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Science Teacher Education in the Time of COVID-19: A Document Analysis

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ABSTRACT

During the spring semester of 2020, education shifted in unprecedented ways due to a global pandemic. Along with the K-12 and university courses that were thrust online, education methods courses, existing in a nexus—often dependent on both education systems to achieve all learning goals, also transitioned to remote learning. In a document analysis, we analyzed the trends of many science teacher educators through a Facebook group and educator-created repositories. In the process, we identified five themes of discussion around the quick transition to emergency remote teaching: modification of teacher education, adoption of online interactive tools, how to address emergent concerns, the shifting foci of science methods courses, and collaboration with the larger community. While some aspects of this pandemic-teaching paradigm will emerge in the new normal of teaching, we expect that most practices will return closer to their pre-pandemic states of hands-on and in-classroom learning. Through this analysis, we provided evidence of the resilience of teacher educators and how the field bands together to help through trying times.

Introduction

On January 10th, the World Health Organization declared a global health emergency due to the COVID-19 (coronavirus) outbreak starting in Mainland China and quickly spreading all over the world. In March, many states in the United States issued stay-at-home directives. This order was followed by school closures and the call for remote teaching, which led to an overwhelming need for technical support, emotional support, practices for distance learning, online resources, and practical ways for moving forward.

Because of the COVID-19 outbreak, most educators, parents, and students were suddenly forced to use technology for learning and teaching practices. It is important to note that the call for remote teaching and learning should not be considered regular online teaching. There is a difference between emergency remote teaching and online learning and teaching (Hodges et al., 2020). Hodges and colleagues (2020) proposed a term for the type of instruction that is being delivered amid the coronavirus outbreak: emergency remote teaching (ERT). The term refers to a temporary shift in teaching under an unexpected circumstance. The authors explained how ERT is different from the online teaching that has been studied for decades:

> It involves the use of fully remote teaching solutions for instruction or education that would otherwise be delivered face-to-face or as blended or hybrid courses and that will return to that format once the crisis or emergency has abated. The primary objective in these circumstances is not to re-create a robust educational ecosystem but rather to provide temporary access to

> instruction and instructional supports in a manner that is quick to set up and is reliably available during an emergency or crisis. (Hodges et al., 2020, Emergency Remote Teaching section, para. 1)

Teaching through coronavirus, science educators began to request resources they could use for reorganizing their lesson plans in ways that they could easily share with their students. Many science education faculty members, science teachers, and science education doctoral students have created online platforms in which they brainstorm ideas on how to effectively modify teaching practices and share some resources with each other through some popular social outlets such as Facebook and Twitter. They have also used Zoom and Google Hangouts to organize online meetings and webinars to communicate with each other. These attempts were supported by many educational organizations and associations such as the National Association of Science Teaching (NSTA), Kappa Delta Pi International Honor Society in Education (KDP), and the National Board for Professional Teaching Standards. Some government agencies such as the National Science Foundation (NSF) have also supported teaching and learning practices under these pressing circumstances by offering emergency research grants for conducting educational research and developing instructional methods.

This paper aims to investigate how science teacher educators have responded to the call for ERT due to the coronavirus outbreak. This study focused on science teacher educators who teach *science methods courses* at the elementary, middle, and high school levels. We selected science methods courses because those courses tend to foster student scientific literacy and develop the ability to translate the theories of science learning and teaching into classroom practices or to start with practice and translate practice to theory (see Britton & Tippins, 2015). Therefore, science methods courses are essential for educating preservice science teachers.

Purpose of the Present Study

The purpose of this study was to investigate how science teacher educators negotiated the shift from face-to-face instruction to ERT amid COVID-19. To accomplish this goal, we analyzed a set of data from a social media outlet that shows how science teacher educators have acted upon moving science methods classes online. During our investigation, we asked the following questions:

- How did science teacher educators modify what they teach in a science methods course?
- How did science teacher educators modify the way they teach a science methods course?
- How did science teacher educators approach practicum experiences in pandemic?
- What did science teacher educators prioritize while moving science methods classes online?
- What type of challenges did science teacher educators face during ERT?

Method

Designed as document analysis, the present study utilized qualitative inquiry using online documents (social media, websites, blog posts, photos, podcasts, news articles, videos, etc.) about remote science teaching amid COVID-19. Document analysis is a form of qualitative research in which researchers collect, organize, and interpret documents to give voice and meaning around a topic of interest (Bowen, 2009). Document analysis can be used as a primary method of data collection and a compliment to other methods as well (O'Leary, 2014). A wide variety of studies in social sciences have already been conducted using social media, such as Facebook, and other online platforms to recruit participants, administer questionnaires, and collet data (e.g., Bond et al., 2012; Goel et al., 2010; Stillwell & Tunney, 2012). Therefore, this investigation built on existing methodologies to gather how a community is reacting to a novel problem, the novel coronavirus pandemic of 2020.

In this study, we aimed to examine posts from a Facebook group page called Repository for Online Science Teacher Education Resources (ROSTER), created on March 17th and populated by science teacher educators (STEs), which was developed to share resources to adapt to ERT during the pandemic, to learn how STEs were adapting their science methods instruction. Our data corpus consisted of the discussion posts, photos, comments, notes, links, and status updates from that Facebook group.

As of May 5, 2020, the Facebook group had 391 members including science teacher educators and doctoral students in science education, both from the United States and international locations around the world. The stated purpose of the Facebook group is to "provide discipline-specific support to science teacher educators as they adjust to the changing educational environment and transition from face-to-face to online teaching and learning" (Repository for Online Science Teacher Education Resources [ROSTER], 2020). The Facebook group is open to public. That means that anyone can see who is in the group and what they post and find this group on the internet.

The ROSTER Facebook group also compiled a list of Science Teacher Education Resources. People from the Facebook group contributed using a Google Form to organize the list of resources that would be helpful for science teacher educators and science educators, including sample teaching videos, virtual field trips, microteaching rubrics, and more. The contributors categorized these by grade level and audience as well as providing a description and key words for easy search functionality.

Worldwide Web (WWW) pages can all stand as documents in qualitative research (Prior, 2003). Two important reasons guided our choosing online platforms as the source of documents. The first reason centers around the dynamism of the documents. Because online texts are dynamic (Prior, 2003), those types of documents provide updated information all the time. The second reason is that online documents offer information via text, visuals, photos, and videos, enabling us to access different perspectives on the phenomenon of interest.

Findings

Identifying what constituted the experience of science teacher educators whose instruction shifted from face-to-face instruction to ERT and how they acted upon moving science methods classes online comprised this study's main purpose. We concluded that the data set from the ROSTER revolved around the following five themes, which we used to structure the findings of this study: (a) modifying teacher education, (b) adopting interactive tools, (c) addressing emergent concerns, (d) shifting the focus of science methods courses, and (e) collaborating with the community. We explained each theme and included illustrative excerpts from the data set. We added statements in brackets for clarification purposes and to designate a change in speaker.

Theme 1: Modifying Teacher Education

In shifting from in-person instruction to ERT, science teacher educators discussed and shared their way of modifying the preservice science teacher experience. The *Modifying Teacher Education* theme emerged from the experiences in which the science teacher educators either provided guidance on how to move a methods course online or asked for advice from other educators to adjust themselves to a new learning environment. The science teacher educators modified two main components of the methods classes: teacher practicum (field experience) and teaching activities based on their weekly lessons plans. Due to the nation-wide school closures in March, the field experience for preservice teachers was canceled. As a result of this, the science teacher educators looked for alternative approaches in lieu of the teacher practicum. The most common approach to modify the field experience appeared to be having preservice teachers watch online teaching videos created by inservice teachers and write reflections on the instruction in those videos. This approach is evident in one of

the science teacher educators' following remarks about what that instructional modification looked like:

> What I am planning to do online for the rest of the semester is really focus on having the students develop critical assessment skills. I'm going to have them watch teachers teaching each week and then provide feedback to that teacher based on what they learned in the first half of the semester. I'll then provide feedback on their feedback. (STE-1)

Another example of modifying the field experience was to make sure that preservice teachers can still practice teaching even if it is not in a formal classroom setting. Discussion ensued of filming short informal teaching experiences using whatever resources and audience preservice students had available. Science teacher educators searched for ways to evaluate these short teaching excerpts as evident in the following discussion post:

> At the webchat last week several of you mentioned that you used microteaching in your methods courses. I am wondering if any of you would be willing to share your rubric for peer evaluations. I decided to have students videotape their microteaching practices and share with classmates assigned to their group. I'd like to have the peers evaluate each other by using a rubric. I'm in need of samples that are simple yet informative for preservice teachers to use. (STE-2)

As mentioned earlier, the science teacher educators also modified their teaching activities on weekly lesson plans. This type of modification included citizen science projects, outdoor science teaching, and virtual science projects. The science teacher educators seemed to take advantage of the stay-home order and encourage teachers, students, and parents to take part in online citizen science projects in an effective and engaging way. One science teacher educator shared how they planned to incorporate different teaching activities in their science methods class as follows:

> I have been talking with my sister (nephew is third grade) about doing a virtual moon study over the next few weeks—that would be cool for a methods class to launch for kids [elementary school students] in collaboration with a cooperating teacher; each kid could have a moon mentor/families could be involved. (STE-3)

Theme 2: Adopting Interactive Tools

Adjusting to a new learning setting within a short period of time, the science teacher educators started brainstorming as to how to deliver online science instruction. The second theme, *Adapting Interactive Tools,* emerged from the discussions and shared ideas about the teaching platforms and instructional materials that are accessible, free, user-friendly, and engaging. Regarding the online teaching platforms, Zoom (videotelephony and online chat) and YouTube (online video-sharing platform) were the top two online platforms that the science teacher educators preferred to use to deliver and enrich their ERT science methods courses.

Several interactive features of these two platforms were highlighted and explained how they were useful for the science teacher educators to keep their methods classes going while their students were remote. For instance, Zoom can be used on laptops, desktops, tablets, and smartphones, giving students many ways to access the class session. It is possible to engage students in online class through chat, screen annotation, polling, non-verbal feedback, break-out rooms, online office hours, pre-recorded videos, student/teacher-made videos, videos with subtitles, and virtual whiteboards. The science teacher educators planned and implemented asynchronous or synchronous online class

sessions via Zoom, creating engagement. The following excerpt showed how Zoom was used to engage preservice teachers during a science methods class.

> In Zoom smaller breakout groups support the quieter students to participate. Right now my students are putting together 5 lesson unit plans and I give the students some time during each class to talk with one another and share resources. I have the groups organized into "like topics" of 2, 3, or 4 students. The organization by topic is not perfect but the students appreciate the time to plan together. I drop in on each group at least once. (STE-4)

The science teacher educators also utilized YouTube to create mini teaching demos or to ask their preservice teachers to create their own phenomena-based teaching videos as part of class projects. One science teacher educator who led the discussion about the remote teaching on Facebook group called ROSTER expressed how they thought of using YouTube to ask student teachers to create a situation in which students can do scientific inquiry at home as follows:

> I keep wanting to start a YouTube channel called "DO Try This at Home" with [preservice teachers] students making videos for kids of science phenomena they can explore in their own homes with everyday objects. (STE-3)

Another novel use of an interactive tool was the use of Flipgrid. Many teachers use Flipgrid as an enhancement of text-based classroom discussion as it mirrors some of the popular traits of social media platform, Snapchat. While many educators were continuing to use Flipgrid in its traditional role for mirroring in-class discussion online, another science teacher educator expanded her use of Flipgrid to replace an in-person opportunity that was lost. Typically, an array of inservice teachers would convene for a panel discussion of the experiences from real classrooms to help provide the preservice teachers with multiple views on handling specific situations and with guidance for their first-year teaching. When the panel could not meet:

> I created a Flipgrid where practicing elementary teachers can upload a short video (< 3 min) sharing some of their experiences with teaching elementary STEM topics. I plan to have my preservice teachers view the videos as part of an online assignment. If they can't be in a classroom, at least they can hear about it from experienced teachers. (STE-5)

> [Comment from another educator] Now I'm even thinking this would be great for a class [science methods course] to make with advice for the next class! (STE-6)

Theme 3: Addressing Emergent Concerns

The third theme denotes the concerns and challenges that were addressed by the science teacher educators teaching through a pandemic. The issue of equitable teaching and physical and emotional well-being kept surfacing across the data from the online documents we collected. It was acknowledged that equitable teaching should be responsive to the current need of students. The concerns about ERT restricting the communications and interactions between instructor-student and student-student were best illustrated in the following comments by two science teacher educators:

> My main concern now is my international students. Some of them went home to China and they won't have access to the websites that the government blocked or banned. I created a subgroup on Canvas to facilitate their group projects based on the resources they do have access. (STE-2)

> My institution doesn't have a Zoom subscription. I may need to find another way to facilitate this. I'll do some searching. I also need to find an alternative for the international students who went back to their home countries. I don't want to have unfair expectations when they are in different time zones than everybody else. (STE-1)

Self-directed learning skills and self-efficacy play an important role in the learning outcome within the context of both face-to-face and remote teaching (Liaw, 2008; Saba, 2012). Those skills are not equally shared by all students. As a result, some students may feel overwhelmed and incompetent to complete their online courses while dealing with personal issues amid pandemic. The issue of maintaining and helping with well-being of preservice teachers was evident in the following two discussion posts by one of the science teacher educators:

> I would like to add high quality feedback shows a lot about how much you care about them and participating in discussion boards. My students really value the level of feedback I provide on their weekly discussion boards as well as assignments. Sometimes I accidentally overwhelm them if I find resources to share or alternative assessments they may want to try. Also, sending out feeler emails-I like to check in with 1-2 students a week especially right now. Asking them how they are feeling about school work and wishing them and their families good health. (STE-7)

> I just want to make sure my students know we're here to support them now and, in the future, as they prepare to be educators. I don't want them to feel like all of this semester was lost. (STE-8)

Theme 4: Shifting the Focus of Science Methods Courses

In moving science methods courses online, the science teacher educators had two priorities: (a) the need for teaching Nature of Science (NOS) and (b) socioscientific issues. Emphasizing the importance of teaching NOS, the science educators and the science education organizations discussed and shared ideas about how to incorporate coronavirus into teaching to explain how science works. By doing so, science educators created an opportunity to deliver authentic science learning experience in the home setting by connecting a scientific phenomenon to everyday life. What teaching NOS and socioscientific issues within the context of coronavirus looks like was best illustrated in the following comments by two science teacher educators:

> I had already started planning for a theme for my secondary methods course in the fall related to public understanding of science. I totally see COVID-19 becoming a big part of that plan. I had already wanted to include socioscientific tasks involving vaccinations as well due to some local issues. I have been trying to file everything from tables and charts to memes simply to illustrate how information spreads from scientists to technicians to the lay audience. (STE-9)

> I'm going to launch it when we discuss scientific literacy. I've been using a video about vaccinations in combination with a *Tug of War* thinking routine. I'm adding a reading from the *NYTimes* on scientific literacy, a video titled *Vaccines: An Unhealthy Skepticism*, and a press conference on COVID-19 that highlighted the difference between evidence and feelings. (STE-10)

Theme 5: Collaborating with the Community

Moving science methods courses online, the science teacher educators also brought the importance of collaboration within the community into sharp focus amid COVID-19. It is important to note that the speed with which this move to ERT was expected to happen was overwhelming and unprecedented. Therefore, the science teacher educators sought guidance and support to find alternative routes, ideas, plans, and methods to deliver their instruction. They acknowledged that it was the time to work in close collaboration with the science education community. Many science teacher educators and researchers were willing to share their lesson plans, instructional materials developed as part of their research projects, teaching videos, rubrics, measurement instruments, and so on. The call for collaboration to compile a list of resources for science methods courses was evident in the following excerpt:

> We are having nearly 30 resources listed in ROSTER [Repository for Online Science Teacher Education Resources]. Please keep sharing your best resources. If you have specific needs, please let the community know! (STE-11)

Another example of collaboration within the science education community can be seen in the following conversation:

> We may have to move our entire elementary science methods courses online for Spring 2020 (quarter system starting in 2 weeks). Is anyone willing to share a syllabus/chat about how you did this? (we have a syllabus but need to help our instructors envision what this might look like in a virtual environment). (STE-3)
>
> [In response to the question above] If you send me a syllabus, I can help align activities or some Edtech. (STE-12)
>
> [Another response to the question above] I teach elementary ed methods as well and am working on moving it online if you need to collaborate. (STE-7)

Discussion

The themes we identified in this investigation address the complex nature of teaching in these uncertain times. Science methods courses within K-12 school settings provide preservice science teachers opportunities to enhance future science teaching practices (Settlage, 2000). During the spring semester of 2020, core ideals of science methods courses were threatened as moves out of school settings and to remote teaching shifted ways of interpreting philosophical and theoretical assumptions of the courses themselves. Each of the themes we identified is evidence of the high standards that we aspire our preservice teachers to reach in their own practices.

We ask science educators to be flexible to constant changes in schedule and responsive to student needs. We educate them on the technology that we think they will find useful, all while knowing that the tools available are constantly changing and they will need to adapt. When students have concerns that stem beyond the classroom, we ask the teachers to be respectful and receptive to their emotional and physical needs, not only their mental and academic ones. While the measures the world has taken to flatten the curve of COVID-19 infection and mortality were unprecedented, it has allowed so many professions to shine in their best light, including teacher education. This crisis has allowed teacher educators to exemplify the characteristics of the teachers we strive to educate.

While the instruction and learning looked different during the semester, the overarching goals of preparing teachers using best practices held fast. In *Modifying Teacher Education*, educators found innovative ways to maintain evaluation of teaching and provide feedback, even with no K-12 classrooms to use. They became Zoom experts overnight with the use of break-out rooms and screen capture software as they *Adopted Interactive Tools*. Some of these tools will continue as practices well after the direct impact of the virus. Teacher educators needed to show a brave face for their students as they *Addressed Emergent Concerns* of problems with internet bandwidth, increased depression and anxiety with uncertainty, limited computer time, and even international internet availability. As all else was in flux, science teacher educators *Shifted the Focus* of their science methods instruction to the basics and heart of science within society: the nature of science and socioscientific issues. If preservice science teachers understand what the essence of science is at its core, and how to navigate teaching that essence with the framework of science in society, the next generation of teachers can be successful against unsurmountable odds. In resuming their science methods classes online, science teacher educators were involved in effective *Collaborations within the Community* to share responsibility and resources to improve their science teaching.

Conclusion

The upheaval in the teacher education caused by COVID-19 had the potential to derail an entire year of teacher education and allow underprepared teachers to enter the workforce or not have enough teachers available to fill vacant positions in a field already struggling to meet demands with qualified applicants. However, the global science teacher education community came together amid crisis to revolutionize the way we taught for a short while. As Kuhnian paradigms go, this revolution will, most likely, only affect the paradigm in which it formed: that of ERT. Some of the remote fixes developed under stress may become incorporated into best practices. As the dust settles, and the paradigm again shifts to the new normal in a post-COVID world, we know how the science teacher education community responds to crisis: with cooperation, collaboration, and courage.

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References

Bond, R. M., Fariss, C. J., Jones, J. J., Kramer, A. D., Marlow, A., Settle, J. E., & Fowler, J. H. (2012). A 61-million-person experiment in social influence and political mobilization. *Nature, 489*, 295-298. https://doi.org/10.1038/nature11421

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal, 9*(2), 27-40. https://doi.org/10.3316/QRJ0902027

Britton, S. A., Tippins, D. J. (2015). Practice or theory: Situating science teacher preparation within a context of ecojustice philosophy. *Research in Science Education, 45*(3), 425-443.

Goel, S., Mason, W., & Watts, D. (2010). Real and perceived attitude agreement in social networks. *Journal of Personality and Social Psychology, 99*(4), 611-621. https://doi.org/10.1037/a0020697

Hodges, C., Moore, S., Lockee, B., Trust, T., & Bond, A. (2020, March 27). The difference between emergency remote teaching and online learning. *EDUCAUSE Review*. https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning

Liaw, S. S. (2008). Investigating students' perceived satisfaction, behavioral intention, and effectiveness of e-learning: A case study of the blackboard system. *Computers & Education, 51*(2), 864-873.

O'Leary, Z. (2014). *The essential guide to doing your research project*. SAGE Publications.

Prior, L. (2003). *Using documents on social research*. Sage Publications.

Repository for Online Science Teacher Education Resources (ROSTER). (n.d.). Home [Facebook page]. Facebook. Retrieved March 30, 2020, from https://www.facebook.com/groups/885756431852684/about/

Saba, T. (2012). Implications of e-learning systems and self-efficiency on students outcomes: A model approach. *Human-Centric Computing and Information Sciences, 2*(1), 6.

Settlage, J. (2000). Understanding the learning cycle: Influences on abilities to embrace the approach by preservice elementary school teachers. *Science Teacher Education, 84*(1), 43-50.

Stillwell, D. J., & Tunney, R. J. (2012). Effects of measurement methods on the relationship between smoking and delay reward discounting. *Addiction, 107*(5), 1003-1012. https://doi.org/10.1111/j.1360-0443.2011.03742.x