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Developing, Implementing, and Refining Approaches for Teaching Science for Social Justice: The Collaborative Work of a Secondary Science Department as Part of Their Professional Learning

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ABSTRACT

Our qualitative case study investigated a secondary science department's professional learning plan (PLP) designed and enacted across an academic school year focused on teaching science for social justice. During the academic year, science teachers were provided with opportunities to collaborate, reflect, and share their professional practice with support from science department peers and their administration. Our research examined the equity discourses and practices that shaped teachers' efforts to teach science for social justice as part of their engagement in the PLP. Data consisted of semi-structured interviews with groups of science teachers and an administrator and artifacts of the PLP (i.e. written teacher reports and reflections) and lesson plans. We found two equity discourses emerged: *increased achievement, representation, and identification in science and engineering* (Discourse 2) and *seeing science as part of justice movements* (Discourse 4), along with accompanying practices for each. The findings can inform how science teachers teach science for social justice, how they think and talk about social justice and equity, and how science departments and administrators can create conditions conducive to teaching science for social justice.

KEYWORDS

Equity; instructional practices; professional learning; social justice

While a historically persistent problem in the U.S., more recent events like the killing of George Floyd (Dreyer et al., 2020) or the disproportionate impact of COVID-19 on ethnic and minoritized groups (Campbell & Lee, 2021) have made it painfully apparent how systemic racism and legacies of injustice are part of the very fabric of our society (Evans et al., 2020). In addition, among other indicators, the lack of minority and women scholars winning the Nobel Prize in science (Meho, 2021; Wade & Zaringhalam, 2019) illustrates injustice and historical exclusion in our society. These events, alongside the longstanding efforts of scholars of color in the field of education (e.g., Gay, 2000; Ladson-Billings, 1995; Paris & Alim, 2017), have given rise to an awareness of the importance of foregrounding social justice and equity as a central priority in education. More recently, this prioritization of social justice and equity can be seen in the many position statements released by professional education organizations (e.g., American Educational Research Association and the National Academy of Education, 2020; Statement in Support of Anti-Racist

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Education; National Science Teaching Association, 2021). Even the most recent standards documents in science education have noted how equity, "as an expression of social justice is manifested in calls to remedy the injustices visited on entire groups of American society that in the past [and presently] have been underserved by their schools" (National Research Council, 2012, p. 278).

However, while there is a growing awareness of the need for an increased focus on social justice and equity in science classrooms, only a limited number of isolated examples of teaching science for social justice can be found (e.g., Bang et al., 2017; Calabrese Barton et al., 2008; Emdin, 2011; Mensah, 2022; Morales-Doyle, 2017; Riley & Mensah, 2022; Tan & Calabrese Barton, 2010). Dimick (2012) noted how "social justice education is undertheorized in science education" (p. 991). Relatedly and more recently, scholars like Philip and Azevedo (2017) and Rodriquez (2015) have pointed out how a lack of clarity and inconsistencies in the equity discourses employed in science education, even in our most recent standards documents, run the risk of detracting from or dampening our efforts to teach science for social justice.

Given this context, as well as the recognition that more research is needed to examine the practices teachers use to teach science for social justice (Bell, 2019; Dimick, 2012; Tzou et al., 2021), this current research was done in a science department in a suburban high school where six female science teachers sought to develop, implement, and refine approaches and practices for teaching science for social justice. The following questions guided our research:

In the context of developing, implementing, and refining approaches for teaching science for social justice as part of a science department's Professional Learning Plan (PLP):

- What equity discourses emerged, and what led to the emergence of the discourses identified?
- What accompanying practices could be identified in connection to the emergent discourses?

Literature review

Social justice and equity in science education

In her work on culturally relevant teaching, Ladson-Billings (1995) lays out three criteria that must be met, "an ability to develop students academically, a willingness to nurture and support cultural competence and development of a sociopolitical or critical consciousness" (p. 483). According to Freire (1970), critical consciousness involves recognizing and questioning oppression systems and working to enact social change. Culturally relevant teaching extends beyond academic achievement into the cultivation of critical consciousness. It gives students knowledge and skills to critically analyze inequities and advocate for change that promotes equity and justice in their communities.

Social justice and equity have been conceptualized in the literature by how it can more centrally frame teaching and learning in science classrooms (e.g., Morales-Doyle, 2017; Philip & Azevedo, 2017; Rodriquez, 2015; Tzou et al., 2021). More specifically, in Philip and Azevedo's (2017) research, they identified four discourses of equity that they found in the literature focused on informal science learning; these have been used widely to interrogate science teaching and learning in both informal and formal settings (e.g., National

Academies of Science, Engineering, and Medicine, 2022; Tzou et al., 2021). In this, Philip and Azevedo revealed how most of the literature over the last 10 years has focused on the significance of personal relevance and access to science (Discourse 1) and the cultivation of science identity and interest as participants in science (Discourse 2). These first two discourses emphasize student achievement and the alignment with scientific disciplines. The first aims to improve academic performance, develop interest, and establish personal relevance. The second focuses on more authentic learning opportunities. Both discourses are limited in addressing systemic inequities in science education or challenging power structures in science.

While these are essential discourses supportive of equity, Philip and Azevedo also pointed to the need for more research and examples of efforts in science education focused on what "counts" as science and challenge the traditional views of science (Discourse 3) and exploring the role of science in social justice movements (Discourse 4). Discourse 3 challenges the idea that only certain types of science are important and broadens the understanding of what is valid scientific knowledge. Discourse 4 explores the role of science within social justice movements and shows how science can be used as a tool for social change through grassroots movements within a community. It also acknowledges that science is not complete and can be biased. Tzou et al. (2021) echoed this while noting how work framed by these discourses requires addressing power and historicity. Tzou et al., in foregrounding power and historicity, referred to the need to thoughtfully interrogate, reflect on, and resist how students and communities have been marginalized due to the complex relationships they have encountered with institutions of power. Identifying and examining these discourses is important because, if overlooked, it can perpetuate inequity. This may create the illusion that science occurs in a vacuum or neutral contexts (Philip & Azevedo, 2017; Tzou et al., 2021). Additionally, Morales-Doyle (2017) conceptualized how social justice and equity could be centered in science classrooms by illuminating how a chemistry class focused on social and environmental justice issues, like lead contamination, brought attention to social justice issues in communities. Morales-Doyle found that after completing a project related to soil contamination in their community, students could act as transformative intellectuals as they developed critical consciousness.

Social justice and equity have also been conceptualized and prioritized in the *Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (subsequently referred to as the Framework; National Research Council, 2012) and the *Next Generation Science Standards* (NGSS) (NGSS Lead States, 2013). However, researchers like Rodriquez (2015) have critiqued this and called for additions to the conceptualizations of social justice and equity in the Framework and the NGSS by declaring a need for a "[t]ask Force charged with integrating a dimension of engagement, equity, and science at all grade levels'" (p. 1048). In his critique, Rodriguez noted how equity and diversity issues are not embedded in the NGSS descriptions and throughout the standards, students" different backgrounds and experiences are not accounted for, and institutional obstacles remain even if teachers are prepared and committed to teaching in culturally inclusive ways. Among other proposals for addressing these issues, Rodriguez advocated for a "new dimension of engagement, equity and diversity … [be] added to the framework" so that just as the other three dimensions proposed in the Framework are centered across all K-12 science education, so too would equity and diversity be centered (p. 1041). Given these critiques and conceptualizations

for how social justice and equity can be incorporated into science classrooms, Philip and Azevedo (2017) and Rodriquez (2015) suggest four discourses for thinking about equity in science teaching and learning that were taken up by the National Academies of Sciences, Engineering, and Medicine (2022) when thinking about science teaching and learning. Consequently, these four discourses, shared in the following, were used to guide our investigations into how teaching for social justice was undertaken in this current research:

(1) Increasing the opportunity and access to high-quality science and engineering learning and instruction;
(2) Emphasizing increased achievement, representation, and identification with science and engineering;
(3) Expanding what constitutes science and engineering; and
(4) Seeing science and engineering as part of justice movements (National Academies of Sciences, Engineering, and Medicine, 2022, pp. 69-70).

Methods

Overview of study

This study examined six high school science teachers (grades 9–12) as they collaborated to implement lessons as part of a professional learning plan (PLP) focused on social justice and equity in the science classroom. All research activity was approved by the institutional review board and conducted in accordance with the ethics requirements of the authors' institution. Throughout the study, pseudonyms were used to ensure participant confidentiality.

Context

This study occurred at a public, suburban high school (grades 9–12) with 564 students during the 2021–2022 school year. Student demographics at the school are predominantly White (80.1%), followed by Hispanic (14.2%), Asian (3.5%), two or more races (1.4%), American Indian/Alaska Native (0.4%), and Black (0.4%). 30% of students are economically disadvantaged, and 31% are on free or reduced lunch (U.S. News and World Report Best High School Rankings, 2022).

In the pursuit of school improvement, teachers are evaluated each year on their classroom performance using various approaches and proxies (e.g., observations, test scores, student surveys, and learning plans). In the school district in which this study took place, part of the teacher evaluation process involves teachers engaging in a Professional Learning Plan (PLP) as well as classroom observations for the evaluation process. In PLPs, teachers consider district and school goals and develop their professional learning goals. Chief among the aims of PLPs is for instructional improvement and reflection on teaching practice. Although this process depends on the school district's structures, it allows teachers to engage in authentic professional learning, whereby teachers can reflect on practices, collaborate, and enact immediate changes in the classroom (Ryan et al., 2017). In some cases, what teachers find as part of their PLP is shared with the entire staff of the school. This process is conducted yearly for all teachers in this school district.

A PLP is a document created each school year by teachers to investigate and improve pedagogical practices in particular disciplinary areas (e.g., science, math, English, and social studies). The PLP represents action research, which has served as a means to innovate science and mathematics education (Miedijensky & Sasson, 2020) and facilitate locally supported systemic reform (Somekh & Zeichner, 2009). The area a teacher chooses to focus on must align with that school year's district and school goals. During the year this study took place, the science department took on the same district, school, teacher, and student goals in their science classrooms (see Table 1).

The outline of the PLP has two main parts, one for the teacher goals and one for the student goals. They each include action steps (i.e., activities, strategies, and resources), evidence of success (i.e., how the growth will be measured and how success will be evident), and a timeframe for each step to accomplish the goals. Midway through the school year, each teacher writes a summary of progress toward teacher and student goals. At the end of the year, a summary of the results for both teacher and student goals based on the indicators identified as evidence of success is written. A written teacher reflection assesses the degree of achievement of the goal and explains and evaluates the actions taken to improve student performance. The reflection considers students whose growth was not consistent with most of the class. The teacher also identifies how the results and new learning could be applied.

As part of the PLP, science teachers met formally one to two times a month to collaborate, design lessons, share resources, and critique teaching practices as they worked through the action steps on their PLP during science department meetings and professional development time. Additionally, science teachers discussed lessons and ideas informally on a more regular basis.

The science department identified social justice and equity in science classes as the focus of their professional learning plan during the academic year that this study took place. The science department did this for many teacher and student-driven reasons. During the school year in which the study took place, the entire science department and administrator were female, and many had backgrounds in science careers before becoming teachers. Many discussions took place prior to and during the year of this study focused on women in science, primarily related to how members of the science department were treated in a field dominated by white males. During the time allocated for department meetings, this led to discussions about equity and social justice issues in science and discussions about equity and social justice issues taking place in society more

Table 1. Goals for professional learning plan for the 2021–2022 school year for teachers in the science department.

District Goal	School Goal	Teacher Goal	Student Goals
Develop a school community focused on establishing relationships and providing supports that foster the health and well-being of all.	Maintain and foster a quality school climate and classroom environment that supports the social-emotional well-being of students.	Teachers will research and implement strategies to improve understanding of how social justice and equity affects student achievement and develop lessons to help students social emotional learning.	*Curriculum-based goal*: Students will improve their understanding of social justice and equity and how it relates to the science curriculum. *Related Foundation Skill and Competency goal*: Students will reflect and generate new questions to extend learning.

generally. Many teachers had previously taught lessons or engaged students in conversations about equity and social justice issues in their classrooms even before it became a focus of the PLP. However, even those who had already engaged in this work expressed interest in developing or identifying additional lessons supportive of this work. Students also brought up social justice issues they learned in English classes that they wanted to learn more about in science classes. Beyond this, at the time of this study, there was also an increased recognition of the historical and ongoing presence of systemic racism, legacies of injustice in society connected to COVID-19 cases, hospitalizations, and the killing of unarmed black men and women by law enforcement, among other societal injustices.

Participants

Six science teacher participants and one administrator participated in this study during the 2021–2022 school year. All of the participants were female, including the administrator. Additionally, all participants in the study were white. At the time of the study, the science teachers had teaching experience ranging from 1 to 19 years (see Table 2 for teacher and administrator participant demographics and information). However, as seen in Table 2, all except one teacher had at least 10 years of teaching experience.

Study design, data collection and analysis

Study design

This qualitative research used a case study to explore the phenomenon of teaching science for social justice as a science department engaged in their PLP across an academic year. Creswell (2013) describes the benefits of using a case study:

> The case study method "explores a real-life, contemporary bounded system (a case) . . . over time, through detailed, in-depth data collection involving multiple sources of information . . . and reports a case description and case themes. (Creswell, 2013, p. 97)

Table 2. Participant information.

Teacher Name	# of years teaching	# of years teaching at this school	# of years in another career	Demographics	Science subject area/ primary grade level(s)
Anne	11	4	10	White female	Biology (9/10)
Beth	12	12	8	White female	Chemistry/Forensics (11/12)
Clara	19	7	0	White female	Physics/Integrated Sci. (9-12)
Dawn	18	9	1	White female	Anatomy/Env. Sci (11/12)
Elizabeth	1	1	0	White female	Biology/Integrated Sci. (9/10)
Francesca	10	2	0	White female	Chemistry/Integrated Sci. (9-11)
Admin. Name	**# years as Administrator**	**# of years as Administrator at this school**	**# of years Teaching before becoming an Administrator**	**Demographics**	**Subject area when a teacher**
Gwen	15	15	12	White Female	History

All names of participants are pseudonyms.

This research focused on science teachers and their experiences within the PLP in the context of their work within the science department (Yin, 2009).

Data collection

Data collected included each teacher's end-of-year PLP with teacher reflections and application to future teaching and learning, semi-structured interviews, and lessons the teachers developed. The interviews lasted approximately 90 minutes and were completed in groups of 2 or 3 teachers. In addition, an individual approximately 90-minute, semi-structured interview was also completed with the school administrator. All interviews were audio recorded and transcribed. The semi-structured interview protocols were developed to elicit details about teachers' approaches to teaching social justice and equity and the equity discourses they used to frame their work. The first author, a researcher participant, and the department chair conducted all interviews except one. Since the first author was also a teacher in the department and a participant in the study, the second author interviewed the first author, who also contributed the same artifacts as the other teacher participants. The PLPs, interviews, and lesson plans were collected to triangulate the data (Creswell, 2013; Creswell & Miller, 2000) and provide a breadth of complementary artifacts to afford a "thick" description of the phenomenon (Geertz, 1973; Lincoln & Guba, 1986).

Data analysis

To answer the research question, Groenewald's (2004) phase strategy was modified to guide data analyses. This included using *a priori* codes (see Table 3) to identify and code the units of meaning and clustering the codes into themes before themes were used to answer the research questions.

Prior to data analysis, an initial *a priori* coding scheme was developed (see Table 3). The set of codes in Table 3 (i.e., 1.1–1.5) were designed to identify units of meaning helpful in answering the research question related to teaching science for social justice and were derived from the work of Philip and Azevedo (2017), Rodriquez (2015) and Morales-Doyle (2017). The interviews were coded first using these codes before lesson plans, and PLPs were coded using the same process. More specifically, when coding the interviews, this was a quote from a teacher that was coded as 1.4, "I had kids just realizing that race and also economic status play a role in science, and where they live and other decisions that are made . . . so we have talked about income, race and where your live relative to the pollution

Table 3. *A priori* codes for social justice and equity science lessons and emergence of teacher leadership.

Category	Codes	Discourse	Description
Equity lessons	1.1	Opportunity and access[1,3]	Improved learning; supplemental experiences for under-represented communities; high quality science[1,3]
	1.2	Achievement, representation, and identification[1,3]	Generating interest, connections to other disciplines, promote personal reliance and learners' identities[1,3]
	1.3	Expanding what constitutes science[1,2,3]	Reframe who does science, what counts, invites learners' families, culture, broader view[1,2,3]
	1.4	Seeing science as part of justice movements[1,2,3]	New possibilities for understanding the relationship, social movements, communities needs and goals, power and historicity for relationships of human communities across time[1,2,3]
	1.5	Other important/interesting to note on social justice/equity lessons	

(Philip & Azevedo, 2017[1]; Morales-Doyle, 2017[2]; Rodriquez, 2015[3]).

you're exposed to . . . we looked at a map of Connecticut and where the pollution is . . . and where [students] see locations within their own town on a smaller scale."

As part of coding the interviews, PLPs, and lesson plans, intercoder reliability (ICR) was established. This was accomplished as both researchers reviewed 10–25% of the interview transcripts, PLPs, and lesson plans independently before comparing their codes. This was used to promote reflexivity and dialogue among the research team and improve the trustworthiness of the analysis (O'Connor & Joffe, 2020). Using percent agreement between raters, the following ICR values were obtained: 0.93 - interviews; 0.91 - PLPs; 1.00 - lesson plans. ICR between 0 and 0.20 is slight, 0.21 and 0.40 are fair, 0.41 and 0.60 are moderate, 0.61 and 0.80 are substantial, and 0.81 and 1 is nearly perfect between coders (Krippendorff, 2004). After ICR was established, the first author coded the remainder of the interview transcripts, PLPs, and lesson plans and met bimonthly with the second author to discuss the data. If disagreements or questions arose during the ICR or subsequent coding process, the coders revisited the interview transcripts, PLPs, or lesson plans where the units of meaning were found for more discussion and the negotiation of consensus. Using interviews, the PLP and lesson plans afforded triangulation of the data and further evidence of the consistency in the themes. More specifically, data from interviews, PLP, and lesson plans were cross-checked to identify any discrepancies or disconfirming evidence and help guard against potential biases that may have been undetected had the interviews been the sole data source.

After all data was coded, the second stage of Groenewald's (2004) phase strategy entailed clustering codes so that 2 to 4 clusters of codes were developed for each set of codes to answer the research questions. These clusters of codes became the themes (Braun & Clarke, 2006) as part of the third stage of Groenewald's (2004) phase strategy. These themes were used to answer research questions.

Before finalizing our findings, after the themes were developed, a member-checking process was undertaken with the participants as another measure of the trustworthiness of our findings (Creswell & Miller, 2000; Lincoln & Guba, 1986; Stake, 1995). To accomplish these, we shared the research questions and themes from our codes with each participant to answer the research questions. The participants were asked to review the research questions and our findings before sharing the extent to which they felt the findings reflected their experiences within the department across the academic year. They were encouraged to share with us any differences in interpretation they had about anything that was shared and to offer any additional insights that may have come to mind as a result of their review of the findings (Creswell & Miller, 2000; Lincoln & Guba, 1986; Stake, 1995). Through ongoing engagement with the participants in this study, member-checking contributed to the trustworthiness of the findings. Participants could review their statements from interviews, reflections from PLP, and lesson plans to ensure that the findings appeared to be reasonable interpretations of what transpired.

A participant researcher in the school conducted this study. The insider perspective as a researcher and science teacher afforded an in-depth understanding of context and connectivity with study participants. This position as a participant-researcher also offered unique access to the daily experiences and challenges of the participants. It supported the participant-researcher in contextualizing the data within the lived realities of the participants in ways that an outsider may not have been able to achieve. Further, attention was also given to mitigating inherent biases in the research process, especially in influencing participant responses. This entailed asking the same open-ended interview questions,

avoiding leading questions, being mindful of nonverbal cues, and reflecting on our assumptions and beliefs to minimize the impact on the study. Beyond this, the participant-researcher also brought to this research experiences as a female researcher in science before teaching and experience related to the equity issues of some of the topics in the lesson plans that were foundational to this study and the selection of the focus of the PLP. Finally, as a white female, the participant researcher and the other study participants worked to interrogate and develop their critical consciousness. To this end, we acknowledged our white privilege and wanted to educate ourselves and our students to create a more just society. The second author is a university science teacher, educator, science education researcher, and advisor of the participant-researcher.

Findings

While our research question and sub-questions organize the findings section, because some important overarching supports were recognized for fostering the emergence of teaching science for social justice in our data, these overarching supports are first shared before this is followed by the two equity discourses (i.e., Discourse 2 & 4) that were taken up, along with the accompanying practices.

Overarching supports for teaching science for social justice

While two different equity discourses emerged in connection to our research questions, it was apparent that both the administration and the collaborative support of other teachers in the department co-engaged in the PLP provided needed leadership and support that was extremely important to the science teachers in this department who reported how this work, at times, felt risky. This can be seen in one teacher, Anne, who reported how vital the support of the administration and colleagues was in her efforts to develop, implement, and refine approaches to teaching science for social justice.

> I felt like you were supported. Even when there was some negative parent feedback, it was very quick that the administration came and said . . . we know you're doing this, we think it's worthy and keep doing what you're doing. I felt like that was good because it wasn't ever the climate where I was worried about my job. I would have been worried in other places . . . When it got difficult initially, we all supported each other, and I think that was super helpful. It was where we decided we were all going to be brave together and how we were going to go forward. I think if I had just been me, maybe I would have just given up, but knowing that everybody else was going to keep trying helped. (Anne, Biology (9/10), Interview)

Gwen, the school administrator, shared the following stance that exemplified the support she provided, including the autonomy she believed was necessary for teachers and the ways in which she understood the teachers in the department were engaging in this work:

> The opportunity for the science department to explore issues of social justice and the autonomy that was given in the department to choose the way in which they want to begin those conversations with students regarding mainly awareness. Whether that was in the area of gender, looking at geographic locations and issues, the use of data that could help present mortality rates in certain areas, or issues related to water quality and what was causing the

> water quality and where did that happen and why and really kind of explore their own thinking about how they saw different things. (Gwen, Administrator, Interview)

Not only was administrative support important, but having a group of teachers in the department who supported each other with resources, collaboration, and discussion helped create the environment and conditions in which the two equity discourses emerged. This can be seen as Anne shared,

> . . . Even if we weren't using exactly the same resources, it helped to see how everybody else was using them . . . .I think it felt okay, even if I felt like it didn't go well, or I was concerned or I wasn't sure how to move forward. I could come talk to everybody and we could figure out a path forward and it wasn't like you were just figuring it out you always had somebody helping. I had never really had, prior to this, a successful, cohesive group like this before. (Anne, Biology (9/10), Interview)

Two equity discourses and accompanying practices

As alluded to already, two equity discourses emerged in the context of developing, implementing, and refining approaches for teaching science for social justice as part of a science department's Professional Learning Plan (PLP). The two discourses were increased achievement, representation, and identification with science and engineering (Discourse 2) and seeing science and engineering as part of justice movements (Discourse 4). Each of these findings is described in more detail next.

Discourse 2

Increased achievement, representation, and identification with science and engineering (Discourse 2) emerged in response or connection to the following three identified themes (italicized throughout the findings): *teachers' experience with a lack of representation in the sciences*, *a desire to generate interest in science in connection to students' identities*, and *concerns related to undertaking more ambitious and potentially riskier approaches to teaching science for social justice*. In connection to the first theme, *teachers' experience with lack of representation in the sciences*, teachers shared how they found it difficult to see themselves in science when they did not see themselves represented in science in the institutions they previously attended. This is exemplified in the following interview excerpt from Beth:

> As someone who went to two pretty prestigious universities . . . at a time when there was only one tenured female faculty member in the chemistry department and . . . had a nervous breakdown. Then, in graduate school, there were zero tenured women faculty members. There were zero in both institutions, people of color. So, in science, if, as we've said before, if you don't see people like you in positions, it's hard to imagine yourself in that position. How do I become a professor . . . If that's really for men or white European men. (Beth, Chemistry/Forensics, (11/12), Interview)

Another reason identified in connection to Discourse 2, *a desire to generate interest in science in connection to students' identities*, emerged in relation to which lessons teachers decided to undertake. One teacher shared,

> I used biographies of diverse scientists and people in STEM fields from the past and current scientists. I think it helped because it was like real people. and the real things that happened to them along the way and how they overcame them . . . they could see the patterns that were

> occurring, and it made it more real to them . . . I've also seen the district change demographically in the past 10 years or so and I think it's important for the kids to be able to see people that, you know, they see themselves doing the kind of work that we're talking about. (Anne, Biology, (9/10), Interview)

In Beth's PLP, she states, "Each of us needs to listen to others, to hear their stories and try to understand their perspective." Beth's focus on understanding diverse perspectives contributes directly to the discourse around representation to welcome student individuality and experiences, which can improve their sense of belonging and identification with scientific disciplines.

This is also echoed in the PLP of Clara,

> The focus for my PLP this year enabled me to further understand how to successfully implement strategies to enhance the inclusivity of my curriculum . . . One of the driving factors for me to get certified to teach physics was so that I could be that positive role model in physics, so that my students could all see a woman doing the hard work of physics while loving it. I always loved physics but was so intimidated by my high school physics teacher (who was very much "old school" in terms of being elitist, and male). (Clara, Physics/Int. Sci. (9–12), PLP)

Clara's role in addressing gender disparities highlights the importance of representation in science education. By emphasizing her desire to serve as a visible and accessible role model for her students, Clara directly contributes to the discourse focused on increasing achievement and representation in science by showing students that a woman can succeed in physics. This supports the finding that these lessons contribute to a discourse of increased representation and identification with science.

An example of a teacher sharing some student takeaways from lessons that made connections to student identities can be seen in the following:

> One of my big takeaways was that students really did like to see themselves represented. When I did the I am a Scientist lesson I asked them why did you pick this scientist to read about? So many students made comments like, I picked this person because they remind me of me or they speak the same language as me, or they were from the part of the world where my family is from, one was in a band and I'm in a band, one wore a hijab like me. (Clara, Physics/Int. Sci., (9–12), Interview)

The teachers' experiences with a lack of diversity in the field were addressed through lessons designed to challenge these gaps. The lessons, *I am a Scientist*, *the Modern Scientist Project, Moonshot Thinking*, and *Gender in Science*, focused on increased student achievement, representation, and identification with science and engineering by broadening students' understanding of who can be considered a scientist. These lessons disrupted stereotypes and expanded students' ideas related to envisioning a more diverse scientific community. They explored both historical and contemporary representations of race, gender, and culture in science, encouraging students to critically examine not only those who can practice science but also how science is practiced.

Finally, in connection to the theme *concerns related to undertaking more ambitious and potentially riskier approaches to teaching science for social justice*, some teachers pointed to how they decided to focus on Discourse 2 because of some initial backlash about science teachers teaching about social justice and equity in a science class from parents and students that unfolded early in the year when they asked students to complete an initial baseline equity survey. Following the baseline survey in one of the classes, parents contacted the administrator, questioning why science teachers were incorporating social justice and

equity into their curriculum. Additionally, students in other classes shared their concerns before the survey was conducted, prompting parents to contact the administrator preemptively. The survey, designed collaboratively by teachers in the department, asked questions like, "What do you know about social justice?," "What do you know about equity?" and "Do you think all races and genders are treated equally in science?." In connection to this initial backlash, one teacher shared,

> I think my biggest struggle was the initial backlash from parents, or some students who just saw the words race and social justice on the initial survey and without having much knowledge already on the subject maybe jumped to some conclusions. (Elizabeth, Biology/Int. Sci., (9/10), Interview)

This initial pushback, especially in Grades 9 and 10, led some teachers to focus their efforts on Discourse 2 because of the backlash they experienced or witnessed other teachers experiencing and their lack of experience or expertise related to teaching science for social justice and knowing how to respond when instances like this happened. Based on discussions in the department after the initial pushback in grades 9 and 10, the department brainstormed ideas and strategies for ways to continue. Some teachers focused more on Discourse 2, while others who did not experience the pushback decided to focus more on Discourse 4. One teacher explained her approach,

> I didn't really have a lot of challenges in terms of pushback from students or parents, but I know that other teachers did and I was fortunate in that they went first. We all kind of talked about it as the department, and it helped me really formulate how I wanted to approach it and how I wanted to present it. Without telling them, hey, we're going to learn about social justice, we just kind of did the lessons and went in from that perspective . . . So, to kind of move beyond my fear and not be controversial. I don't know why, because I love teaching about evolution and the big bang theory that people think is controversial, but when it gets to this topic, it's kind of scary, but I think it's a bit scary because it's not my area where I took classes. (Clara, Physics/Int. Sci., (9–12), interview)

While some teachers reported resistance from students, the backlash from parents most concerned the teachers who decided to focus more on Discourse 2, rather than diving deeply into social justice issues. Anne (Biology, 9/10), expressed her initial hesitation in her interview, noting, "I felt some difficulty because I felt like there was some definite parental blowback . . . That took me back a bit, and I was pretty apprehensive in the beginning." She elaborated on this in her PLP, where she explained her choice to "use gender-based inequality in STEM fields as my focus as I believed it provided an easier entry point to the discussion for young students, as social justice has become a hot-button topic politically." According to Anne, "The mere discussion of the term 'social justice' in my classroom triggered parental responses throughout the community . . . It became apparent that using the terms 'social justice' and 'equity' were triggering for some students."

This response shows how teachers sometimes strategically approach sensitive social justice topics, particularly in communities where these terms can cause strong reactions. Focusing on representation and inclusivity in science may reduce potential backlash, but still promote meaningful change in the socio-political context of a secondary school as students are engaged to think about differential opportunities that have and continue to shape differential participation in science fields.

Table 4 includes instructional practices teachers developed along with lessons for each practice that were refined as part of their focus on Discourse 2, which is connected to their engagement in the PLP.

Discourse 4

Equity Discourse 4, seeing science as part of justice movements, emerged in connection to the following themes: *the structure of the PLP* and *teachers' ability to conceive of logical connections between social justice and the science discipline they taught*.

Generally, the PLP, as a systematic approach to engaging in professional learning, permitted teachers as professionals time and space to seek out, learn about, try out, and

Table 4. Instructional practices for discourse 2 developed and refined as part of PLP engagement.

Instructional Practice	Quote from Teacher	Example Lesson(s)
Knowing students and their backgrounds to design and pick particular examples in the curriculum.	If you can't see it, you can't be it. So for me, it was all looking at people who look like my students or have something in common with my students in terms of the first language that they speak, or even like an activity that they're interested in. Like, I'm into music, or I'm into this specific sport, or something like that, or a country of origin, or a religion and being able to expose them to the idea that anybody can be a scientist. So that was really a focus for me. This year was for kids to recognize, hey, somebody who has these qualities similar to I do is a scientist, maybe I could be a scientist or for predominantly white students to say this is a diverse field and people don't have to look like me in order to do science There are scientists from all walks of life, all parts of the country, all languages and religions. So they see that (Clara, Physics/Int. Sci. (11/12) interview and I am a Scientist Lesson).	I am a Scientist Lesson Gender in Science
Actively plan for examples to use in the curriculum throughout the year so that students can see representation which can lead to higher student engagement.	Who did the discovering, you know, the rich white men? And the way I fit social justice into the physics curriculum is through representation and recognizing that when I choose media to show, kids are going to notice if I only choose white males. So I've been really conscious of showing media videos, articles, and ted talks of people who are diverse. For example, there's a smarter every day video that I show about breaking the sound barrier and there's tons of videos, but I specifically showed a blue angel female pilot so kids could see that hey women can fly planes too or I show a crash course physics video where an Indian woman hosts. I try to represent different groups of people. I don't want to say to kind of sneak it in, but to just have that be the kind of background of, like, the people doing this work and talking about these topics and the people show are interested in them. In these topics there are a diverse group of people, not just Isaac Newton (Clara, Physics/Int. Sci. (11/12) interview). Before it was more random and discrete and not as connected. This year I tried to make it a common thread through different units. Instead of just teaching Henrietta Lacks or Rosalind Franklin, I tried to seek out more real people in the curriculum . . . I felt like I had a higher level of engagement especially in the later lessons that I did and when the kids were working collaboratively and trying to research specific people and work they had done. They really were engaged and took it upon themselves and were interested and worked together (Anne, Biology (9/10), Interview and Modern Scientists Lesson).	Modern Scientists Lesson Moonshot Thinking

refine approaches to teaching science for social justice, which in the case of Discourse 4 meant learning about ways science teaching and learning supports social transformation. More specifically, the *structure of the PLP* served as infrastructure. Star (1999) defines infrastructure as a system of common working practices or routines and material resources that a community of professional actors draws on collaboratively as a structure or process for accomplishing their work. The PLP involved specific processes, and in the case of this research, two of the specific parts of this process were found to be connected to the emergence of Discourse 4. First, the PLP required teachers to collect baseline data from students at the beginning of the year that would later be collected again at the end of the year as a means of providing data to understand the extent to which student goals, identified as part of the PLP process, were met. In the case of this research, the baseline data collected was a social justice and equity survey, alluded to earlier, intended to gauge students' understanding of social justice and equity in science. While the survey provided information about students' baseline knowledge as expected, another important affordance was also realized. The survey gave teachers insights into the students' experiences and worlds. Data collected during the survey helped guide teachers in planning lessons connected to students' interests, communities, and concerns. In some cases, the baseline survey led to students initiating discussions about social justice and equity issues identified immediately after completing the baseline survey. Personal stories from students that emerged connected to the baseline survey helped shape teachers' equity discourse since many of the concerns or stories concerned the need for social transformation (i.e., Discourse 4). Dawn describes this,

> . . . based on the baseline survey . . . Many of the students in this class are in the social justice club and mentioned they knew what these terms meant because of their involvement in this club. Some even started to talk about the terms and were explaining them to other students . . . When asked if they thought all patients are treated the same in regard to medical care [a question included in the baseline survey], many students answered "no," stating that people of different races and people that did not have as much money did not get good medical care. Some stated that "if you have more money, you get better medical care." Another student commented that "patients are treated differently based on race and gender." One student stated, "Yes, because I'm a Latina and they have treated me the same way as an American." Another Latina student in the class contradicted this by stating, "No, I do not. Sometimes, color, gender, and ethnicity can influence how they are treated in medical care. In my view, there is inequality that still occurs. Some may be scared of others due to their story that was told, or just by the way they look." One student even went on to relate this to COVID by stating, "No, if you look at the discrepancies in COVID-19 treatment and the distributions of vaccines based on race, you can see that it is all tied back to racism, slavery, and bias." (Dawn, Anatomy/Env. Sci., (11/12), PLP)

Second, beyond the baseline survey, another part of the PLP process involved science teachers meeting formally one-to-two times a month to collaborate, design lessons, share resources, and critique teaching practices as they worked through the action steps on their PLP during science department meetings and professional development time. This meant that informal discussions of lessons and ideas happened regularly. This time for discussion and reflection also supported the emergence of Discourse 4. This happened when a teacher implemented a lesson in a class and then discussed the successes and challenges of lessons, especially related to Discourse 4, since it empowered other teachers to consider, identify, and try out lessons focused on social transformation. As an example, after a discussion of the maternal medicine lesson or a lesson about Henrietta Lacks, other teachers reported trying to engage students in lessons more focused on disrupting unjust systems. Beth shared,

> In a small department meeting people talk about some of the different ideas. I know some did a whole study on asthma and geographic distribution and asthma rates and children and you [Dawn] looked at maternal health . . . I think simply generating ideas is, for me, really beneficial because it gets me to think and I may not necessarily take your idea, but it might stimulate within me something that I hadn't thought of that I would want to do in a lesson. (Beth, Chemistry/Forensics, (11/12), interview)

The second theme, *teachers' ability to conceive of logical connections between social justice and the science discipline they taught*, also led to the emergence of Discourse 4. In her PLP, a teacher, Francesca, reflected on why she chose to do this type of lesson on air pollution and how the lessons fit into the curriculum in a chemistry class when that also incorporated students' interests.

> Environmental justice and green chemistry is a way to engage students in real-world and interdisciplinary lessons. Relevancy is important to higher student engagement in the content and develops global citizens and problem solvers. The goal of the environmental justice lesson was to help students understand how pollution disproportionately affects different people. Students were interested in what these pollution sources were in their own state so I wanted to create a lesson with the research I had done as well as student interest. (Francesca, Chemistry/Int. Sci., (9–11), PLP)

To meet their PLP teacher goal of creating lessons incorporating social justice in science, teachers wanted to focus on making science relevant to students' lives, connect it to the science course, and connect it to other disciplines. Teachers identified these foci to help students better understand science's critical role as part of justice movements. For example, in a Forensic science class, Beth used current events to make logical connections to the curriculum with her work on the Innocence Project.[1]

> I don't know how many years I looked at the Innocence Project and the statistics of incarceration rates. Students have done case studies that looked at a particular individual and had to analyze and present the evidence with all the factors that led up to their conviction as well as the factors that led up to their exoneration. We tried over the years, to look at compiled data from a number of these cases to say, what are the leading causes of wrongful convictions. We didn't look at too much beyond that. We would look at other issues. So, this year it kind of opened up a door in which to explore the whole issue of qualified immunity, or, three strikes, you're out laws, or no knock warrants. Especially on top of the George Floyd case, it made the students much more interested and willing to engage in that kind of work. (Beth, Chemistry/Forensics (11/12), Interview)

Table 5 includes the instructional practices and accompanying lessons for those instructional practices we identified that teachers developed and refined as part of their engagement in the PLP in relation to Discourse 4.

Table 6 lists the social justice lessons implemented by the teachers in this study and the equity discourses associated with them.

Tables 4–6 provide accompanying practices in connection to the emergent discourses 2 and 4. These practices offer insights into teachers' pedagogical strategies to address social justice issues in the science curriculum. In Table 4, the emergent practices center on integrating student-centered approaches with the curriculum. One practice entails understanding the students and their backgrounds to inform the selection of curriculum examples

[1]The Innocence Project "works to free the innocent, prevent wrongful convictions, and create fair, compassionate, and equitable systems of justice for everyone" (https://innocenceproject.org/).

Table 5. Instructional practices developed for discourse 4.

Instructional Practice	Quote from Teacher	Example Lesson(s)
Give students data about particular social justice and equity issues that are situated where students lived	I found, through my research, that environmental justice within the chemistry classroom helps to keep kids engaged. So, I went with that lens and I gave them instead of looking at definitions, looking at data that they could draw their own conclusions from. The data was actual data we got from the state of [XXX state names removed for blind review]. So it's relevant to where they live. I found that kids were more engaged that way and then kind of scaffolding the questioning to get them to come to their own conclusions where they're like yeah, this actually makes sense. It wasn't something we didn't address again, it was helpful and it was connected to the specific content we were learning at the time. The topic was chemical reactions so we looked at air pollution. I think that kind of helps them understand why we were learning what we were learning. (Francesca, Chemistry/ Int. Sci. (9-11), Interview and Lesson on Analyzing Environmental Justice)	Respiratory System and Asthma Analyzing Environmental Justice A case for Environmental Justice (Hazardous waste sites)
Teachers facilitated questioning, adding to controversy and discussions for students to think more deeply about social justice	I think it generated a sense of agency because I had them write additional questions they had so that really made or fostered a discussion after each lesson. A lot of the kids came up with questions like, is this [e.g. are injustices like what happened to Henrietta still happening now in hospitals?; even though good came out of taking Henrietta's cells without her consent, it shouldn't have happened in the first place. What can be done to make sure something like this does not happen again?] So they want to take more steps after the lesson to see more about it [e.g., what can we do to help avoid social injustice?; were more regulations for research made because of this story?; what can be done to fix an injustice that is years in the past like Henrietta Lacks is?] and actually see if they can do something about it in real life … A lot of students were more vulnerable in those discussions because they were talking about certain topics they weren't necessarily comfortable with, but it created a safe space for them (Elizabeth, Biology/Int. Sci. (9/10), Interview, PLP and Lesson on Henrietta Lacks). I had kids just realizing that race and also economic status play a role in science and where they live and decisions that are made. I had a student say I would have never thought this could go together [science and social justice], but it really makes sense that we talked about income and race relative to where you live and pollution you are exposed to. She's like I never would have ever put these things together, but actually it really makes sense now looking at it. Just making kids more aware, because they live in such a small town that even kids didn't know much about. We looked at a map of [state] and [students] not even realizing where different locations were within the state and why cities are located relative to transportation. And why are people living in cities? Why don't they move away from where the pollution is? I thought was great and then we even brought it back to looking within their own town and where do you see locations within your town that show [this] on a smaller and smaller scale (Francesca, Chemistry/Int. Sci. (9-11), Interview and Lesson on Analyzing Environmental Justice)	Henrietta Lacks Analyzing Environmental Justice Populations and Environmental Justice

(*Continued*)

Table 5. (Continued).

Instructional Practice	Quote from Teacher	Example Lesson(s)
Application of science to societal and cross-disciplinary contexts	I just want to find more ways to incorporate it [social justice] within my lessons so that it makes sense within the content and there's the application for the students. I want to continue to address it and not just because it's part of our PLP this year . . . I wanted to see how social justice is being addressed in other classes because some had said they learned about it and other classes and others seemed to not have learned about it in other classes. Where is it [social justice]? How are they teaching it [social justice]? So that I can try to make stronger connections for the students as well as interdisciplinary connections. (Francesca, Chemistry/Int. Sci. (9-11), Interview and PLP).	Innocence Project Designing a Sustainable City
Influence that extends beyond the classroom	[As part of a forensic science class this teacher explains how the influence can extend beyond the classroom] I think to me, one of the biggest benefits was seeing kids understand a little bit more about our criminal justice system. How it works, how cases are handled by the courts, how most of them are settled out of court or plea deals and why people take plea deals. Why does someone confess? So I think that was a huge take, like, kids were like . . . I never knew this happened or . . . how did these people become judges because the judges were so bad, or the lawyers were so bad, and so that brought up a whole discussion into different state statutes. I think this is rewarding. This was really where kids took the material and where they kind of moved on from that and on to other questions that opened them up to areas that I may have never even thought of (Beth, Chemistry/Forensics (11/12), Interview and Criminal Justice in America Lesson).	Criminal Justice in America Flint Water Crisis
Allowing students to come to their own conclusions	I think having the students come to their own conclusions in the lessons made them more accepting of what they're learning, rather than just like a statement being thrown at them about social justice. Having concrete examples, from my lessons, I think they're more understandable to the students. When they looked at case studies of injustices within medicine or science I think they had more empathy toward that because they knew it actually happened versus some theoretical happening (Elizabeth, Biology/Int. Sci. (9/10), Interview and Maternal Medicine Lesson).	Maternal Medicine Reproductive System and Gender

(e.g., Gender in Science lessons). This practice shows the importance of culturally responsive teaching, where teachers tailor instruction to resonate with a diverse student body. Additionally, teachers actively plan to include representative examples throughout the year to foster inclusivity and engagement for academic success (e.g., Modern Scientist Lesson).

Table 5 shows practices derived from Discourse 4. One practice entails providing students with data about local social justice issues (e.g., Asthma and the Respiratory System). This practice helps to empower students with awareness of societal inequities and fosters critical consciousness and advocacy. Teachers also facilitated discussions for students to explore social justice issues (e.g., Henrietta Lacks Lesson). Another practice involves the application of scientific concepts to real-world contexts (e.g., Criminal Justice in America). Practices in Table 5 illustrate the importance of teachers extending beyond the classroom for students to advocate for justice in their communities. Each teacher planned for and led lessons incorporating social justice in science, as shown in Table 6.

Table 6. Social justice science lessons, subject area, and equity discourse.

Equity Discourse	Lesson Title	Culturally Responsive Practices Related to Equity Discourses	Science Subject Area	Teacher(s)
2	I am a Scientist	Identification and representation	Biology; Physics; Chemistry; Integrated Science	Anne, Clara, Elizabeth, Francesca
2	Gender in Science lesson and gallery walk	Identification and representation	Biology	Anne
2	Moonshot Thinking	Identification and representation	Physics	Clara
2	Modern Scientist Project	Identification and representation	Biology	Anne and Elizabeth
4	Henrietta Lacks Lesson	Health disparities	Biology	Anne and Elizabeth
4	Analyzing Environmental Justice (Air pollution)	Inequalities in local air pollution	Chemistry	Francesca
4	A Case for Environmental Justice (Hazardous Waste Sites)	Inequalities in community hazardous waste sites	Chemistry	Francesca
4	Env. Justice in the U.S. - Flint Water Crisis	Inequalities in clean drinking water	Chemistry	Beth
4	Criminal Justice in America	Inequalities in the criminal justice system	Forensic Science	Beth
4	Innocence Project	Inequalities in the criminal justice system	Forensic Science	Beth
4	Designing a Sustainable City	Equity and environmental justice	Env. Science	Dawn
4	Flint Water Crisis and Env. Justice	Inequalities in clean drinking water	Env. Science	Dawn
4	Env. Justice and Populations	Environmental justice issues	Env. Science	Dawn
4	Maternal Medicine	Health disparities	Anatomy	Dawn
4	Reproductive System and Gender	Health disparities	Anatomy	Dawn
4	Respiratory system, climate change, and social justice	Health disparities	Anatomy	Dawn

Discussion

This research illuminated overarching supports (i.e., administration and the collaborative support of other teachers in the department) and two equity discourses (i.e., increased achievement, representation, and identification with science and engineering and seeing science and engineering as part of justice movements) that emerged when a group of science teachers developed, implemented, and refined approaches for teaching science for social justice.

In order to develop, implement, and refine practices for teaching science for social justice, some support was required. Strong administrative leadership provided a culture where teachers felt supported to take risks, inspired and enabled the teachers to take on and continue this work in the face of challenges. Several challenges connected to initial student and parent resistance, among other challenges, had to be negotiated. When the administration supported and defended the efforts of the teachers, it fostered an environment where the intersection of science and social justice could be further explored. Adah Miller et al. (2024) state that these are the same conditions for professionalism for equity and social justice goals. More specifically, with administrative support, teachers could reflect, take risks, make mistakes, learn, and change practice.

The second finding related to the importance of the collaborative support of other teachers in the department cultivated the department as a space for learning, reflection,

and changing teaching practices. The structure of the PLP, which not only aligned this work with the district and school goals but tied it to the teacher's evaluation, could also have motivated the reflection, discussions of teacher learning, and the emergence of the lessons created and implemented by the faculty. Teachers were vested in action inquiry because the PLP was tied to their teacher evaluative rating. In addition, teachers could choose the goals they wanted to focus on based on personal and professional reasons. Two discourses emerged with accompanying practices from the collaboration of department members and the administration's support. Understanding and analyzing these discourses are central to this research because they shed light on how equity is addressed and conceptualized in science education and how it can influence practices (Tzou et al., 2021). In this study, science teachers identified and refined practices connected to Discourses 2 and 4 that other teachers can use, something that previous studies have noted is desperately needed (Adah Miller et al., 2024; Philip & Azevedo, 2017; Tzou et al., 2021). The theoretical framework proposed by Philip and Azevedo (2017) and Rodriquez (2015) laid the foundation for examining equity in science teaching.

Discourse 2 emerged in this study because of concerns related to undertaking more ambitious and potentially riskier approaches to teaching science for social justice, especially in the context of a politically charged environment that teachers were navigating at the time of this study. This discourse also emerged because of teachers' prior experiences in the sciences, either in courses they took or previous careers in science, where they experienced a lack of representation. Because of these experiences, teachers wanted to ensure that representation in science was apparent so that students could see themselves engaged in science in the future. Teaching practices that emerged for Discourse 2 (achievement, representation, and identification) included knowing students and their backgrounds and actively planning for examples in the curriculum so students can see representation. These teaching practices, among other possible types of culturally responsive pedagogy, recognize diverse perspectives, cultures, and experiences and elevate them as necessary in science teaching and learning contexts.

Discourse 4, which has not historically been a common discourse in science education (Philip & Azevedo, 2017; Tzou et al., 2021), emerged as a lesson theme. Discourse 4 emerged in the PLPs due to 1) the structure of the PLP, which used the baseline survey of student knowledge that led to discussions about the topic of social justice in science, and 2) the logical connections teachers were able to make between social justice movements and the disciplines they taught. The infrastructure of the PLP (Star, 1999) and the logical connections teachers could make supported the teachers in designing meaningful lessons for students. The teaching practices that supported teaching science for social justice, such as the use of case studies, resulted in, according to teacher recollections (Table 5), students feeling valued and respected. In these lessons, the teacher acted as the facilitator of student learning rather than lecturing to the students. Discussions were guided by student discourse instead of the teacher's premeditated lectures. This allowed students to interrogate data and cases as they synthesized their conclusions about what transpired and what actions they could propose to be done about it, something other researchers have identified as important (Morales-Doyle, 2017; Upegui et al., 2022). Additional teaching practices used in our study connected the lessons to students' lived experiences and their communities (Morales-Doyle, 2017; Tzou et al., 2021). For example, in this research, teachers engaged students in interrogating local air pollution data and asthma rates in their region (see Table 5). In the

framework, Philip and Azevedo (2017) explain how Discourse 4 provides more opportunities for societal transformation. In this example, learning more about local data held the potential for making the science students learn in classrooms more meaningful by connecting their experiences to relevant phenomena outside the classroom, especially if they are given the opportunity, as part of science learning, to create change about air pollution, in this example, in their communities.

Discourses 1 and 3 may not have emerged because the initial two lessons shared in the department focused on Discourses 2 and 4. Teachers used those initial ideas for lessons (i.e., I am a Scientist—Discourse 2 and Maternal Medicine—Discourse 4). Additionally, the structure of the PLP only had teachers implement two lessons with students during the year. This limited the time afforded to teachers to explore and discuss the other two discourses. Additionally, if examples of lessons for Discourses 1 and 3 had been shared, this may have led to the emergence of lessons focused on these additional two discourses. Alternatively, if the PLP structure had more than two lessons required, this may have also led to the emergence of a focus on Discourses 1 and 3. Finally, it may also be that the other discourses were a focus in teachers' classrooms, yet this may have gone undetected if they were not written about or discussed in the PLP. Philip and Azevedo (2017) argue that Discourses 1 and 2 provide students in marginalized communities with new opportunities, but these discourses do not change the "status quo." Discourse 3 focuses on recognizing more expansive ways of knowing and legitimating these ways of knowing as important in science and human pursuits. However, as Tzou et al. (2021) suggest, Discourse 3 "requires that teachers are attuned to seeing sensemaking as culturally, ethically, and politically laden and that teachers are adept at incorporating those forms of sensemaking into learning environments productively" (p. 860). As it appeared to be the case in this research, without an explicit and intentional focus on Discourse 3 accompanied by teacher professional learning focused on Discourse 3 and close partnerships with communities, it makes sense why this discourse did not emerge organically for teachers in classrooms and represents an area of focus that Tzou and colleagues, as well as others (e.g., Philip & Azevedo, 2017; Rodriquez, 2015), identify as a needed focus in science teacher education moving forward.

Conclusion

Injustices and historical exclusion in our society are persistent problems in the United States. Although position statements from leading education organizations outline commitments to addressing these problems, limited examples of how addressing such challenges might be undertaken for teaching science for social justice make this work challenging. Consequently, this research adds to the growing number of studies that identify supports and teaching practices that create conditions for students to connect with the enterprise of science (Discourse 2) and see science as part of social movements (Discourse 4) more readily. This research is essential for science educators, administrators, and policymakers if science teaching and learning are to play a role in creating a more equitable and just society. More specifically, the implications of this study to science teacher education reside in how equity discourses can emerge and improve science education when teachers are provided with collaborative support from each other and administrators. As science teachers are trusted, given latitude, and supported when taking risks, they can take on the critical, sometimes challenging, work of teaching social justice as part of the science curriculum. Just

as occurred in this study, political tensions are expected to emerge when systems of oppression are challenged. In this research, the administrator and the support of other teachers co-engaged in collaborative professional learning created conditions for overcoming such challenges. However, specific local, state, and national standards that more explicitly address social justice and equity can provide another needed layer of support for teachers in cases where administrator and collaborative support, like was available in this research, is unavailable. Additional challenges include the need for curriculum, especially educative curriculum (Davis & Krajcik, 2005) that provide teachers with resources and visions for how this work can be undertaken meaningfully with students.

Based on this research, some targeted recommendations for in-service and pre-service teachers include:

- Engage in professional development (in-service teachers) or science teaching methods classroom experiences (pre-service teachers) that offer strategies for teaching science for social justice, eliciting diverse perspectives, and engaging in critical inquiry.
- Become a member of a community of practice (in-service teachers) or create a climate of inquiry in pre-service teacher education programs (pre-service teachers) aimed at sharing resources and discussing challenges related to teaching science for social justice.
- Engage in (in-service teachers and pre-service teachers) identifying and adapting curriculum resources that elevate a focus on teaching science for social justice by focusing on, among other possible foci, environmental justice, health disparities, and equity in STEM.
- Develop partnerships (in-service teachers and pre-service teacher educators) with community organizations focused on engaging students and pre-service teachers in authentic action, taking opportunities that can bring about social transformation.

In the end, while this study provides teachers with resources and visions for how this work can be undertaken, additional studies are needed to provide teachers in all areas of science with curriculum resources they can try out, learn from, and adapt.

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