Going with the Flow: Shifting Face-to-Face PD to Fully Online in the Era of COVID-19

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Immersive professional development is often used to provide teachers first-hand experience in developing place-based curricula. Knowing this, we had carefully crafted such a professional development for our participants to learn how to engage their students in local watershed research and ecology. However, following year one of a two-year grant-funded weeklong summer professional development opportunity for teachers in the Okefenokee Swamp, a shift to online instruction occurred due to COVID-19 related travel restrictions. Although the first summer in the swamp and the successive year of follow-up with teacher participants proved successful, the shift to online asynchronous instruction proved surprisingly successful as well. Qualitative and quantitative data compared across year one and year two indicated positive outcomes, such as a self-paced, engaging experience that required outdoor activities in participants' local area.

From water wars and droughts to sea-level rising, freshwater is becoming an increasingly valuable commodity, and a community's relationship with water is vital as human activity contributes most to detrimental changes watersheds are facing (Grimm et al., 2008; Vitousek et al., 1997). The United Nations further acknowledged the fundamental right of all people to have access to clean water with goal six of the 17 Sustainable Development Goals (United Nations General Assembly, 2015); thus, the need for water-literate communities is urgent as access to clean water is a shared global equity and justice issue. One way to increase water literacy is by creating science learning opportunities that infuse students' local communities with scientific research involving water quality (Moreno-Guerrero et al., 2020; Sozcu et al., 2020; Bonney et al., 2009). This transforms not only where science is learned but also the science practices used and the identities-in-practice that can develop (Hiller & Kitsantas, 2015; National Academies of Sciences, Engineering, and Medicine, 2018).

Yet, historically in the United States, marginalized, non-dominant groups experience a lack of access to science and environmental education (EE) (Calabrese Barton & Tan, 2008; Taylor, 2002). Students, who have more ready access to science experiences, are afforded more opportunities to make decisions about and act on local environmental issues, such as water quality (Amahmid et al., 2019). Therefore, an imbalance exists of equity and access in terms of which student populations are provided opportunities to learn about and engage in their local watersheds and develop their water literacy.

Given this, we developed an immersive, face-to-face, placed-based professional development (PD) for middle and high school teachers focused on watershed science (Authors, 2021). This immersive experience included travel to the Okefenokee Swamp where faculty and teacher participants stayed onsite for the week-long PD. All of the activities for the PD were conducted in our makeshift classroom or outside exploring the swamp. However, the recent pandemic of COVID-19 required us to shift from the face-to-face, residential format we ran in Year 1 (Authors, 2021) to a fully online, asynchronous format in Year 2. With the stark contrast between a face-to-face and fully online PD, we had to rethink how we designed assignments to still capture aspects of the immersive, place-based PD given all participants were not experiencing and learning in the same location. Thus, we ask the following research question:

How does an immersive, face-to-face, place-based science PD compare to a fully online environment?

RESEARCH ON ONLINE SCIENCE TEACHING

Transitioning face-to-face science labs into remote learning experiences has been handled in a number of ways over the years. Most often, traditional laboratory experiences are replaced with online labs through simulations and virtual learning environments, remote use of equipment through virtual platforms, and at-home or take-home experiences. Faulconer and Gross (2018) found in their review of research articles from 1997-2017 on non-traditional laboratory experiences in higher education that a non-traditional lab experience can be as effective as a face-to-face lab experience in regard to content knowledge gains and student evaluations. Yet, they caution that universities need to take into consideration the needs of their learner as well as the institution before selecting a remote learning experience. We took this into consideration as we designed our online PD. Given we would have modeled instruction and activities in the field had we been face-to-face, we provided our participants with online simulations, videos, and at-home experiences to compensate for this.

Heintz and colleagues (2015) examined the current usage and experience using online labs for students and teachers in 23 European countries. They discovered that the usage of online labs and STEM educational software was low for students and teachers, and when used, the same type of online learning platform (e.g.PhET) was most often implemented. Thus, they concluded that providing a variety of online learning platforms was a critical need to help support the use of online labs and educational software in STEM education. Another important component that Heintz and colleagues (2015) analyzed was the equipment and Internet browsers participants were most often able to use. This ties in with Faulconer and Gross's (2018) reminder to consider one's learner when designing non-traditional science learning experiences. Since we were not able to survey our participants prior to our PD creation, we made sure that all videos and online simulations were compatible on multiple browsers and devices.

In addition to knowing the prior experience and comfortability of participants with non-traditional learning environments,

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Martin and colleagues (2019) analyzed what consisted of best practices for award-winning online faculty. They discovered that course design, assessment, evaluation, and facilitation were key aspects of effective online learning across successful online teaching instructors. Backward design and course organization were two strategies not only employed but also recognized by students as being highly effective for their learning. We utilized these aspects by placing our content into Modules and designing our participants' final product as a cumulative plan they would develop based on what they had learned during the PD. We modeled for our participants a variety of ways to assess their own students through online surveys, social reading software, quizzes, maps, photography, and backyard observation journals. We had several measures of evaluation throughout the PD, and we had an external evaluator provide us a report at the conclusion of the PD. Finally, the three aspects of facilitation that Martin and colleagues (2019) highlighted were timely feedback, availability/presence, and periodic communication. In this regard, we set up a discussion board for questions that we checked every day. We sent out weekly group emails about upcoming events. We sent out a weekly completion report so our participants could track their progress in real-time, and we hosted weekly Zoom check-in meetings, which were informal times for us to answer questions and share resources.

METHODOLOGY

For this study, we were interested in understanding our participants' perceptions of the online PD and whether the understanding they gained would be similar to the face-to-face PD that occurred the year prior. Thus, our case study focuses on two years of a PD program that resulted from a grant opportunity that was part of the mitigation funds from the Deepwater Horizon oil spill—OUR2SWAMP - Okefenokee - Understanding Real-world Relevance through Suwannee Watershed Assessment and Monitoring Project.

Context

The purpose of OUR2SWAMP was to create a new hands-on research-based PD designed to train participants for local watershed monitoring and prepare them to teach the impacts of water quality on the Gulf of Mexico. The PD utilized place-based instruction in the Okefenokee Swamp to guide participants in learning about local watershed ecology. Participants completed the week-long training ready to lead local watershed health monitoring (through Adopt-A-Stream and other citizen science projects) in their own schoolyards and local communities. In addition, the regular monitoring of local watersheds led to increased students' understanding of relationships between local watersheds and larger bodies of water. The project team included two science and environmental educators (authors), a biology professor, a chemistry professor, and two consultants who had experience leading multiple groups into the Okefenokee Swamp.

Participants

For Year 1 and Year 2, participants were selected through an application process. Preference was given to applicants who taught in areas historically underrepresented in science and in our state Adopt-A-Stream water monitoring database as well as those who lived in watersheds that drained into the Gulf of Mexico. In Year 2, additional spots were available for returning Year 1 participants; returning participants had to fill out an additional application explaining what they implemented in their classrooms and why they wanted to return for a second year. Twenty participants completed Year 1 week-long PD, while thirty participants (20 new and 10 returning) were invited for the Year 2 online PD (Table 2). However, in Year 2, two new and one returning participant were unable to complete the requirements for the PD; thus, there were 27 participants that completed the PD. All participants gave their informed consent for inclusion before they participated in this study.

Year 1: Face-to-Face

Year 1 was a face-to-face PD that consisted of a weeklong, immersive residential summer experience in the Okefenokee swamp. In preparation for the weeklong summer PD, four preview days were planned during spring 2019 as orientation for participants. The preview day introduced the participants to their local watersheds and addressed how our various state watersheds impact two different coastal areas. Preview days were planned to minimize participant travel and therefore were hosted at different sites around the state. Preview days also provided training for some of the technology they would work with during the week-long summer PD.

In June 2019, participants traveled to the Okefenokee Swamp where they attended a week-long PD. This area on the Georgia Florida border encompasses our state's largest swamp, a well-known National Wildlife Refuge. This 400,000+ acre wetland serves as the headwaters for two rivers, the St. Mary's River and the Suwannee River, which positions it in a unique situation as it drains to both the Atlantic Ocean and the Gulf of Mexico. As participants stayed on-site during the week-long PD, they were trained and certified through our state Adopt-A-Stream water monitoring agency. Each participant would develop their own water chemistry testing, bacterial testing, and macroinvertebrate survey sites when they returned to their schoolyards/communities. Throughout the week, additional citizen science projects were also introduced such as birding using Cornell's eBird, tree and bird phenology using Nature's Notebook, and the leaf pack network from Stroud Water Center.

Year 2: Online

During the spring of 2020, it became clear that a face-to-face, immersive experience with workshop participants traveling from across the state to share rooms with other participants was not going to be possible. After reaching out to the funding source and requesting to delay the year-two PD experience to the following summer, the PI received word from the funder to shift the entire workshop to be fully accessible online. This notification arrived approximately one month before the Year 2 PD was scheduled to begin. The team of faculty quickly divided up responsibilities and began creating materials, including many videos to make the online experience feel as authentic as possible. An LMS platform was used to create individual modules, house forms, assessments, and participant work submissions.

Each topic that was taught by different facilitators was developed using methods they were most familiar with, i.e. screencasts, videos, PPTS, etc. The PD facilitators worked together to screencast a welcome video that was personable and informative. This was the first introduction to the online course. The orientation was designed as the first module in the course and blocked access to additional course modules until completed. The orientation included videos, screencasts, forms to submit, waivers, and weekly scheduled meeting times (not required, but available). Once all aspects of the orientation module were completed, the other modules were opened. Although all of the successive content was intended to progress consecutively, there were no restrictions in place to control how participants moved through the content. They could move through the modules in any order, although the acknowledgment of completion was the final step and included requesting a Zoom interview. In Table 1, alignment is shown for the face-to-face version of activities from year 1 and the year 2 online adaptation.

DATA COLLECTION

Participants from both years completed a pre/post-watershed content assessment and a pre/post-watershed mapping assessment. They also participated in an individual semi-structured interview, which was approximately 35–45 min long. There were twelve questions designed to better understand how participants described themselves regarding their experiences in the PD and how they envision the experience impacting their teaching practices. In Year 2, we added two additional questions to capture what their expectations were for an online PD and how the actual PD compared to their expectations. Each audio-recorded interview was then transcribed for data analysis.

Data Analyses

Individual watershed content assessments and watershed mapping assessments were scored using an answer key generated by the team, and a raw score was generated for each participant based upon the number of correct answers. Paired samples t-test were conducted to compare the raw scores on the pre and post-content assessment and the watershed map for each year. Pre/post assessment scores were also compared across years. Only new participant scores were included for Year 2 data since returning participants had participated in the PD before and had prior knowledge of the content. For our qualitative data, we analyzed Year 2 interview questions that focused on how participants described themselves during PD, their initial expectations of an online PD, and how the actual PD compared to their initial expectations. We used Dedoose to initially code the interview responses as positive, neutral, or negative. Then, we analyzed each a priori code for emerging themes (Miles & Huberman, 2014).

FINDINGS

In Year 1, participant scores from the pre-watershed content assessment ($M = 59.3$, $SD = 18.9$) and the post-assessment ($M = 90$, $SD = 4.6$) showed a significant gain in knowledge acquired ($t(38) = –7.07$, $p = 0.000$). In addition, participant scores on the pre-watershed mapping assessment ($M = 35.3$, $SD = 24.8$) and the post-assessment ($M = 88.5$, $SD = 12.8$) indicated a significant gain in understanding ($t(38)= –8.53$, $p = 0.000$). Likewise in Year 2, the pre-watershed content scores ($M = 70.9$, $SD = 11.2$) compared to the post-watershed content scores ($M = 92.4$, $SD = 7.1$) demonstrated new participants experienced a significant gain in their knowledge of watershed ecology ($t(34)= –8.91$, $p = 0.000$). Similarly, Year 2 new participants' scores on the pre and post watershed mapping ($M = 68.1$, $SD = 21.8$; $M = 93.1$, $SD = 8.9$) showed a significant gain in understanding of local watersheds ($t(34)= –4.49$, $p = 0.000$).

These findings assured us that both Year 1 and Year 2 had content gains during the PDs; however, given the radically different format of the PDs, we also examined whether there was a significant difference between Year 1 and Year 2 scores. Interestingly, we discovered that there was significance difference between the Year 1 (Year 1: $M = 59.3$, $SD = 18.9$) and the Year 2 ($M = 70.9$, $SD = 11.2$) pre-watershed content assessment scores ($t(36)= –4.31$, $p = 0.000$) as well as the pre-watershed mapping Year 1 ($M = 35.3$, $SD = 24.8$) and Year 2 ($M = 68.1$, $SD = 21.8$) assessment scores with Year 2 scoring significantly higher than Year 1 ($t(34)= –4.31$, $p = 0.000$). We surmised that this was either because our participants were more familiar with the content as we had more environmental science and Advanced Placements teachers or that some Year 2 participants might have not realized they were not supposed to use resources on the pre-assessments given that they took it online on a computer. Even though there was a significant difference in pre-assessment scores for both assessments, there was no significant difference between Year 1 and Year 2 post-assessment scores for the watershed content assessment (Year 1: $M = 90$, $SD = 4.6$; Year 2: $M = 92.4$, $SD = 7.1$; $t(36)= –1.23$, $p = 0.210$) or the watershed mapping assessment (Year 1: $M = 88.5$, $SD = 12,8$; Year 2: $M = 93.1$, $SD = 8.9$; $t(36)= –1.26$, $p = 0.216$). This further confirmed that our attempts to convert face-to-face professional development to an online format were successful as both groups showed significant growth from pre to post, and yet the post score comparisons were not significantly different.

Though our quantitative findings indicated that our participants had success in the new online environment, we also wanted to see what our participants' perceptions of the online PD were given they had originally applied for a face-to-face experience. Ten themes emerged: five themes from the negative code and five themes from the positive code (Table 3). The first four negative codes were participants' perceptions of what they thought the online PD would be like prior to participating in it. The final negative code (missed hands-on/place-based learning) was mentioned by participants in both their pre-perceptions and in their overall impression of the PD. These negative themes also aligned with our own perceptions of online experiences, so we initially tried to address them when building the PD prior to selecting our participants. At the conclusion of our coding, we noted that the emerging themes unintentionally paralleled each other. Thus, indicating our participants' perceptions were that we had addressed their concerns regarding online learning.

The first theme that emerged from the negative responses participants gave regarding their feelings/concerns about what an online PD would be like was concern about busywork. Participants were concerned that a shift to online would mean that they would be completing menial tasks with little to no connections to learning. As one participant shared, "I wasn't really sure what to expect from it [the PD]. I had a little trepidation, I will admit, 'cause I was worried that it would be a lot of busywork rather than substance." Later in her interview, this same participant shared, "And it actually wasn't a lot of busywork. I was pleasantly surprised that it was a lot of information but not a lot of read-this-and-answer-questions kind of thing." Thus, the first positive theme regarding how the actual PD matched their expectations was that transitioning the PD to online did not equate to a lot of busywork being assigned. A second positive theme was that there was an outdoor component to the online PD; participants appreciated how we provided opportunities for them to practice

Table 1. **Curriculum comparisons from Year 1 and Year 2**

Curricular Activity	Year 1: Face-to-Face	Year 2: Online analogous experience
Materials/Supplies	• Delivered to participants and explained how to use at Spring Preview • Supply stipend: participants used a spreadsheet to request lab supplies ($1500) • Supplies hand delivered to participants by facilitators	• Video created to explain supplies and materials; checklist included • Supply stipend: participants used a spreadsheet to list lab supplies ($1500) for approval • Materials and supplies were ordered and received at institution then repackaged and shipped to participants
Deepwater Horizon	• Whole group viewing of Deepwater Horizon movie (opening night of PD to set the stage for the weeklong PD) • Problem Based Learning module • Completed in person during Spring Preview • Set stage by asking the question: Can upstream water quality affect downstream water quality? • Use of crumpled paper, Stream ecology simulation, Model My Watershed, and DataClassroom	• Recommended individual viewing of Deepwater Horizon movie • Problem Based Learning module • Template provided to organize into a 5-day lesson segment and hyperlink activities to guide participants through the PBL • Screencasts created and timestamped to specific activities referenced in the template
Introduction to Citizen Science	• Whole group guided discussions • Hard copy provided of sample lessons and articles involving citizen science	• Perusall used to facilitate social reading and discussion of citizen science
Adopt-a-Stream Training	• Hands-on lecture with fieldwork and collaborative lab practice for water chemistry • Training for macroinvertebrate sampling techniques and identification • E.coli sampling, identification, and data reporting • Assessments completed at the end of each day	• Faculty created video: • Explaining all of the materials to conduct the water tests • Modeling how to conduct each test • Online assessments were created and completed at the end of each module
Birding	• Practiced using binoculars outside in small groups • Flatbirds used in a designated outside area to train how to use flatbirds in the classroom • eBird App used in whole group training on how to record sightings and practice in small groups; also how to set up an eBird classroom account	• Faculty created videos: • How to use binoculars • How to use flatbirds to teach unique bird characteristics • Screencasts created for using eBird data collection; • Homework assignment given to locate, photograph/describe, and identify local species of birds
Phenology	• Whole group discussion regarding phenology (what is it, why is it important, how to structure data collection for classrooms) • Practice with tree phenology using local tree cards and forest area around lodging	• Video links provided to explain phenology (what is it, why is it important) • Articles provided to explain phenology across multiple organismal types • Screencast with photos from the first-year experience explained how to set up a phenological study on local school grounds • Sample phenology lessons provided • A variety of phenology tree cards provided for use in the classroom
Multimedia Assignments	• Photovoice Assignment (assigned during spring preview): • Captured personal photographs and video of their local schoolyard • Prepared a presentation to introduce their schoolyard through images • Presentations shared to the whole group during evening sessions	• Schoolyard videos: • Completed and submitted through LMS • Participant videos were shared with the instructors, but not their peers
Tristate Water Conflict PBL	• Background information/articles/sites shared to set the context • Whole group discussion modeling how to lead PBL • Template/rubric provided for students to write letters to Georgia Congressmen	• Materials provided to use at participants' discretion.
Technology: ArcGis, CoDAP, DataClassroom, ModelMyWatershed, StreamStats, StoryMaps	• Spring preview structured to introduce each of these technologies	• Screencasts created to model how to use each technology • Live Zoom training for DataClassroom • StoryMaps used for the final presentation of online experience
Citizen Science Action Plan	• Developed a citizen science plan for their schoolyards either individually or as part of a small group • No specific format required • Presentations given on final day of PD	• Used provided template to develop a citizen science plan for schoolyards • Completed and submitted through LMS • Shared their videos with the instructors, but not their peers
Data Collection	• IRB collected at Spring Preview • Pre-watershed content and pre-watershed mapping assessments given at Spring Preview • Link to pre-environmental identity survey given out at Spring Preview to be completed at home • Individual interviews conducted in person • Post-watershed content and post-watershed mapping assessments given on final day of week-long PD • Link to post-environmental identity survey given out to be completed at home	• IRB collected through LMS as part of orientation module • Pre and post watershed content collected through Qualtrics • Pre and post watershed mapping assessments collected through LMS • Pre and post environmental identity survey collected through Qualtrics • Individual interviews conducted through Zoom
Collaboration	• Nightly debriefs of the day's finds from the field • Daily discussions of how to apply to classroom	• Weekly Zoom check-ins to debrief together and ask/answer questions

Table 2. **Participant Demographics**								
Year	**Gender**		**Race**		**Ethnicity**	**Level of Education**		
	Male	Female	Black/ African American	White	Hispanic / Latinx	Bachelors	Masters	Doctoral
1	3	16	2	17	2	6	12	1
2	1	26	2	24	1	6	20	1

and learn outside of the online environment. Participants shared how the requirement of birding in their backyards provided a connection to nature that they were not only excited to do but also were often able to share with family or friends. One participant described how the online PD was different from her expectations: "The first time I went out to look at the birds, I was like, 'oh my God, I'm out here looking for birds.'" Participants also countered the lack of busy work with the fact that the PD required them to be engaged. As one participant shared, "you had to read, you had to go through and you had to follow along, watch the videos, you had to engage yourself in it. And if you didn't, then you could find yourself just not understanding or falling behind." Another indicated that the PD material "made me want to learn more about it, and all the lessons were pulling me in and pulling me in deeper each time."

Participants' responses also indicated that the group did not really know what to expect which led to initial feelings of being overwhelmed, especially when they first entered the LMS and saw all the curricular modules. One person shared that she was "a very social person", so doing the PD online and in her home was overwhelming. Another participant indicated that "the sheer amount of content" was overwhelming, while a couple of others were at first concerned about technological programs they were expected to use but as one said, it "got better, obviously, as I worked my way through it." This not knowing quite what to expect and feeling overwhelmed by the amount of content was not unique to the online environment. In Year 1, participants also shared these sentiments in their individual interviews and indicated they would have liked to have more time to process the information they were exposed to during the week-long PD.

The online PD did provide an opportunity for participants to work at their own pace, which provided more time for processing and reflection. Participants also recognized this as a positive aspect of having the PD online. As one participant highlighted in her analysis of the PD, "I love the layout of the course in the modules and having the time to pause and go back. I mean, it's everything that we say of differentiation in self-paced instruction, all of those good things. I really appreciated that about the course." This was purposeful on our part in that we did not provide deadlines throughout the summer as we felt our participants were professionals and could organize their own completion of the PD dependent upon their interests and time in the summer, especially given the COVID pandemic and how work/home life and schedules had shifted.

Even though there was an advantage of self-pacing in the online PD, themes of missing face-to-face collaboration and hands-on/experiential learning were also present. One person described this as "not being in the moment, not being able to really apply [what we learned] and collaborate with the others" which "was a downside." A couple of people indicated they would have liked more synchronous interactions during the PD than the weekly meeting we held to debrief together. Given the stress of COVID and realizing that people's commitments and schedules were in flux, we decided in designing the PD that we would run it asynchronously and provide weekly check-ins for anyone interested in debriefing with others, but we did not require attendance at the weekly check-ins. Most participants mentioned at some point in their interview how they were disappointed about not being in the swamp. As one participant put it, "I was, of course, a little bit bummed out coming into it [the PD], knowing that we weren't gonna actually get down to the swamp." However even though the participants and our team wished we could have all been in the swamp together, the online environment did provide a unique opportunity for participants to learn in their local ecosystem. As one participant shared in her perception of the PD, "it definitely gave me a good jumping-off point to teach my students, from a perspective of what they can do in their local areas, instead of teaching environmental science just out of the textbook and this is how the processes work. I feel a little more comfortable, describing the water around them, and where they live, and how they impact it and getting them thinking about how their own actions affect the water around them."

DISCUSSION

Our findings confirmed what Faulconer and Gross (2018) discovered that online science learning can be as successful as face-to-face learning based on content knowledge and our participants' perceptions. However, we also discovered that not only can science learning be achieved but that best practices in science teaching can also be modeled through asynchronous instruction. Unlike previous studies on online science teaching, we were not simply trying to convey science content, but we were also trying to model for our participants how to teach their own students face-to-face while they, themselves, were learning online. Thus, we were worried about whether we could truly translate this aspect of the PD. Given our participants' perceptions, they felt confident to use what they learned during the PD in their classes. Most discussed how they looked forward to introducing their

Table 3. Ten Identified Themes	
Negative Codes	**Positive Codes**
Perceived busywork	Not a lot of busywork
Overwhelmed with the amount of content	Self-paced
Missed physical interactions with others	Required engagement with course
Not knowing what to expect	Local area
Missed hands-on/place-based learning	Outdoor component

students to their watersheds and were excited to implement data collection on their school grounds. Participants also shared how learning online during the PD gave them ideas for ways to implement online learning in their own classrooms given COVID-19 was going to require most of them to teach online in some way.

As we reflected on our experience, we realized that even though our experience with creating an online professional development was limited, we were able to achieve the seven aspects of effective teacher PD as outlined by Darling-Hammond and colleagues (2017) in their review of 35 methodological studies on teacher PD. First, our PD was content-focused, and we aligned state science standards with the content we presented. We also provided supplemental material for our participants to go deeper into the content if their own interests warranted this. Second, even though our PD was online, we were able to incorporate aspects of active learning through backyard observations, problem-based learning scenarios they could use with their students, and provided field equipment to conduct the sampling in local waterways. Third, collaborative opportunities were given through our Zoom debriefing sessions. We also connected participants in geographically close watersheds so that they could work on their citizen science projects and watershed ArcGIS StoryMaps with other people if they choose. Fourth, models of best practice were shared through lesson plans, screencasts, and video samples. Fifth, we provided coaching through the Zoom debriefing sessions as well as offered individual meetings whenever participants wanted to connect and discuss the PD or their ideas for their classroom. Sixth, we continually offered feedback during the PD on assignments and activities our participants engaged in, and during the school year, we even had a few participants send us lessons to look over and provide feedback on. Finally, the aspect of the online PD that surprised us the most was how we noted and our participants confirmed that through the self-paced aspect of the PD we were able to provide more time for participants to engage with the material and reflect upon what they were learning as they set their own schedules.

Our findings move the field of online teaching and teacher education forward in understanding how effective face-to-face PD can be moved online with similar outcomes. Given COVID-19 and the rapid movement to online teaching that occurred across the country, learning how to provide PD that models both face-to-face and digital learning is needed now more than ever. Our study is one example of how this can occur. Even though we had to rapidly adapt our PD to a new and untested environment, we were able to provide our participants with a robust and authentic learning opportunity.

LIMITATIONS

Since we only focus on one PD program, the generalizability of our study is limited. Our small sample size also makes it difficult to apply our findings to a large population. We also recognize that since our participants knew us, and we were the ones to interview them, this might have influenced their responses to the questions asked.

Future Research

Given the unique nature of teacher PD and how COVID-19 has generated more online teaching opportunities, future research questions should explore how attending an online PD influences how teachers construct and implement online lessons. This would have implications for PD developers and for pre-service teacher educators to best understand how to model best practices for online teaching. In addition, examining multiple online PDs focused on a variety of science content would help to further generate best practices for facilitators and learners. Finally, examining how students were impacted and the outcomes achieved in the classroom would further the field's understanding of online PD and teacher learning.

CONCLUSION

In conclusion, the shift to online PD from a fully face-to-face designed PD was successful. Although both facilitators and participants lamented the fact that the hands-on work did not happen in the swamp, and collaboration among participants was less spontaneous, the overall impression by the participants was that this online PD was successful in preparing them for watershed ecology and developing local schoolyard sites for collecting data. The facilitators also felt surprisingly confident with the outcome of the online PD. Although it felt rushed and unnatural initially to shift something that focused on being IN a place to learn about it, we realized that it is possible to convey the knowledge and enthusiasm about place-based learning through an online PD.

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