

STEM Teachers' Designs for Learning: Addressing the Social and Political Climate during COVID-19

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This study examined how seven math and science secondary teachers addressed social justice teaching during the COVID-19 pandemic and how their instructional practices mapped onto their pedagogical intentions. Guided by trauma-informed teaching practices and learner engagement conceptual frameworks, the authors argue STEM induction teachers need greater support to design instruction that enables students to apply knowledge to social justice issues. Participants' understanding and enactment of social justice pedagogy varied, leading the authors to provide continued support to the cohort of teachers for their students to feel empowered to address, discuss, and apply the discipline knowledge in STEM to social justice issues.

Introduction

Although the social and political climate of the United States and the COVID-19 pandemic present challenges for all, an opportunity exists for teacher educators to work collaboratively with educational agencies, schools, and teachers to provide “expertise, research, and a commitment to centering social justice and equity” to support teachers and students during and beyond the pandemic (Campbell et al., 2021, p. 5). One means of addressing social justice and equity issues for those with instructional design expertise is to support educators on the design and development of social justice teaching personalized to their classroom contexts; however, the ways in which teachers designed lessons and facilitate social justice teaching during the COVID-19 pandemic is not well established. Therefore, this study examines how a cohort of science, technology, engineering, and mathematics (STEM) teachers, who were supported in creating online and blended lessons attending to the socio-emotional and engagement needs of students, expanded their instruction to include social justice issues of interest.

This article argues teachers, especially those in the induction years, need greater support to design instruction enabling students to apply knowledge to social justice issues. To this end, the researchers designed and delivered a free five-week online summer professional development (PD) opportunity for 11 teacher participants that supported personalized learning goals for online and blended teaching. The PD was guided by trauma-informed teaching practices (Carello, 2018) and learner

engagement conceptual frameworks (Bond & Bedenlier, 2019; Bond et al., 2020; Fredricks et al., 2004) as part of a larger case study examining how a cohort of secondary STEM teachers designed online instruction to support student engagement (see Roman et al., 2021). When viewed through the lens of trauma-informed teaching, teaching and learning is student-centered with an emphasis on both cognitive and affective student engagement. In this study, participants were asked to create engaging, trauma-informed remote learning experiences for their students. Participants were also encouraged, but not required, to address the social and political climate within the project they designed.

Literature Review

In the following section, a definition of social justice in education is provided and the approach to social justice pedagogical practices is explained. Then, the article delves into social justice teaching practices in STEM education, and details specific *approaches* within mathematics and science education.

Social Justice in Education

A challenge in addressing social justice in education is that the construct itself is broad, resulting in various interpretations and definitions. Social justice in education has been defined as “a set of attitudes, beliefs, and behaviors in relation to teaching, learning, and students that form the foundation of one’s pedagogy” (Nieto, 2013, p. 21). Thus, one’s attitudes, beliefs, and behaviors are foundational to one’s perspective on social justice. For

purposes of this paper, the study uses Nieto's (2013) assertion that social justice pedagogy (a) confronts biases that amplify inequality; (b) builds upon the assets of all learners; (c) provides all learners the material and emotional resources needed to succeed; and (d) supports all learners in developing agency to participate in democracy (p. 21). Additionally, the researchers view culturally-responsive pedagogy as complementary to social justice pedagogy, particularly for those designing instruction. Young and Asino (2020) have long advocated for more "cultural considerations of how the design of curriculums, experiences, and technologies for education influence and affect learning" (p. 278).

Teaching for social justice is much more than method. The researchers frame teaching for social justice as an approach driven by the conviction that: (a) people, not disciplinary subjects, are the focus of the work and (b) subject matter is a context for learning mastery of oneself for making a positive difference in one's realm of influence (Berry et al., 2020; Rubel, 2017). In other words, to teach for social justice requires a human-centered approach in which students seek to create positive change in their local or broader community. Typically, teaching opportunities promoting social justice tend to be curricular and extracurricular discussions sparked by controversial issues and problems bearing on educators' and students' sense of equality and equity. As faculty who support in-service STEM educators in Georgia, the researchers work to support secondary STEM teachers in their efforts to support students' growth in becoming citizens who apply STEM knowledge to the critical thinking and reasoned discourse characterizing participation in a democracy. This requires teachers to anticipate, plan, and enact instruction responsive to social issues of injustice which are in turn relevant to the STEM curriculum.

Social Justice Teaching Practices in STEM Education

STEM social justice teaching is defined as connecting the curriculum to issues students know and care about, and consequently, want to change. Teaching STEM for social justice involves helping youth identify inequities within their communities and determining how disciplinary knowledge can be used to understand and respond to local (often societal) issues (Barton, 2003; Esposito & Swain, 2009). When related to mathematics and science teaching practices, approaches are similar, but there are subject-specific differences. In the area of mathematics, Gutstein (2006) posited students can deepen their understanding of math by studying and using mathematics in the context of their lived experiences which strengthens both their conceptual and procedural understanding and proficiencies. A challenge, however, is math teachers often feel state curriculum standards and

standardized testing forces them to teach mathematics with a focus on formulas and procedures students can memorize and easily recall during testing (National Council of Teachers of Mathematics, 2014).

Like mathematics, in secondary science, externally imposed assessments of student learning influence how instruction is approached. Often, "covering content" may take precedence over building understanding via scientific investigations. When students' STEM education consists of test preparation via drill and practice or information transmission, they miss opportunities to think critically and to explore how STEM knowledge can be used to make sense of the world (Erduran et al., 2020). Because students are often exposed to social issues such as poverty, racial discrimination, food insecurity, wage gap, and more recently, the COVID-19 virus and its impact on their communities, they are filled with curiosity and questions that can be investigated and explored using STEM (Finkel, 2018).

Theoretical Framework

The theoretical framework guiding the social justice focus of this study included trauma-informed teaching practices (Carello, 2018). Trauma informed teaching practices are relevant as teachers and students are currently operating within the context of COVID-19, which Horesh and Brown (2020) argued should be viewed from a perspective of trauma. Trauma-informed teaching includes being aware and responsive to forms of privilege and oppression, as well as attending to issues of social justice (Carello, 2018). Trauma-informed teaching and learning principles include: (a) physical, emotional, social, and academic safety; (b) trustworthiness and transparency; (c) support and connection; (d) collaboration and mutuality; (e) empowerment, voice, and choice; (f) social justice; and (g) resilience, growth, and change (Carello, 2018; Fallot & Harris, 2009; Substance Abuse and Mental Health Services Administration, 2014). These principles were discussed with teacher participants to assist them in creating and facilitating instruction prioritizing students' emotional safety while minimizing any additional trauma (Carello & Butler, 2015) resulting from the social, political, and pandemic contexts potentially impacting their students' learning.

Taking a trauma-informed approach to teaching provides a framework for STEM teachers to create lessons that provide students with access to mathematics and science, support their understanding of the world, and help students to develop empowerment and agency in responding to social injustice (Berry et al., 2020; Gutstein, 2006; Ladson-Billings & Tate, 1995). Teaching STEM for social justice is critical to connecting STEM to students' lived experiences (Berry et al., 2020). Reasons for teaching social justice include (a) helping students

learn to use disciplinary knowledge as a tool for social change; (b) empowering students to confront and solve real-world challenges; (c) connecting STEM subject matter with students' cultural and community histories; and (d) building an informed society (Berry et al., 2020). The reasons for teaching social justice presented by Berry et al. (2020) can be applied to teachers across all dimensions of STEM in secondary schools.

Research Questions

The researchers examined the following research questions related to teaching in trauma-informed online/blended learning environments during the COVID-19 pandemic:

1. How do secondary STEM teachers intend to address social justice teaching in their curriculum designs?
2. How did secondary STEM teachers' attempt to enact their curriculum designs for social justice teaching?

Methods

The researchers employed a single case study design (Yin, 2018) to examine how STEM teachers designed remote learning with intent to engage their students in mathematics and science instruction using trauma-informed pedagogical approaches while addressing the current social and political climate. A sub-group (seven out of 11) of early career STEM teachers who experienced a PD workshop comprised the case. In accordance with Institutional Review Board approval, each participant provided consent prior to data collection. To ensure anonymity, participants were assigned pseudonyms.

Participants and Professional Development Context

Eleven STEM Teaching Fellows of the Institute of Citizens and Scholars (ICS), formerly Woodrow Wilson National Fellowship Foundation, received an online five-week summer PD opportunity during the summer of 2020. ICS enables individuals with STEM backgrounds to receive a graduate degree in STEM education, classroom experiences, and ongoing mentoring. As part of the program, the Fellows made a three-year commitment to teach in high-need secondary schools in STEM subjects. All participants had a Masters of Arts in teaching in their content area and one to three years of teaching experience (see Table 1). Of the 11 participants, a purposeful sample of seven expressed desire to increase social justice-oriented teaching practices and served as the case for this study.

Table 1

Participant Information

Participant Pseudonym and Years of Teaching Experience	Gender & Race	Subject Areas Taught in 2020-2021
KC 2 years	Female White	10th grade Biology, 9th grade Computer Science, 11th grade Genetics, 10-12th grades Biotechnology
LU 1 year	Female White	9 th grade Biology
NX 3 years	Female Black	7 th grade Life Science
NT 3 years	Male White	10 th grade Biology
BC 3 years	Female White	10 th grade Honors Chemistry, 11 th -12 th grade Biology, 9-12 CTAE Essentials of Biotechnology, 9-12 CTAE Applications of Biotechnology
EP 2 years	Female White	7 th grade Mathematics
NC 2 years	Male White	9 th -12 th grade Engineering (four course levels)

The intent of the PD was to support the participants' cognitive, affective, and social needs (see Trust et al., 2020) and to provide training and support to help meet their professional goals for online and blended teaching (Trust & Horrocks, 2017). Structured as a Stage 1 pilot (Borko, 2004; Hill et al., 2013), implementation of the PD occurred online due to the COVID-19 pandemic. Three faculty members from instructional technology, mathematics education, and science education directed the PD in this study. The fourth faculty member on the project, with expertise in instructional design and teacher reflection, served as a research collaborator. These faculty wanted to use their leadership capabilities to provide high-quality PD (see Borko, 2004) by: (a) bringing together a cohort of educators with shared interests across different schools; (b) facilitating high-quality synchronous sessions/asynchronous learning opportunities; (c) addressing teachers' immediate needs; and (d) providing teachers with desired content expertise not readily available within their school or district (Bates et al., 2016). Participants attended five weekly synchronous sessions led by faculty facilitators and worked asynchronously on their projects throughout the duration of the PD. To support the teachers in the creation of their projects, each participant met one-on-

one with the instructional technology faculty member for one-hour co-planning sessions in the second week of the PD. The faculty member introduced specific content-based instructional tools and strategies to support the participant in meeting identified goals grounded in trauma-informed, engaging, and remote learning experiences.

Data Collection and Analysis

The researchers collected participants' data from the summer 2020 PD workshop, as well as interview data obtained during winter of the 2020-2021 school year. Since teachers needed time to apply what they learned from PD in practice, data collected over time (e.g., months later) is recommended to better understand how teachers make sense of the knowledge and skills acquired during the PD and how changes, if any, are applied to their instruction (Dede et al., 2009). Table 2 identifies the data and data collection timeline that provided insights into the participants' design plans, decisions, and lesson implementation. Additional data were collected as part of a larger study on student engagement in online and hybrid learning environments (see Roman et al., 2021). Each participant was interviewed twice (see appendices A and B). The mathematics faculty educator conducted interviews with the mathematics and engineering teachers, while the science faculty educator interviewed the science teachers. Interviews were recorded using Zoom and audio files were transcribed using Otter.ai. Only interview data pertaining to STEM social justice teaching were included in this study. The research team developed theoretical and data-driven codes (Boyatzis, 1998) and used Atlas.ti Cloud to facilitate their collaborative thematic data analysis (Cornish et al., 2014). Codes derived from the principles of trauma-informed teaching (Carello, 2020) were used to identify data patterns related to social justice (see Roman et al., 2021). Open-coding was used to explore STEM social justice topics, teaching approaches, degree of implementation and barriers to implementation.

Table 2

Data Collection

Data Source	
Final Project Presentation Files	July, 2020
Final Synchronous Session Transcript	July, 2020
PD Exit Interview	July-August, 2020
Follow-Up Interview	January, 2021

Findings

Q1: How do secondary STEM teachers intend to address social justice teaching in their curriculum designs?

Table 3 provides a summary of planned and implemented social justice STEM lessons from each participant. Through the analysis of teacher artifacts and individual interviews, participants indicated they were devising ways to incorporate activities related to social issues including Black Lives Matter and COVID-19. For example, NX commented, "in light of everything that happened [in 2020], I think kids need to feel heard in the classroom, especially our black and brown kids." For her 7th grade life science students, NX developed a lesson facilitating student analysis and discussion of two medical research injustices: (1) the Tuskegee Study of Untreated Syphilis and (2) the taking and distribution of cervical cancer cells from Henrietta Lacks. These efforts stand in contrast to four participants who were not ready or interested in developing social justice-oriented STEM lessons. Of the seven participants who were interested in expanding their emphasis on social justice, one participant did not generate a specific curriculum connection for planning instruction relating to social justice. Nevertheless, she later reported guiding student discussions of social justice issues as an extracurricular component of her care for students.

Table 3

Participants' Social Justice Topics for Intended and Implemented Instruction

Participant ID	Social Justice Topics for Intended Instruction (summer 2020)	Social Justice Topics of Implemented Instruction (fall 2020)
KC	Environmental Science Topics: Food insecurity; energy and transportation Life Science Topics: COVID-19 epidemiology and racial disparities	Computer Science Topic: Digital divide and access to learning during COVID-19
LU	Biology Topics: Disproportionate impacts of COVID-19 on black and LatinX communities.	Biology Topics: Take/not take COVID Vaccine; GMOs; Designer Babies; Capitol Riots
NX	The workshop prompted her to develop a life science lesson guiding her 7th graders to analyze medical ethics.	Life Science Topic: Henrietta Lacks (planned for spring 2021); "climate refugees" from Isle de Jean Charles
NT	Biology Topics: Disproportionate impact of COVID-19 on people of color and lower-economic communities	Biology Topics: Flint River Crisis; Climate change's disproportionate effects on low-income communities
BC	Biology Topic: Race as a social, not biological, construct Chemistry and Biology Topic: Minority scientists.	All Science Courses: Discussions on current events that relate to social justice
EP	General Instructional Plans: Implement social justice strategies with students in classroom (e.g., creating community of support, connection and collaboration) but specific content-connections were not articulated.	Homeroom: Discussions on current events that relate to social justice
NC	Engineering Topic: Examining the discrimination in STEM career and STEM education	After School Club: Changed the Robotics Club designation to LGBTQ

Note: The social justice topics listed were *intended* for instruction and communicated by participants during the final synchronous session of the PD, as part of a larger culminating presentation about instructional planning for

COVID-19 online- or blended-learning with socio-emotional-affective supports. Thus, we were not surprised to find that the social justice topics *implemented* in fall 2020 were different and often more extensive than what was initially envisioned by participants during the summer PD.

Several science teachers, such as participant LU, planned to connect COVID-19 to their science content and the "disproportionate impacts of COVID in the black community and the LatinX community." Participant AB intended to engage students in conversations about "minority science inventors and contributors that get left out of the textbooks" and mentioned the intention to teach that race is not a biological construct. Similarly, NC, an engineering teacher, planned to teach a unit on STEM careers, guiding students to examine the injustices existing in STEM fields and education, including at their own school (see Figure 1 for NC's unit overview).

Figure 1

STEM Careers Unit Overview created by Participant NC



Picture of a PowerPoint slide describing the overview of a STEM careers unit

Two participants (NT and KC) planned to introduce projects based on environmental science and social justice. For example, KC aspired to increase the sense of belonging in science felt by her ninth-grade on-level environmental science students. Citizen science was her approach to "...help kids be like a citizen of the world, not just a high school science student." Her plans included providing students a choice of projects among several she identified as feasible in a blended or online environment. Her hopes for success were high, as she envisioned "...ongoing citizen science projects that every single student can participate in because they are things that either require an app on their phone, or there's a lot where they're doing data analysis by looking at pictures" (see Figure 2 for a list of KC's class project requirements). NT designed a unit on Human Impact on the Environment in OneNote for his students. He wanted to maximize problem-based learning using case-studies related to social and environmental justice. NT also made plans to increase student engagement via opportunities

for student collaboration in Microsoft Teams (see Figure 3).

Figure 2

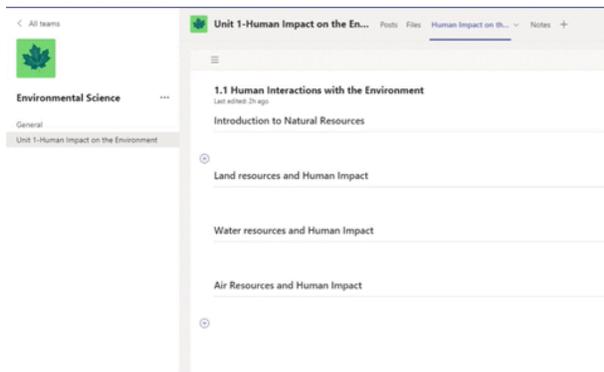
KC Citizen Science Project Requirements

	Due Date	Requirements
Part A	09/08/2020	Submit a proposal with the following information: (Use the template on the blog) <ul style="list-style-type: none"> • Summary of the research project • Explain how this research relates to Environmental Science • Explain why you chose this project • Describe what your contribution to the research will be • Whether you will be working with other students
Part B	09/14- 10/23	For four of the five weeks your weekly summary should include: <ul style="list-style-type: none"> • Summarize what you accomplished during the week • State which day(s) you completed the work • State the total time you spent for the week (20mins minimum) • Submit a screenshot/some kind of evidence of your progress One week of your choosing: <ul style="list-style-type: none"> • Teach someone in your house/life about your research project • Explain what you taught to this person and how it went • Reflect on what you learned from this experience and whether you enjoyed it
Part C	12/04/2020	This will be the final presentation for your project and it will include the following: <ul style="list-style-type: none"> • Overall summary of the research project, its importance and how you contributed to the project • Connect your project to at least 2 units in a meaningful way • Explain how you went beyond the research and what you have created for that

Picture of project requirements with deadlines

Figure 3

NT Human Impact on Environment Unit



Screenshot of a unit and subtopics.

Q2: How did secondary STEM teachers attempt to enact their curriculum designs for social justice teaching?

In their final presentations, mathematics teacher participants articulated plans to facilitate lessons to address social injustices within the community; however, one of the two study participants cited several reasons why they were unable to implement their social justice related plans. The reasons ranged from not having enough time to adapt or create new lessons to a lack of resources or existing lesson exemplars. Participant EP stated, “I haven’t had the capacity in my own life to really sit down and come up with some great mathematical way of looking at social justice issues.” This comment was based on the challenges associated with time constraints involved in adapting current lessons to meet the needs of

students learning in both virtual and face-to-face contexts because of COVID-19. It is not unusual for teachers to experience a lack of time to design, locate, or implement social justice mathematics lessons (Bartell, 2013). While teachers might be aware of social justice issues occurring in society, connecting those issues with mathematics can be difficult. EP explained “I have always found that in a math class it can be very difficult to find a way to address those [social justice issues].” Gregson (2013) and Gutstein (2012) reported engaging in discussions with students about community issues assists teachers to develop curriculum and activities enabling the construction of mathematics knowledge.

While some participants were challenged to facilitate planned social justice lessons in their specific mathematics classrooms during fall 2020, several were able to engage students in discussions around social justice issues (see Table 3). In some cases, these discussions led to actions. An engineering teacher participant, NC, encouraged and supported his Robotics club students who decided to use their voice at a school board meeting to advocate for changing the name of their local high school, named for a Confederate general. He also facilitated discussions with Robotics club members about becoming nationally recognized as a LGBTQ+ friendly school site. For another math teacher participant, EP, discussions with students during homeroom provided an opportunity to build relationships with students through listening and using what she knows about her students as a starting point for building connections to mathematics. Research suggests this is a first step to beginning the practice of culturally responsive or social justice teaching (Gay, 2002; Gutstein, 2012).

All five science teachers who had expressed interest in addressing social justice issues in their teaching at the beginning of the semester expressed continued desire to do so when reflecting on fall 2020 teaching at semester’s end. Environmental pollution (e.g., Flint, Michigan water crisis) and disease transmission (e.g., COVID-19) are relevant topics for chemistry, environmental, or life science courses. That three of these science teacher participants taught these issues with reference to disproportionate impacts on people of color and lower socioeconomic standing is early evidence of social justice teaching. Participant KC indicated two other social justice-oriented lessons from her computer science classes. One lesson was an ethical issue about crash-response algorithms in self-driving cars and the other lesson was a discussion about the digital divide. In the context of virtual schooling during COVID-19, the issue of “...who’s allowed to learn now and who is not allowed to learn because of their access to internet or technology” was particularly salient.

In this first stage of collaboration with STEM teachers on

social justice-oriented teaching, informal discourse is the first step these teachers seem to be taking together. That is, participants provided examples of either curricular or extracurricular conversations about social justice issues that emerged often from caring interactions with students. This is congruent with a shared social constructivist epistemology within the group of teacher participants and project leaders. It also seems to be a logical outgrowth of the summer 2020 professional learning community collaboration, through which application of trauma-informed instructional design principles and student engagement indicators led the group to a deepened appreciation for how social and affective engagement supports learning. Participant LU represents the experience of four of the participants, regarding school during the first week of January 2020 stating “We literally had a spur of the moment conversation last Friday, about everything that transpired last week [January 6 Capitol riots], and we were encouraged to do that by the district.” It was also LU who stated the widest variety of references to social justice issues in her fall 2020 teaching. These included discussions of genetically modified organisms, “designer” babies, and reasoning behind peoples’ choice to receive or avoid vaccination. NX related two historical injustices from medical research suffered by Black Americans as an upcoming opportunity for social justice instruction in life science:

I've always wanted to hit the Henrietta Lacks issue in genetics and every year I say I'm going to do it and I never get it but I'm definitely going to do it this year. So that's not a present issue but I can tie it to the mistreatment (of) ... the Tuskegee (syphilis) study, and why right now there are a lot of people of color who are distrusting of the [COVID-19] vaccine.

Although outside the immediate scope of this study, four out of eleven participants from the larger engagement research project (Roman et al., 2021) stated they did not intend to implement instruction related to social justice. Reasons cited included difficulty “fit[ting] it into their curriculum” due to online learning amid COVID-19, as well as concerns about emotional fatigue. These perspectives highlight important work remaining in supporting *all* teachers to use STEM as a tool to address issues of social injustice (Berry et al., 2020). There is a need to co-construct with these teachers, to create a working definition of social justice-oriented teaching, and to engage in culturally responsive and culturally sustaining pedagogy (Ladson-Billings, 1995; Paris, 2012).

Discussion

When it comes to teaching mathematics and science for social justice, many teachers are often unsure how to begin. Social justice issues can be challenging to address in any classroom particularly among teachers who fear being inaccurate, insensitive, or offensive when speaking with their students. One mathematics teacher participant, EP, stated “I wouldn’t want to boil it [a social issue] down to numbers and that’s all it is, because it’s ... not. I find this offensive.” NC also stated, “It’s [social justice issues] a very vulnerable thing to talk about in general...it needs to be a supportive environment that everyone feels welcome and trusted in.” Some teachers might hold a belief that mathematics is neutral and culture free and teaching mathematics exclusively focuses on the computation of numbers and procedural fluency. Others position themselves as having limited knowledge and understanding about how to facilitate teaching STEM for social justice suggesting limited teaching resources available to support culturally relevant or social justice teaching. These beliefs and positions often lead teachers to conclude that exploring social justice issues does not fit well within the mathematics classroom, particularly when the focus is solely on sensitive racial issues or numbers and procedures (Berry et al., 2020; Leonard & Evans, 2012).

It is difficult to envision engagement in STEM learning apart from the application of knowledge developed in the practice of those disciplines. Social justice STEM teaching operates from an equity imperative that all students can achieve in these disciplines. Educators can support their students in the STEM literacy goal of developing scientifically and mathematically savvy citizens who reason and solve problems germane to their sphere of influence. This view of STEM education sees learners as change agents (Freire, 1970), and teachers as guides who prepare learners “for life as socially conscious and active citizens who can use science for personal and community purposes” (Finkel, 2018, p. 41). Leonard and Evans (2012) defined teaching mathematics for social justice as embracing social justice perspectives and actions enabling all learners to engage in cognitively demanding STEM in culturally specific and meaningful ways which support improving the economic and social conditions of marginalized individuals or groups. Marginalized individuals and groups are those who are denied involvement or participation in mainstream economic, cultural, political, or social activities. As such, teaching STEM for social justice involves teachers emphasizing equitable opportunities for *all* students while empowering them to use STEM to understand and critique inequities within *any* community and work to improve or reduce inequitable conditions within those communities.

Scholarly Implications

Strategies for Addressing Topics of Social Justice

As it relates to teaching social justice in education, working with this cohort of in-service STEM teachers brought to the researchers' attention that the initial efforts in summer 2020 to encourage the integration of social justice issues into trauma-informed engaging lessons were insufficient, at best. To support teachers in designing instruction enabling students to apply knowledge to social justice issues, instruction requires considering teaching *with*, *for*, and *through* social justice; it is not just about lesson development and implementation (Berry et al., 2020; Wager, 2008). Relationship building by teachers with and among students and the dialogue that emerges is as imperative as social justice lessons themselves (Berry et al., 2020). Teacher and student rapport can best be established when teachers first attend to the trauma-informed teaching practice in which they establish physical, emotional, social and academic safety (Carello & Butler, 2015).

In many ways COVID upended the 2020-2021 school year interrupting the typical school year resulting in unexpected changes in planning, teaching, learning goals, and classroom environments that included both face-to-face and online students. Under normal circumstances, teachers are afforded opportunities to engage in explicit lesson planning which includes anticipating students' thinking, misconceptions, and problem-solving strategies. This type of formal lesson planning serves as an explicit road map for how students will interact during the learning process (Smith & Stein, 2011). However, during this atypical school year, teachers experienced balancing *in the moment* social justice teaching with more formalized learning designs tying existing curriculum to social justice issues. For example, teaching in the moment of a major current event (e.g., January 6, 2021, capitol riots) requires teachers to think and act quickly with potentially limited resources, which is different from learning activities designed well in advance within formalized curricular units (e.g., Henrietta Lacks and genetics, digital divide and computer science, self-driving cars and ethics within AI). This was especially difficult for teacher participants who had not seen strong examples of social justice teaching modeled to them in their content areas, particularly in mathematics. This spurred the researchers to provide teacher participants with usable resources. In terms of just-in-time teaching, one teacher participant in the study, KC, noted that on the day the capitol riots transpired, her superintendent provided the entire district with resources all teachers could use in their classrooms the very next day. Another example is the lesson plan generated following the inaugural poem

read by Amanda Gorman (e.g., School Library Journal, 2021). These are opportunities for instructional designers to consider the need for just-in-time resources.

Social Justice in the Field of Instructional Design

In the instructional design (ID) field, the bar is often set high in terms of what ID practice *should* encompass. Whether it be attending to Merrill's first principles of instruction (Merrill, 2002) or designing with the characteristics of authentic learning in mind (Reeves et al., 2002), there are many ways to engage and support learners. Yet, noticeably absent from instructional design principles or guidelines are recommendations to teach with and for social justice. For example, in the 5th edition of the *Handbook of Research of Educational Communications and Technology* (HRECT; Bishop et al., 2020), a comprehensive 900-page document recently released, the term "social justice" is referenced only 11 times in-text. By comparison, digital badges are mentioned 178 times in *HRECT*. Design case(s) are mentioned approximately 250 times. Similarly, in the *Journal of Technology and Teacher Education (JTATE)* Hartshorne and Baumgartner (2020) identified key trends transpiring in 2020, and although *equity issues* were noted as a key trend, the term *social justice* was absent from the article. Why is the term social justice relatively absent in the field of instructional design, especially given the recent and current social and political climate? Why is design for social justice not at the forefront of the field's conversations? These questions should be voiced loudly as faculty educators, instructional designers, and K-12 educators work together to address social justice issues through their work.

Advancing Teacher Practice and Future Research

The results of this study have provided the authors with a great deal of insight into understanding the challenges teachers face facilitating social justice lessons in their classrooms. Evidence suggests cultural dispositions play a significant role in ensuring that teachers' and students' cultures co-construct learning opportunities (Banks et al., 2005). The STEM teachers in this study possess cultural dispositions, which Schussler et al. (2008) defined as "teachers' inclination to meet the needs of the diverse learners in the classroom" (p. 107). However, they faced challenges designing, locating, and engaging social justice lessons in their classrooms. While demonstrating a culturally responsive disposition plays a key role in successfully facilitating social justice teaching, it is not sufficient. To develop a rich understanding of social justice teaching and all that it entails, teachers need deep engagement and sustained support (Wei et al., 2010). STEM teachers cannot simply take an issue of inequality

or social justice and connect it to science or mathematics without giving thought to their students' perspectives or lived experiences. STEM teachers need assistance understanding the process of making meaningful connections between their content and issues impacting students' lives and communities. These teachers benefit from additional support in the form of social justice lesson exemplars, PD on classroom community building, and in-classroom training, mentorship, and follow-up support, particularly if technology integration is involved (Kopcha, 2012). The results of this study will benefit all those engaged in STEM teacher education by providing opportunities for further discussion on the critical need to support STEM teachers' development of social justice pedagogy.

The teachers in this cohort expressed a desire for additional support because they felt they were unable to integrate social justice teaching in their STEM instruction to the degree desired. As a result, more work is currently being completed. As faculty scholars, the researchers are leading a support group for this cohort of teachers to design for social justice learning in summer 2021. Six of the seven participants returned for additional collaboration in this area. The researchers' goal is to provide these teachers an opportunity to co-construct knowledge regarding what it means to be socially-just educators, as well as to allocate dedicated time for pedagogically productive talk on social justice teaching in STEM. According to Lefstein et al. (2020), pedagogically productive talk is:

(a) focused on problems of practice; (b) involves pedagogical reasoning; (c) is anchored in rich representations of practice; (d) is multi-voiced; (e) includes generative orientations toward students, learning, content, teaching, and problems of practice; and (f) combines support and critique, fostering trust and collegiality, as well as critical, problematizing inquiry. (pp. 362-363)

By coupling pedagogically productive talk (Lefstein et al., 2020) with deep engagement and sustained efforts to improve instruction and learning (Wei et al., 2010), the researchers' goal is to facilitate discussions on the challenges of teaching for social justice and potential problems that teachers may encounter at their respective school sites. During the COVID-19 pandemic, occasions for teachers to develop and participate in remote and online blended learning opportunities proved beneficial (Safi et al., 2020), particularly when the PD activities were unstructured, offered social connection, and centered on learners (Geiger & Dawson, 2020). The researchers aimed to enable the cohort to create lessons

with and for social justice, implement the lessons they designed, and return to the group to describe the successes and challenges faced during lesson implementation and reflect on lesson modifications.

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Appendix A

Exit Interview Questions

1. Previously you defined learner engagement as [insert definition that the individual wrote prior to the summer PD]. Knowing what you know now, would you change or expand your previous definition of "learner engagement"?
2. What edits to that definition might you make?
3. How do you intend to approach learner engagement during online days this fall?

4. What factors will you look for this fall to see if your students are engaged online?
5. What teaching strategies do you plan to use to create a highly engaged classroom online?
6. As part of your Professional Development this summer, you created a project that you shared out to the group during the last synchronous session. Can you describe what you created?
7. What problem were you trying to address through the creation of this project?
8. What new skills or knowledge did you gain this summer that are reflected in the project (e.g., making an instructor screencast video for the first time in order to flip instructional time during sync sessions, creating a collaborative notebook space for your students
9. Within the project you created, what learner engagement strategies did you include and why?
10. Think on the dimensions of learner engagement. [[Share Bond and Bedenlier's 2020 chart of learner engagement on screen to aid in recall](#)]. What aspects of your project touch on those three dimensions of learner engagement?
11. Do you think you'll share your project with your colleagues at your school? Who might you share it with? How do you hope that they'll use it?
12. **Before** this PD workshop, on a scale of 1 to 10, with 1 being not at all prepared and 10 being incredibly prepared, how prepared did you feel to design and implement instruction for rapid online learning/emergency remote teaching in spring 2020?
13. **AFTER** this PD workshop, on a similar scale of 1 to 10, how prepared do you feel currently to design and implement instruction for online/hybrid learning in fall 2020?
14. What did you learn this summer that impacts your perceptions of your ability to teach in an online/hybrid manner?
15. Has your school shared what the return to school will entail? What are the plans?
16. How will you tackle that approach this fall in your own classroom?
17. What factors, experiences, etc. inform these plans?
18. Face to face teaching this fall may involve socially distancing within classroom (if/when meeting face to face). If students must remain six feet apart, what types of instructional strategies would you like to employ to foster learner engagement in the classroom?
19. How might you enable collaboration in a physical classroom setting even if students are spaced at a distance?
20. What factors, experiences, etc. inform these plans?
21. During the summer PD, trauma-informed teaching

practices and social justice resources were shared and discussed. What role do students' experiences during these challenging times play in your instructional decisions?

22. [Share on screen the principles of trauma-informed teaching practices to help jog the memory of the Fellows](#)
 - Did you intuitively integrate any *trauma-informed teaching practices* listed here during the spring?
 - Have you intentionally made any plans to address any of these this fall?
 - If so, what do you plan to do? If not, can you explain why you might not explicitly address it?
1. Since emergency remote teaching ended in the spring, there has been social and political unrest.
 - Do you intend to address these issues this fall?
 - If so, what do you plan to do/resources you plan to use? If not, can you explain why you might not explicitly address it?
8. Thinking to the fall and potentially the spring 2021 semester, what ongoing supports do you need to feel supported in blended/online teaching?

Appendix B

Follow-up Interview Questions

1. Summarize your teaching context - courses, grade level, and your school's schedule with regard to face-to-face or virtual instruction.

Learner Engagement Defined

2. Previously you defined learner engagement as [insert definition that the individual wrote prior to the summer PD].
3. Based on your teaching this past semester, how would you change or expand your definition of learner engagement?
4. Compare, and contrast emergency remote teaching of Spring 2020 with your teaching in the past semester (fall 2020/ ask again end of spring 2021 semester).

Learner Engagement Strategies

ONLINE

3. How did you approach learner engagement during online days this past semester?
 1. What factors did you look for this fall to see if your students were engaged online?

2. What teaching strategies did you use to create a highly engaged classroom online?
 3. Considering your fall 2020 teaching context, what successes and/or challenges did you face, to engage your students relative to the Bond et al. framework.
 4. To what do you attribute those successes or challenges?
4. As part of your Professional Development this summer, you created a project that you shared out to the group during the last synchronous session. It attended to a problem that you experienced during emergency remote teaching in spring 2020. You included certain learner engagement strategies to support the implementation of your project.
1. Did you implement the project that you planned? If so, tell us how it went.
 2. Did the learner engagement strategies that you included in your project map out successfully?
5. On a scale of 1 to 10, with 10 being the highest level of expertise, given your experience teaching online,
1. how prepared do you feel currently to design and implement instruction for online or hybrid learning in the new semester?
 2. What did you learn through your experiences teaching this fall that impacted your perceptions of your ability to teach in an online/hybrid manner? *[request an example or two]*
Has your school shared what the return to school will entail? What are the plans?
6. Has your school supported you to engage learners virtually or in a hybrid manner?
1. Did you receive ongoing teacher training or professional development?
 2. How has your district/school/administrators supported you well?
 3. What could have been improved?
7. Thinking to the next semester, what ongoing supports do you need to feel supported in blended/online teaching?

SOCIALLY DISTANT CLASSROOM

8. In the past semester, what types of instructional strategies did you employ to foster learner engagement in the classroom:
 1. Virtually (if applicable)?

2. Hybrid (if applicable)?
3. Face-to-face and socially distant (if applicable)?
 1. How did you enable collaboration in a physical classroom setting even if your students were spaced at a distance?
 2. What factors, experiences, etc. inform these plans?

TRAUMA-INFORMED TEACHING PRACTICES + SOCIAL AND POLITICAL CONTEXT

10. During the summer PD, trauma-informed teaching practices and social justice resources were shared and discussed. At the end of the summer, we discussed how you might address those topics during your fall teaching.
11. Were you able to incorporate any trauma informed teaching practices?
12. b) What did you do and how did it go?
13. Were you able to address social justice issues within your math and/or science instruction at all this fall? *[If the participant proposed action steps in their final presentation, refresh their memory on what they proposed]*
 1. Describe what you did and the frequency of that instruction.
 2. Can you give a detailed example how you designed instruction to support social justice issues?
 1. Did you use any specific resources?
 2. What learner activities did you have the students engage in?
 3. Did students make/create any artifacts of their learning? Can you describe those in detail?
 4. Do you have any teaching artifacts that you are willing to share with us?
 3. What instructional decisions impacted how you addressed the social issues this fall with your students?
 4. How might you address social justice issues with your students in the spring? Why?

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