Responding to an Emerging Epidemic through Science Education (REESE): Project Highlights Spring 2021

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The Responding to an Emerging Epidemic through Science Education (REESE) project is pursuing two related goals as the COVID-19 pandemic unfolds. First, the project is working with high school science teachers to create COVID-related curriculum materials. Second, REESE is conducting research on how teachers enact COVID-related materials and how students are responding to associated learning opportunities in the midst of the pandemic. REESE data and analyses provide a close view of teachers' and students' experiences as they navigate the numerous challenges presented by the pandemic.

COVID-19 has impacted nearly every aspect of life in the US and across the globe. As of March 2021, approximately 120 million people have contracted the virus and over 2.5 million individuals have lost their lives due to the virus (New York Times, 2021). This pandemic presents an example of why scientific literacy, conceptualized broadly to include science concepts, the nature of scientific evidence, and ideas about how science works (Roberts & Bybee, 2014), is so critical. We contend that it is essential for science classrooms to be spaces in which learners explore complex issues like the COVID pandemic and develop science understandings associated with these issues. In addition, learners should explore how science can be used to inform solutions and personal decision-making.

Issues like epidemics, which are based in science and have societal influences and impacts, can be particularly challenging for teachers to introduce in science classrooms (Sadler et al., 2006). Despite near universal agreement that scientific literacy is a worthy goal and that issues like the COVID pandemic are ideal contexts for helping students develop scientific literacy, teachers are often reticent to introduce issues into their classrooms because the associated science may still be emerging and curricular resources are limited (Hancock et al., 2019). Therefore, despite the relevancy and urgency of the COVID pandemic, evidence from previous pandemics and other international crises suggest that science teachers may not be well prepared or have access to the resources they need to effectively teach science in the context of COVID (Smith et al., 2017). The REESE project responds to these challenges by working with experienced high school teachers to design and enact curriculum materials focused on COVID-19 as well as to study how the materials are enacted and student perspectives on the pandemic.

This project is informed by our team's multi-year efforts to study issue-based teaching and learning and to design tools and supports for teachers committed to this approach. These efforts have produced a framework for teaching with socio-scientific issues in a manner that prioritizes learner engagement in scientific practices such as modeling (Sadler et al., 2017; Zangori et al., 2017). A simplified representation of this framework (figure 1) provides an overview of the experiences that students should have during issues-based teaching and offers guidance in terms of instructional priorities and sequencing. The framework suggests that issues-based learning experiences begin with student opportunities to identify and explore an

important societal issue. Next, students build understandings of relevant science ideas and engage in scientific modeling and other scientific practices. Students should also have opportunities to consider the issue from multiple perspectives including ideas from their homes and communities (Bang et al. 2010). This leads to student analysis of socio-political dimensions of the issue including questions of power and oppression in their lived realities while also developing their agency toward using science for social change (Madkins et al. 2019). The learning sequence culminates with an opportunity for students to synthesize their science understandings, modeling competencies, perspective-taking and socio-political analyses to justify their own positions, perspectives, and/or solutions on the issue. This framework informed design of teacher professional development as well as creation of the COVID-19 curriculum materials.

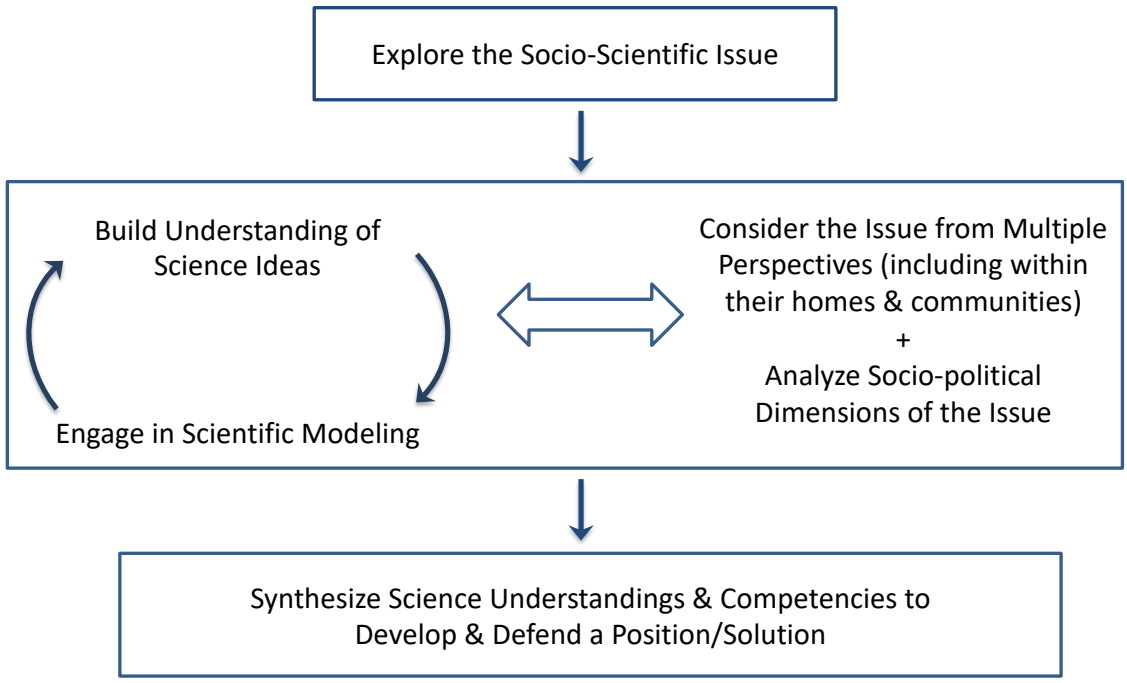

Figure 1. Framework for issues-based teaching and learning.

Project Context

The project is guided by a design-based research framework (Brown, 1992; McKenney & Reeves, 2013) in which iterative rounds of design and development of educational resources are complemented by the systematic collection and analysis of data. In the case of the REESE project, data collection and analyses have focused on both teacher processes and student learning and perspectives.

The project recruited teachers who had previously worked with issue-based curricula and who were interested in integrating a COVID-themed unit in their high school science classes. Ultimately, the project partnered with 12 experienced high school science teachers from three different districts in the state of Missouri. A central part of the project design was to engage participating teachers in professional development (PD) opportunities focused on co-

design of COVID-19 curriculum materials. The co-design process entailed teachers collaborating with each other and project staff for the creation of curriculum materials well suited for their teaching contexts. An expectation of the project was for teachers to enact the materials they had helped to co-design in their high school science classes. The first teacher PD and co-design sessions occurred in spring 2020, and enactment of the COVID curriculum materials initially occurred a few weeks later. A second round of PD and co-design was implemented in summer 2020 with enactments that followed in fall 2020 and spring 2021. Both PD's were held virtually (Sadler et al., 2020). Figure 2 presents a graphic of project iterations. The materials developed through this process include learning activities designed to help students:

- Develop understandings of how viruses spread and how prophylactic strategies such as mask-wearing can slow or stop the spread of COVID-19.
- Use computational and mathematical models to explore viral spread.
- Develop media and information literacy competencies for finding and critiquing information resources about the COVID pandemic and other socio-scientific issues.
- Build systems thinking skills in order to consider the multidimensional relationships among scientific ideas and social factors relevant to the pandemic.

These curriculum materials are available on the project website: https://epiclearning.web.unc.edu/covid/.

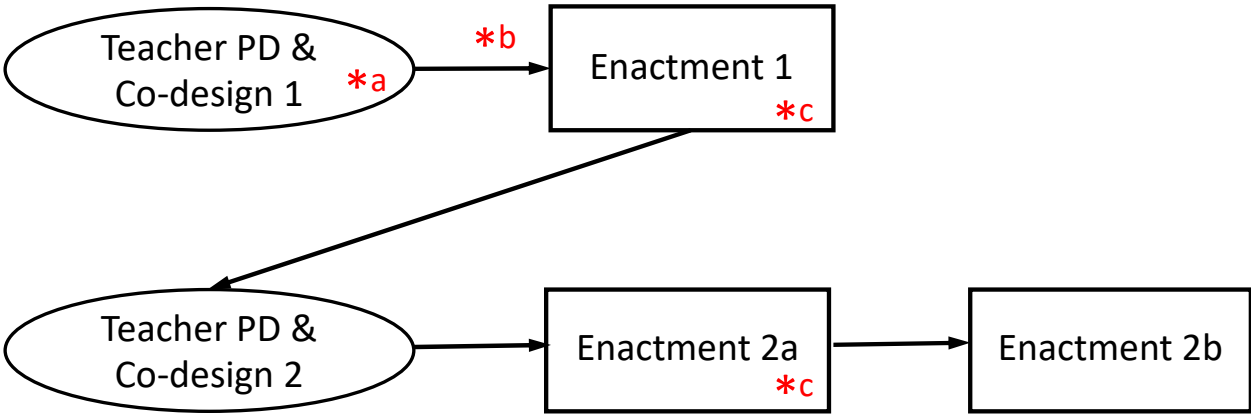

Figure 2. Graphic overview of the REESE project. The red *s, labeled a-c, highlight places within the project design where key findings were generated.

Data Sources

The project has generated data from multiple sources that explore various dimensions of the educational systems involved. Student data centered on surveys completed by students (n=261) as they were engaged in the COVID learning opportunities and artifacts developed during the unit. Teacher data included interviews of project teachers after the second PD experience and again after their enactment of the COVID materials. In addition, teachers completed instructional logs throughout their enactment practices. Project team members collected field notes along with video recordings of the PD sessions. Finally, numerous

communications, primarily through email, among the project team, teachers, and district leaders were captured as data sources.

Findings

In-depth analyses associated with specific research questions are being presented through peer-reviewed journal articles. The first of these articles (Sadler et al., 2020) describes the teacher PD, explores the ways in which technology supported the PD and co-design processes, and highlights findings with implications for future teacher PD. This article is available online through the *Journal of Technology and Teacher Education* (https://www.learntechlib.org/primary/p/216087/).

The second research article (Ke et al., in press) from the project explores student use of multiple models to make sense of complex issues like the COVID pandemic. In this contribution, we use literature and theory to advance an argument about why it is essential for students to develop and use multiple models as a part of their science learning experiences in general, and how the practice benefits students as they engage with socio-scientific issues in particular. We use student models and modeling experiences from the COVID curriculum enactments to show how this approach to models and modeling can promote students' understanding about scientific phenomena associated with issues. It can also support students in using their scientific knowledge to reason about how interacting science and social factors impact the position students take on complex issues. This article is currently in production and will be available through *Science & Education* soon.

With the remainder of this report, we highlight a series of key findings that have emerged from the work at different times across project phases and across different levels of the system. In referencing a system, we call attention to layered realities of modern schools (Scileppi, 1988) and differentiate findings that emerge at the levels of students, teachers, and schools/districts. We organize this presentation by where the findings emerged across project phases, which are shared in Figure 2. These findings are referenced in the figure with an "*".

Teacher level concerns

In the first phase of the project, we brought teachers together in an online workshop in order to co-design COVID-themed curriculum materials and plan for associated instruction. This first PD session occurred in spring 2020 just as COVID-19 began to spread across the US. Analysis of the field notes and video records of the teacher discussions and interactions with the project team during the PD lead to our first key finding (designated as *a in Figure 2). All of the participating teachers had used issues-based teaching approaches prior to the PD and had expressed enthusiasm about using the context of COVID-19 to teach important science content and practices. However, when presented with the opportunity to design specific COVID-related materials, many of the teachers expressed hesitation to move forward with teaching COVID because of concern for their students' mental health. They recognized that students were struggling with multiple consequences of the pandemic including acquaintances infected by the virus, family members whose jobs were threatened, general uncertainty, and anxiety about the health of themselves and their families. The teachers questioned how learning about COVID-19 would interact with the trauma students experienced as they lived through its effects. In response to these concerns, we invited a pediatric psychologist, who was a former K-12 teacher

and familiar with issues-based learning, to speak at the workshop. The psychologist discussed how engaging in systematic inquiry and learning about facts associated with trauma-inducing circumstances, like COVID, can support students' mental health. Engaging in these activities can help students focus on what they can do (e.g., steps they can take to protect themselves, sharing evidence-based information) while acknowledging some aspects of the situation that are beyond their control. Following this session, the teachers were much more at ease with the prospect of teaching about COVID-19 in the midst of the crisis. The key insight for our team based on this situation is that even when teachers may be generally supportive of issues-based teaching, or other innovative approaches, there may very likely be contextual factors that shape the ways in which they approach that work. Additionally, PD facilitators need to be prepared to anticipate or at least surface these concerns and respond in real-time.

Another key finding that emerged at this early stage of the project related to standards. The teachers in this project work in an NGSS state, and they were all committed to using NGSS aligned materials. In surveying the NGSS, there is little in the standards that related directly to viruses and pandemics. The teachers found themselves in a difficult position: on one hand they saw the immediate need to help their students make sense of an emerging global health crisis; on the other hand, they felt a responsibility to implement NGSS aligned curriculum. Unfortunately, there existed a mismatch between these two goals—teaching about the COVID issue did not align with the content focus of the NGSS. Ultimately, two tactics were used to resolve this tension, one that was promoted by the project team and another that was generated by the teachers. The project team highlighted student engagement in multiple scientific practices (with a particular focus on modeling) as an important point of alignment with NGSS. The teachers acknowledged the connection to practices but also sought stronger connections with required disciplinary content. Even though viruses are not a significant element of the standards, the teachers saw connections between teaching about viruses and content standards related to the defining characteristics of life. Therefore, they positioned the COVID materials as a unit that could replace content materials about what counts as living. The key insight for our team based on this finding is a limitation of the NGSS. While three-dimensional learning, which emphasizes disciplinary core ideas, science and engineering practices may be generative and support deep learning, the structure can also create dangerous limitations to what teachers are comfortable teaching in their classrooms.

School/District Level Challenges

As teachers worked to transition from project PD and co-design experiences to classroom enactment, we identified a different key finding related to school and district level policy making (identified as *b in Figure 2). By the time we initially met with teachers in the spring of 2020, the three districts with which the project was working had announced plans to shift instruction from face-to-face to online formats. As our partner teachers finalized their plans for enacting the COVID materials, one of the districts made a decision that would have drastic implications for that group of teachers in our project. The district made an across-the-board decision that no novel content material would be introduced while students were learning online. District and school leaders (i.e., the science coordinator and lead teachers for individual science subjects) developed materials designed to review and reinforce content that had been previously covered within courses. This decision seemed to be made with the

assumption that classes would shift back to in-person learning. However, even after it became clear that classes would remain online, the mandate to not introduce new content remained. Our partner teachers from this district were not able to implement the COVID materials. The decisions regarding what and how to enact the materials they had co-designed were effectively eliminated. In contrast, the other two districts from which project teachers came left curricular decisions up to the teachers even as the districts shifted to online instruction. Our partner teachers from these districts enacted the COVID materials in spring 2020.

For the school year beginning in fall 2020, the district that had enacted the no-new-content policy continued to operate in a fully online modality but dropped the policy restricting introduction of new content. Instead, the district implemented a new policy mandating greater levels of consistency within courses across school buildings. All classes within a course across the district's three high schools were expected to follow the same curriculum with the same schedule and pacing. Whereas the initial policy limited enactments of the COVID material, the second policy actually increased enactments. Based on suggestions from teachers participating in the project along with the district science coordinator who was familiar with the project, the COVID materials became a mandated part of the high school biology curriculum. In fall 2020 and spring 2021, all biology teachers across the district, including six of our partner teachers along with the other biology teachers who had not participated in co-design of the materials, enacted the project curriculum. The key insight for our team based on this finding relates to the significance of multi-level partnerships for designing, enacting, and researching educational innovation.

Student Level Perspectives

The final finding that we highlight in this report comes from data collected through student surveys (designated as *c in Figure 2). In one part of the survey, students were asked to rate the importance of various information sources as they tried to make sense of the COVID pandemic. They identified several sources that most educators would recognize as desired information outlets including medical professionals, government agencies such as the CDC and NIH, and national media. Many students also identified more questionable sources such as social media and political figures. Within this mix of information sources, most students identified their science teachers as one of their most important information sources for the COVID crisis. We also asked students to report on how interested they were in learning about various dimensions of COVID. Overall, student respondents indicated that they were very interested in learning about the virus and the pandemic. In breaking down individual areas of interests, students tended to be more interested in pragmatic aspects of the issue like how COVID-19 spreads, what the symptoms are, and what to do if they have symptoms as compared more conceptual aspects such as how viruses reproduce and the structure of COVID-19. This result provides evidence to support inferences made in research with teachers in response to the Ebola crisis in 2014 (Smith et al., 2014); that is, health crises can generate significant interests among high school students for learning about the crisis itself and associated science.

The survey also asked students to share their experiences and concerns with the pandemic. While there were a small number of students who suggested that the situation was having minimal impacts on their lives, most students expressed deep concerns and significant hardships associated with the pandemic. Students were worried about the health of their

family members (particularly parents and grandparents), their family's economic situation and the status of jobs, the wellbeing of their communities, the future of schooling, and the mental health of their friends and themselves. Many students related stories of family members or friends having conditions that add further complications to COVID such as asthma, autoimmune diseases, compromised immune systems, and heart problems. We heard from students whose anxiety is at an all-time high, are depressed, and "feel trapped and as if there's no point in online school." Many of the students in our sample shared dramatic ways in which the COVID pandemic affected them, and also indicated that they were looking to their science classes as a place to find useful information. The key insight for our team based on this finding is that students recognized the potential of meaningful science education experiences in their lives particularly in the context of a socio-scientific issue like the COVID pandemic.

Conclusions

The participating teachers and their students were very interested in learning about COVID-19 and strategies for stemming spread of the virus. These results are consistent with previous research on teacher perspectives about the role of science education in pandemics (Smith et al., 2017) and about student perspectives about learning with socioscientific issues more generally (Ke et al., 2020). Teachers wanted to introduce learning opportunities for their students to better understand the virus and the disease; however, they also had to work through significant concerns prior to doing so. A primary teacher concern related to how COVID-19 instruction would interact with the trauma students experienced as they lived through its effects. They also struggled with a tension between their desire to teach about an important, contemporary issue and the need to align their curriculum with NGSS, which did not include a focus on the issue. The project provided supports for addressing the concern about teaching COVID and related trauma, and the teachers were able to navigate the tension generated by the desire to align their teaching with NGSS

Despite universally high levels of enthusiasm for enacting COVID-19 curricula, district level policies emerged as the major determinant for if and how teachers used the materials with their students. All three districts with which we partnered transitioned to remote learning mediated by online platforms in spring 2020. One district maintained high expectations for student engagement in remote learning, and both teachers from this district enacted the full complement of COVID materials. Interestingly, this district served the most diverse student population including a high proportion of students from economically disadvantaged backgrounds. The second district encouraged student participation in online learning but removed some of its grade incentives. The two teachers from this district enacted about half of the designed materials. The third district decided to mandate that new content material not be introduced through online instruction. The teachers from this district ended up not enacting any of the COVID-19 materials during spring 2020. However, district policy shifted substantially in fall 2020; the new guidelines mandated a common curriculum within courses across all schools and teachers. As a result, every biology teacher in the district, including those who had participated in the PD to support their enactment of the materials and those who had not, enacted the COVID curriculum. The project provides a powerful case of how district-level decisions can substantially impact teacher- and student-level experiences.

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