2022

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Elizabeth Langran (Ed.)

Original Publication Citation

Lee, M. J., Kidd, J., & Gutierrez, K. (2022). Lessons learned from two teacher educators: What COVID-19 can teach us about preparing elementary preservice teachers to teach the next generation of students. In E. Langran (Ed.), *Proceedings of Society for Information Technology & Teacher Education International Conference.* (pp. 1315-1320). Association for the Advancement of Computing in Education. https://www.learntechlib.org/p/220910/

Lessons Learned from Two Teacher Educators: What COVID-19 Can Teach us about Preparing Elementary Preservice Teachers to Teach the Next Generation of Students

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Abstract: Over the last two years, the COVID-19 pandemic has required teacher educators to teach their classes online. Teacher educators now need to reflect on the learning opportunities that the COVID-19-induced shift to online learning has provided. This study draws upon multiple data sources (e.g., interviews, surveys, lesson artifacts) to share two teacher educators' experience teaching preservice teachers (PSTs) online during the pandemic, specifically supporting their PSTs to teach engineering online to elementary students. The two teacher educators noticed (a) changes in PSTs' attitudes and beliefs about technology integration, (b) PSTs' patterns in selecting and using educational technologies, (c) PSTs' recognition of the importance of online interaction and feedback from K-12 students, (d) the importance of providing PSTs with extended access to physical hardware, and (e) the importance of providing developmentally appropriate digital resources. The paper concludes with suggestions for teacher educators who are preparing elementary PSTs for the next generation of teaching.

Introduction

When universities transitioned online due to COVID-19, most educators opted for synchronous delivery to replicate the real-time interaction in face-to-face practice (Henriksen et al., 2020). This brought unforeseen challenges, such as Zoom fatigue (Schulman, 2020). Online education experts suggest there should be a balance between synchronous and asynchronous sessions as the associated benefits and challenges of both modalities are different. For example, while synchronous sessions seem to provide a better environment for giving feedback as the interaction happens in real-time, asynchronous sessions enable more thoughtful questions and responses as time is given to think (Lowenthal et al., 2020). Understanding the affordances of synchronous and asynchronous approaches is a critical aspect of online pedagogy, which is distinct from in-person teaching and which educators must understand for teaching the next generation of learners.

Though this generation of preservice teachers (PSTs) is often comfortable using technologies, research shows that they feel unprepared to effectively integrate technologies into their lessons (Ottenbreit-Leftwich et al., 2010). According to Hew and Brush (2007) and Kim et al. (2013), PSTs' lack of knowledge and beliefs about technology are barriers to integrating technology into their instruction. For example, Ertmer et al. (1999) found that teachers who viewed technology as "a way to keep kids busy," gave computer time after regular classroom work as a reward for the completion of assigned tasks. While PSTs can easily obtain knowledge and skills about technologies through teacher education programs, such as educational technology courses (Polly et al., 2010), changing their attitudes and beliefs is not easy. Therefore, teacher educators must help PSTs build positive attitudes toward technology integration in their future classrooms. Otherwise, they are unlikely to incorporate appropriate technologies for their content areas throughout their future lessons (Koehler & Mishra, 2009). Moreover, researchers suggest that PSTs need frequent interaction with technology, including step-by-step instruction with specific applications (Beyerbach et al., 2001) and observations of successful technology usage that allow them to witness how it can be used, how valuable it is, and how feasible it is to integrate in their lessons (Lim & Chan, 2007).

While the emergency transition to online instruction in Spring 2020 was completed hastily, many teacher educators had time to plan for remote teaching the following academic year. This experience of teaching online has allowed teacher educators to increase their knowledge and confidence with online pedagogy. Rather than considering this remote teaching as a temporary response to the COVID-19 pandemic, we encourage teacher educators to reflect on the learning opportunities that the COVID-19 situation has provided, as well as the needs of PSTs to be prepared for teaching the next generation of students. This paper shares lessons that two teacher educators learned during their time teaching remotely. To explore the lessons, the following question was posed: To what extent did remote teaching influence two teacher educators' future preparation for elementary PSTs?

Methodology

This study employed an embedded multiple-case study (Yin, 2009) that integrated two teacher educators' (second and third author) experiences of teaching and supporting 89 PSTs to teach engineering online across three education courses: Foundations of Education, K-12 Instructional Technology, and Science Methods. These courses were taught at a university located in the Mid-Atlantic region of the U.S. and were involved in the Ed+gineering project, which partnered undergraduate engineering students (UESs) and preservice teachers (PSTs) to learn from and with each other as they planned and delivered engineering lessons to elementary students. After elementary schools and universities moved to remote teaching due to COVID-19, the teams of PSTs and UESs modified their in-person engineering lessons for online delivery. PSTs in the Foundation of Education and the Science Methods courses converted their in-person lessons to an asynchronous format by designing a Google Slides presentation that included multiple types of media (e.g. audio recordings) and interactive elements (e.g., Padlet). These presentations were distributed to partnering elementary teachers in the Ed+gineering project. To support PSTs and UESs in converting the engineering lessons to a virtual asynchronous format, the teacher educators provided three different resources—an asynchronous sample lesson, a template for the lesson, and directions for creating and embedding multimedia into their lesson. The online transition was different for the PSTs in the K-12 Instructional Technology course as their engineering lessons were set to occur within the context of an afterschool technology club that they were leading, which extended over ten weeks. In the club, teams composed of a PST, an UES, and an elementary student designed, built, and coded bio-inspired robots to address a global challenge. After COVID-19 forced schools to close, which occurred midway through the club sessions, the club transitioned to online, and the teams worked entirely through virtual synchronous sessions (i.e. Zoom).

Data Collection & Analysis

To frame the two teacher educators' takeaways from their experiences remotely teaching and supporting 89 elementary PSTs as the PSTs converted their engineering lessons to online formats, the first author collected written survey responses from the two teacher educators and then interviewed them. Using open coding of the surveys and interviews, themes regarding the lessons that the two teacher educators learned were derived. After member checking the themes with the two teacher educators (Merriam & Tisdell, 2015), 144 elementary PSTs' artifacts from Spring 2020 (n=89; 55 from Foundations of Education, 21 from Instructional Technology, 13 from Science Methods) and Spring 2021 (n=86; 55 from Foundations of Education, 16 from Instructional Technology, 15 from Science Methods)—which includes each PST's reflection, nine focus group interviews, and 44 interactive presentations—were reviewed to find supporting evidence for the themes that were derived from the two teacher educators' data. Using these multiple sources of data, this paper illustrates what the teacher educators learned from teaching and supporting elementary PSTs to teach engineering online.

Findings

Five main themes, which are lessons that the two educators learned from their experiences teaching and supporting PSTs remotely to teach engineering online, emerged. Each lesson learned is discussed in depth below with suggestions for other teacher educators preparing PSTs for the next generation of teaching.

Change in PSTs' Attitudes and Beliefs about Technology Integration

Compared to previous semesters, the two teacher educators noticed rapid changes in elementary PSTs' attitudes and beliefs toward technology integration in their teaching.

> I think that the pandemic has made this [integrating technology to teaching] an easier sell to my students overall. Because sometimes I have a hard time convincing my students that still see technology as being about teacher use: It's about me knowing how to use PowerPoint, or me knowing how to use YouTube.

Instead, it's about how do you facilitate your students to use technology (Second author, Interview, Spring 2021).

During the COVID-19 pandemic, PSTs who never imagined teaching online experienced first-hand how important and powerful educational technologies are to engage and connect with students. From their experience of teaching an engineering lesson online as well as their own and their family members' experiences as learners during the pandemic, PSTs noted the struggles and frustrations students faced when teachers were unable to provide needed resources and structure for learning after school buildings closed. Thus, PSTs became more receptive to the importance of being prepared to teach virtually and the necessity of learning to use a variety of educational tools. As one PST said,"It [transition to online] showed that… technology is a great resource to facilitate learning" (PST's reflection from K-12 Instructional Technologies, Spring 2020). It is evident that one benefit from the COVID-19 transition was the improvement in PSTs' attitudes and beliefs about the importance of technology in their teaching.

PSTs' Selection and Use of Educational Technologies

The two teacher educators noted that elementary PSTs and UESs tended to use technologies they felt most comfortable with (e.g., Google Slides) or that we're currently in vogue (e.g., Bitmojis) regardless of whether or not they matched their communication needs (Figure 1).

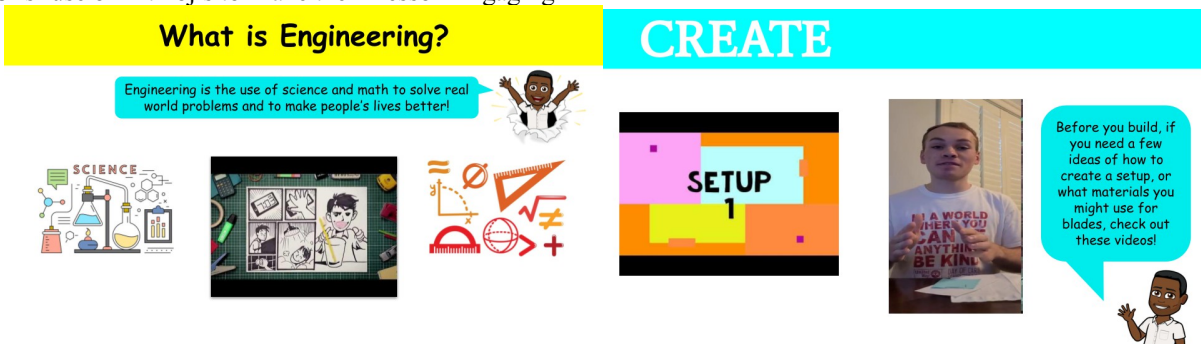
I think that PSTs used the bitmojis, which were very new at that time. I think that kind of set their presentation apart visually from the other presentation, because it was like 'Oh, look at that, isn't that cute?' So, it was visually stunning… So a lot of people, a lot of the teams [of PSTs and UESs] just started kind of throwing things in (Second author, Interview, Spring 2021).

From this pattern in PSTs' educational technology choices, teacher educators recognized the importance of engaging PSTs in deliberations about the tools they are using in their instruction and sharing their own decision-making process with their students. By making their own technological pedagogical content knowledge (TPACK) transparent, they could help PSTs develop theirs. Therefore, teacher educators need to provide PSTs with opportunities to evaluate how well technology applications align with instructional goals and with opportunities to select tools that best support their instructional strategies. Such opportunities can help build PSTs' TPACK.

It's a two-step process: me teaching appropriately, using modeling, and showing different types of technology and apps and whatnot. But also, helping to teach them how to select what's appropriate for the fourth-grade students to learn these things virtually (Second Author, Interview, Spring 2021).

Figure 1.

PSTs' use of Bitmojis to Make their Lesson Engaging



Importance of Interaction and Feedback from K-12 Students

From multiple years of teaching experience, the two teacher educators understand the importance of feedback from elementary students and the classroom teachers. When the schools closed due to COVID-19, they coordinated efforts so the PSTs would still be able to receive feedback from elementary students. For example, they asked PSTs to add formative assessments at the end of their lesson. They reached out to multiple elementary teachers to give out the asynchronous lessons to their students. However, at the time of the school closure, it was logistically challenging for the classroom teachers to distribute the lessons and collect feedback from their students.

They [elementary PSTs] could have learned more [if] they got more feedback on their Google Forms, on their padlets, whatever, before the end of the semester. We didn't get a ton of feedback from the kids, which was, you know, PSTs can't learn what went well, and what didn't (Third author, Interview, Spring 2021).

Many PSTs were skeptical of their competence in both teaching engineering and teaching online. They lacked the self-confidence to design their engineering lessons using effective pedagogical approaches. In the case of the PSTs teaching asynchronously, their self-doubt was exacerbated by a lack of interaction with and feedback from

the elementary students for whom the lesson was prepared: "I also felt I did learn a bit less since I wasn't able to see the live reaction of the students, their engineering ideas, or conduct the lesson in person" (PST's reflection from Foundations of Education, Spring 2020). PSTs seemed to instinctively understand the importance of interaction and feedback from elementary students for improving their teaching. In contrast to the PSTs who prepared asynchronous lessons and were unable to receive feedback from the elementary students, the PSTs in the instructional technology course collaborated in real-time with elementary students and expressed an increase in their competence and self-confidence in delivering engineering lessons and using effective pedagogical approaches. As a PST in the K-12 Instructional Technologies explained in her reflection:

> I felt most confident about the way I was able to convey information between myself and my fifth grade partner. I felt we really clicked and I was able to guide her in a way that let her do most of the work.

The teacher educators' experiences with the two different delivery modes showed that PSTs desire feedback and interaction with elementary students. We encourage teacher educators to provide opportunities for PSTs to prepare and share lessons with elementary students. However, teaching in an online setting is a different experience compared to teaching in-person. Thus, as teacher educators, we need to prepare PSTs to teach in online, as well as face-to-face, environments. Such preparations can include adding a virtual microteaching session, inviting a technology expert to class, or modeling effective synchronous lessons (Arsal, 2014).

Hands-on Experience on Physical Hardware of Teaching Engineering Online

When the university transitioned to remote instruction, the teams of PSTs and UESs in the Instructional Technology course were asked to complete their engineering lessons (i.e., building bio-inspired robots) at home. Thus, the physical hardware, including Hummingbird robotics kits, were purchased to ensure individual students' access to all necessary resources to build their robot when the school closed due to COVID-19. As a result, all 5th graders in the afterschool club, as well as PSTs and UESs had their own physical hardware to build their own robot. Working with only the virtual support of their teammates, the process of individually creating their own robot necessitated perseverance through challenges and failures. For example, PSTs reported that they built their own robot before the lesson to better understand the problems that they might run into while teaching their 5th grade partners. This allowed them to create solutions before they arose: "By having my kit at home I was able to explore and test different functions of the kit. I used my robotics kit approximately 8 times outside of class time instruction, to build and test different functions for the project (PST's reflection from Instructional Technology, Spring 2021)". Having their own physical hardware helped the PSTs not only learn more about robotics, but also gain confidence teaching the content and skills virtually to elementary students.

> I actually loved being able to work with my own robotics kit. I think having to share with someone or multiple people would've caused me to be a bit less hands on and not as thorough. Having the kits at our disposal at home during the training phase helped a lot and I don't think I would've felt as comfortable if I didn't spend extra time playing around with the materials. I spent a few days in between training sessions messing with the codes and materials to be able to feel confident that I understood everything. After we started Wow club, I used the kit mostly in the time frame we had with our student but at this point, I had already ensured I was comfortable using everything (PST's reflection from Instructional Technology, Spring 2021).

Based on this evidence, the teacher educators realized the importance of providing PSTs with the opportunity to explore and manipulate their own physical hardware in preparation to teach hands-on engineering tasks. Thus, we encourage teacher educators who are specifically introducing PSTs to technology and engineering to allocate time and resources for PSTs to explore physical hardware at their own pace.

Use of Digital Resources for Asynchronous Online Teaching

Since the transition from in-person to online was made quickly, the two teacher educators agreed to provide digital resources that the teams of PSTs and engineering students could refer to when designing their asynchronous engineering lessons.

> A sample seemed like the best way to help everyone [teams of PSTs and engineering students] be able to envision what this could look like and have this model to follow. And then, you have just a model, which is great, but then there's still the question of 'okay, we see your neat model, but we don't know how to do this. We don't know how to put the GIF in. We don't know how to embed the video. We don't know how to get audio in there.' So then, I could have like embedded it all together in one thing, but then it seems like that would have been confusing to have the sample and the directions all together in one slideshow. So I just thought, well, maybe it would be simpler to then come up with the directions later (Second Author, Interview, Spring 2021).

Specifically, two slideshows were provided to the teams of students: a sample digital lesson and directions for using instructional technologies to create multimedia (Figure 2).

Figure 2.
Two Digital Resources Provided to Teams of Students

Note. The Sample Interactive Lesson slideshow (left) introduced Padlet as a tool for making the asynchronous lesson interactive. The second slideshow (right) provided instructions for creating and inserting interactive and multimedia technologies into their lessons, for example this slide which showed the PSTs and UESs how to record and insert audio files.

In general, PSTs from all three courses found the sample virtual lesson and the technical instructions provided by the teacher educators beneficial as they helped them quickly reformat their lesson from an in-person synchronous format to an asynchronous online one. As one PST explained:

> I personally found the slideshow template and sample lesson to be the most beneficial resources. I think having the slideshow template helped us ensure we had the necessary information ready, without being concerned about constructing the slideshow from scratch and becoming caught up in the cosmetic part of it. I think it really allowed us to start working on the important aspects, which was the Engineering information and design challenge. The sample lesson was also beneficial to help us navigate how to create our challenge and entire project. It was the first stepping stone to help us make our way to an effective presentation and Engineering challenge (PST's reflection from Science Methods, Spring 2021).

However, PSTs had mixed feelings about the lesson template that was provided for their online lessons. Most of the students in Foundations of Education, which is an introductory course in thea teacher education program, perceived the template as useful for them. These PSTs mentioned that the template was useful because it helped them structure their lessons; "We used the slideshow template as the backbone for our final presentation and helped to give us a road map as to how the lesson should have gone" (PST's reflection from Foundations of Education, Spring 2021). They also elaborated that it gave them a sense of the components that should be included to be a good virtual lesson; "I think once we moved to an online classroom seeing the slide show that showed how to present the same work as a virtual lesson was very beneficial" (PST's reflection from Foundations of Education, Spring 2020). Other PSTs, particularly those in Science Methods, a course taken later in the teacher preparation program but also some in the foundations course, stated that the template was not as beneficial to them because it limited their creativity and opportunity for problem-solving and autonomy. Also, some of them saw the template as a strict guideline that they had to follow.

> I feel like our lessons all ended up looking like almost identical copies of each other. Because the way that we went in originally was we had the template for the lesson plan, so it was more of like a templated lesson that we did. So, you had to follow the template and just fit "what you wanted" in there. Like, so the materials that we chose, not a single material was included on the final materials list. So it's like how much impact did our group have on what the final project was? (PST's focus group from Foundations of Education, Spring 2021)

Based on these PST reflections, the teacher educators learned that when providing supplemental resources to support online teaching, the structure and details of the template should complement the PSTs' experience in their teacher preparation program. Thus, we suggest teacher educators carefully choose resources that are leveled appropriately for PSTs based on their progression in their preparation program.

Discussion

While the lessons shared in this paper resulted from two teacher educators' personal experiences and instructional decisions during remote teaching, we believe there are broader implications for teacher preparation. Considering the demand for K-12 online learning and the need for flexible modes of educational instruction (e.g, synchronous, asynchronous, or blended learning), PSTs need to be prepared for all forms of education. Many PSTs may not have experienced these modes themselves as K-12 students, and furthermore, just experiencing these modes as students do not prepare PSTs to teach through these modalities. Instead, PSTs need explicit instruction in online pedagogy. In addition, PSTs are expected to integrate technology in their lessons because K-12 students will need to be proficient with technology to actively participate in 21st-century culture. Considering such needs, teacher educators need to carefully expose PSTs to appropriate technologies that align with their pedagogical and disciplinary goals.

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Acknowledgements

This material is based upon work supported by the National Science Foundation under Grants #1821658 and #1908743. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.