshops have their place. Accessibility and convenience definitely favor virtual workshops. It seems likely that cost does as well even if the exact price difference is unclear. We leave it to future research to more carefully weigh the different factors and suggest a correct balance between them.

We are also interested in further work measuring the effect on participants' professional identities of presenting and publishing about their work. Publication can be a strong motivator for pre-tenure faculty, who are also still establishing their professional identities and who, given their longer time horizon, also offer the greatest potential return on efforts to encourage them to embrace PDC education. Another possible incentive to consider is providing travel support to attend a conference related to PDC education, ideally so they can present their own work.

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