Redesigning a Science Teacher Preparation Program for Equity: Using Critical Whiteness Pedagogy to Educate Secondary Science Preservice Teachers

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Abstract

In this article, we describe the redesign of a secondary science teacher preparation program. The goal of the redesign was to help preservice teachers in the program become more justice-oriented science teachers. We describe the impetus for the redesign and how we went about redesigning the program through an iterative process of conjecture mapping (Sandoval, 2014), and we highlight important elements of the program. Ultimately, we argue that teacher preparation programs can draw upon practice-based teacher education and critical whiteness pedagogy to assist preservice teachers in becoming justice-oriented science teachers. By blending practice-based teacher education and critical whiteness pedagogy, preservice science teachers can practice being justice oriented, helping them become novice critical whiteness ambitious science teachers.

Introduction

In 2017, we noticed that preservice teachers (PSTs) participating in the secondary science teacher education program at The Pennsylvania State University (Penn State) struggled to describe how race mattered in science teaching and learning. For example, in the second of two methods courses in the program, we noticed that Black students were being marginalized in the middle school science classrooms the PSTs were observing and teaching. In one instance, the first author, Jonathan, asked two White PSTs how they would get a particularly quiet seventh-grade Black boy-presenting student to participate more in class. The PSTs said they would inform the student that participation was necessary to succeed in the class and in science. This was a particularly punitive statement in Jonathan's opinion, and he gave the PSTs other ideas. Later in the semester, the same Black student shared their ideas publicly, something they had not done prior. In debriefing with the PSTs, Jonathan asked them to reflect on what was potentially different for the student during the later lesson. The PSTs could not articulate a reason why and looked at Jonathan with confused expressions. What these moments showed us was that the PSTs in the program were not equipped to negotiate race and racism in science classrooms. Our solution was to redesign the program to focus on equity in science education. Little did we realize that this would not be enough, leading us to shift the focus of the program to white[1] supremacy,

which we define as a racialized system of oppression created and used throughout history to exploit and oppress People of Color to maintain and defend the material wealth and power of elite White people through practices of whiteness.

This article documents the redesign of a secondary science teacher education program at Penn State, a large, primarily White institution in the Mid-Atlantic region. Over 5 years, starting in 2017, the program adopted a vision of science teaching that married practice-based science teacher education with critical whiteness pedagogy. This shift created opportunities for the secondary science PSTs in the program to practice being science teachers who enacted what we are calling *critical whiteness ambitious science teaching*: ambitious science teaching that is purposefully and intentionally enacted to resist and dismantle white supremacy. In what follows, we describe the previous design of the secondary science program, how the program was redesigned, and how the redesigned program supports secondary science PSTs in enacting critical whiteness ambitious science teaching.

Previous Program Design

Central to the design of the secondary science teacher education program was preparing PSTs to use *ambitious science teaching* (AST; Windschitl et al., 2018), a set of four core science teaching practices. The core practices of AST are: (1) “planning for engagement with big science ideas,” (2) “eliciting students’ ideas,” (3) “supporting ongoing changes in students’ thinking,” and (4) “drawing together evidence-based explanations” (p. 4). These practices should be used flexibly and responsively based on a classroom’s cultural and community context (Stroupe et al., 2020). AST is intended to help teachers create classrooms in which students leverage their epistemic agency (E. Miller et al., 2018) while they participate in science and engineering practices to develop models about natural phenomena.

To teach PSTs how to use AST, the secondary science program at Penn State used practice-based teacher education. In other words, we had PSTs participate in “representations, decomposition, and approximations of practice” (Grossman et al., 2009, p. 2058) as the primary activities for their learning. The goal of the program was to provide PSTs with support while they participated in authentic teaching experiences. For example, each course in the program was designed to have the PSTs participate in the work of teaching rather than only talking, writing, and thinking about teaching.

Throughout the program, PSTs completed several assignments designed to prepare them to be teachers, particularly in the two methods courses: Teaching Secondary Science I (SCIED 411W) and Teaching Secondary Science II (SCIED 412). For example, in SCIED 411W, the first methods course, PSTs planned and taught 20–30-minute AST-aligned lessons for local middle school students. To help the PSTs plan the lessons, we designed several experiences such as participating in an AST-aligned lesson as students, watching videos of teachers

using AST, and teaching their lessons in rehearsals to one another. After teaching their lesson to middle school students, the PSTs analyzed video of themselves teaching the lesson, revised it, taught it again to new students, and analyzed that video. In SCIED 412, the second methods course, the PSTs taught alongside mentor teachers who were experts in using AST. The PSTs moved from passive observers to facilitating small groups of students while they tried specific teaching practices. Eventually, the PSTs took on the role of lead instructors for some lessons (for details, see McDonald et al., 2020).

Although SCIED 411W and 412 were separate courses, one assignment, the self-ethnography, spanned both courses. Drawing inspiration from autoethnography (Ellis et al., 2011; McCausland, 2022) and storytelling (Barone, 1992; Johnson, 2017), the self-ethnography was similar to a cultural biography (Lee, 2012; Thompson et al., 2021). Prior to 2020, the self-ethnography was the only assignment focused on equity and other justice-oriented themes. To complete the self-ethnography, the PSTs wrote at least five drafts during their time in the program. For the first draft, PSTs were prompted to think about important aspects of their identity or seminal moments in their lives that have informed how they understand themselves, society, and schools. After receiving feedback on the initial drafts, PSTs were prompted to edit their self-ethnography based on the feedback and write about their racialized identity. The PSTs repeated this process and added gender and ability in the drafts that followed. Throughout the courses, the PSTs participated in activities and were assigned readings focused on race, gender, and ability in schools, society, and science. The project culminated in a final draft in which PSTs were encouraged to think about the connections and intersections between each of the aspects of their identity they had discussed in previous drafts. The goal of the self-ethnography was to support PSTs in practicing critical consciousness and reflection.

Although self-ethnography helped the PSTs understand their lives and society in more critically conscious ways (McDonald et al., 2020; Thompson et al., 2020), from our perspective, it had little impact on their teaching practice. For example, one White preservice teacher wrote in their self-ethnography that Asian and Indian students were often positioned as being “the smarter ones.” They went on to say that because of this positioning, Asian and Indian students they attended high school with were “expected to help” their White peers. Although this preservice teacher unpacked the power structures within the story they told, they did not describe how this realization mattered in their teaching. We also did not see any difference in their teaching. The trend of PSTs being more critically conscious held across most PSTs in the program, but just like the preservice teacher above, we saw no change in their teaching that we would describe as equitable, antiracist, or socially just. This led us to believe we needed to do more than have PSTs practice AST and reflect on their identity if we wanted them to be more justice-oriented and antiracist science educators.

[1] Throughout this article, “White” is capitalized to signal a specific group of racialized people. The word “white” is used to signal descriptors, discourses, and processes that are not identity specific.

Redesigning SCIED 411W and 412

Redesigning the secondary science program took 5 years. Each year, we collected artifacts, wrote memos, and recorded parts of the program we targeted for redesign. Between each iteration of SCIED 411W and 412, the teaching team met to discuss what happened in the previous cycle. Initially, the teaching team consisted of two White men, Jonathan, a graduate student at the time, and Scott, a professor, and one White woman, also a graduate student. Because the majority of the PSTs in the program and the teaching team were White, we worked to identify how our racialized identities influenced what we noticed and how we addressed our noticing (Chadderton, 2012; Foste, 2020). We recognized that the data we collected said just as much about us as about the PSTs; therefore, we worked to recognize the tensions that existed within the data as affordances that provided opportunities to critique white supremacy. For example, we paid particular attention to moments in which we felt ambivalent (Ellison, 1953/1995; Lensmire, 2017) or nervous (Thandeka, 1999) to identify white supremacy in our pedagogy and curriculum.

Central to each of the discussions was the development and revision of *conjecture maps* (Sandoval, 2014). By conjecture mapping, we were able to record salient features of the redesign and how we thought the features would work and did work together to produce desired outcomes. Conjecture mapping helped us plan the redesign, reflect on each iteration, and conduct research. In fact, our conjecture maps also serve as documentation of the redesign over the 5 years.

Conjecture mapping gave us a logic and language to make connections between the design, theory, and outcomes as we redesigned the secondary science program. For example, we began each conjecture map with a *high-level conjecture*: a singular statement that captured the type of learning we hoped to support in the program (Sandoval, 2014). Figures 1 and 2 show how the conjecture map changed from the 2017–2018 iteration to the 2021–2022 iteration. After articulating a high-level conjecture, we identified the most salient features of each redesign. For example, in the 2017–2018 and 2021–2022 iterations, the self-ethnography was identified as a salient task, but our one-on-one debriefs with the PSTs during SCIED 412 were not. The next step was to describe the *outcomes* we hoped to see. For example, in the 2017–2018 conjecture map, we wanted to see PSTs have an “understanding of positionality.” Our final conjecture mapping step was to link our *embodiments* (most salient design features) with the outcomes by describing *mediating processes*: how the learning would take place. An example of this in the 2021–2022 map is self-advocacy/agency (Matias & Mackey, 2016). For us, participating in the self-ethnography

would help PSTs “take [on the] racial responsibility of whiteness” (Matias & Mackey, 2016, p. 48), which would help them be what we describe as “novice critical whiteness ambitious science teachers.”

Figure 1

2017–2018 Conjecture Map for the Secondary Science Program Redesign

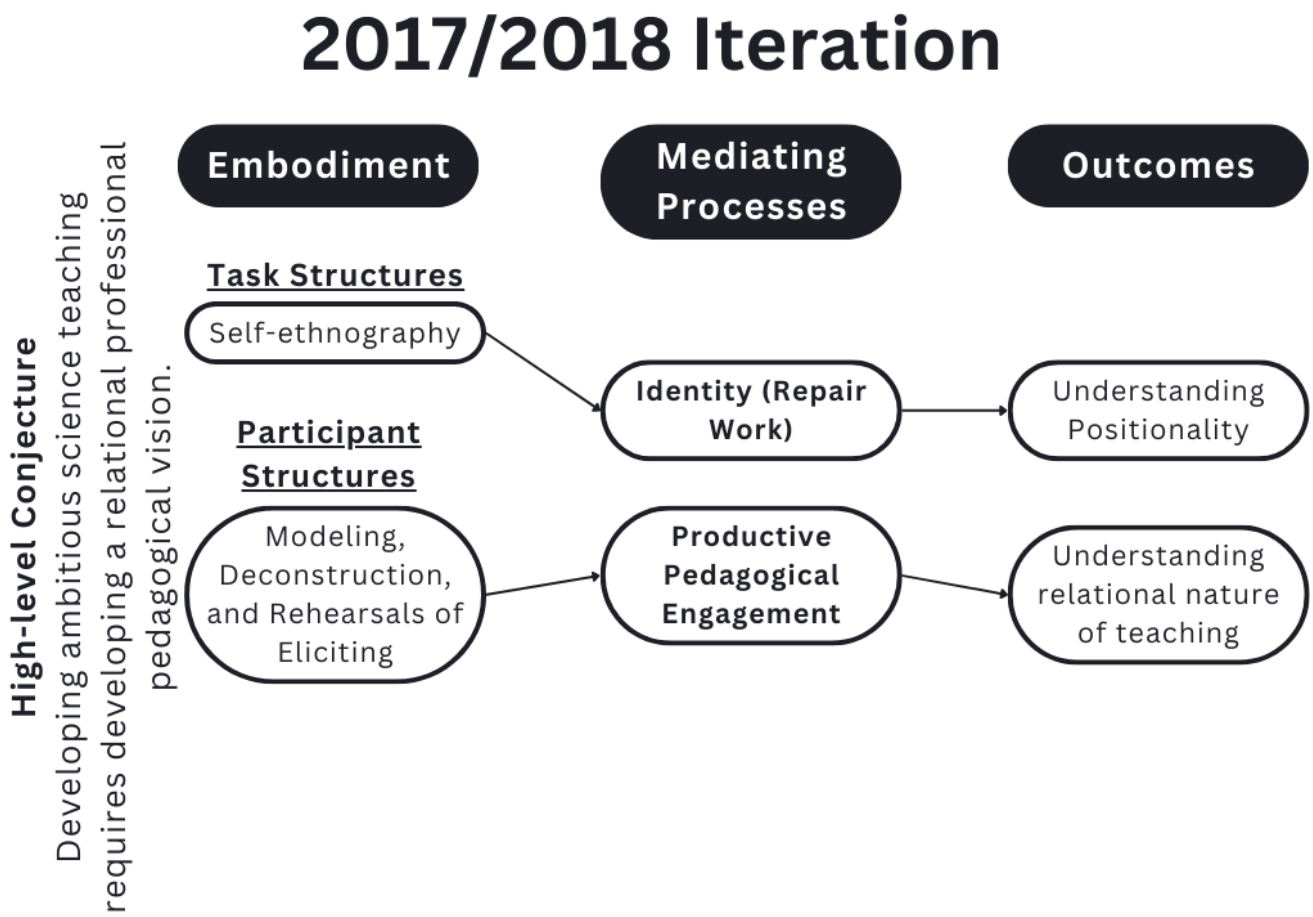
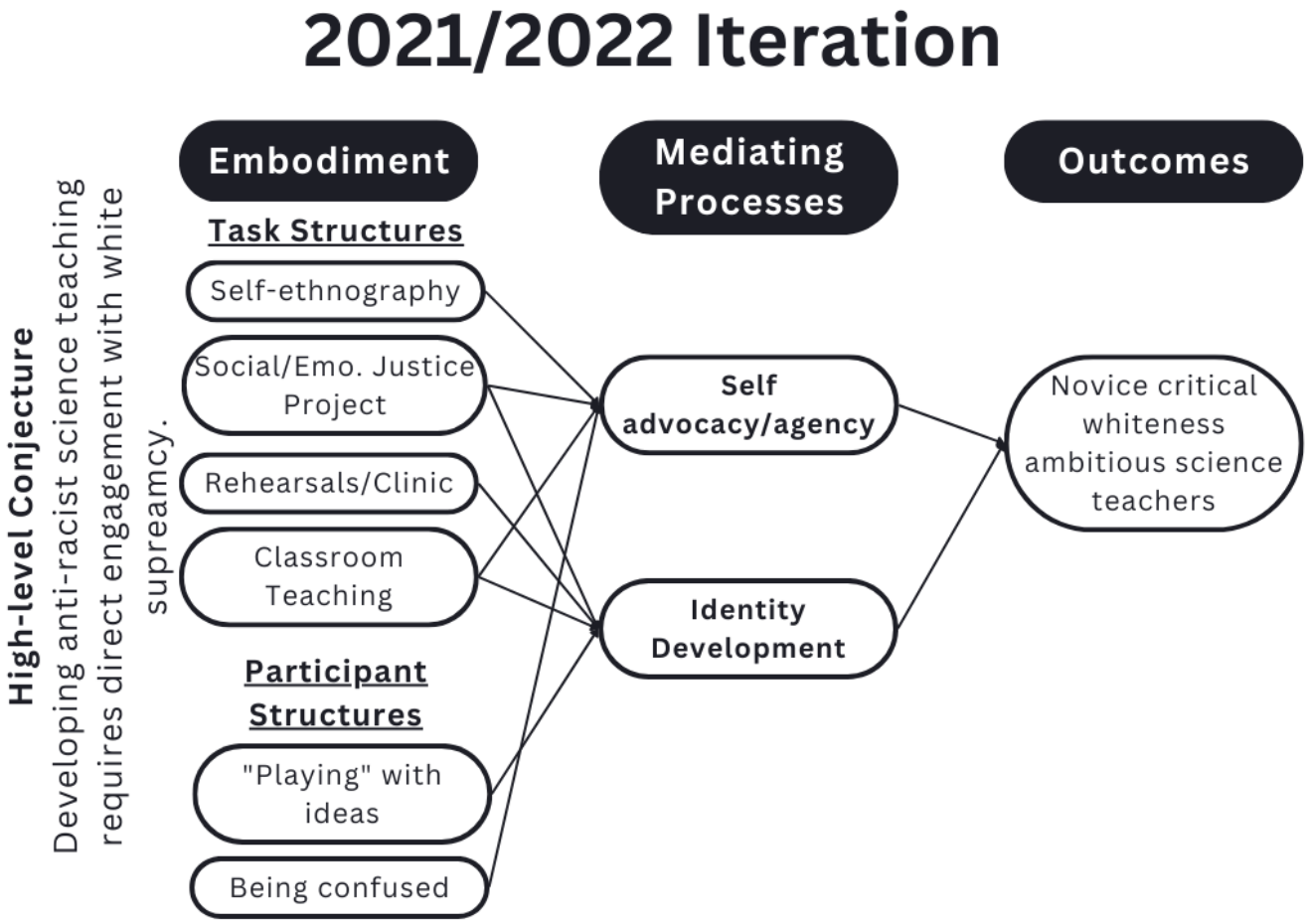


Figure 2

2021–2022 Conjecture Map for the Secondary Science Program Redesign



From 2017 through 2022, we undertook a constant process of conjecture mapping, implementing SCIED 411W and 412, collecting data, and reflecting on each iteration. Each year, based on our observations and research, we revised the conjecture maps and overall program. Wanting to make the redesign sustainable, we chose to focus on a different goal each year. For example, after 2017, we realized the PSTs needed to be more familiar with AST and do more equity work before getting to SCIED 412. This resulted in having a senior doctoral student teach SCIED 411W. In SCIED 411W, PSTs taught a lesson to the local middle school students that they would be working with the following semester. Jonathan observed SCIED 411W that iteration and led the PSTs in discussions focused on equity in science education. At the conclusion of the 2019–2020 iteration, it became clear our focus on equity in science education was not enough. So, in the 2020–2021 iteration, we married our practice-based approach with critical whiteness pedagogy.

Critical Whiteness Pedagogy

Critical whiteness pedagogy (CWP) is a form of teaching that has people explicitly focus on learning about white supremacy. There is no one way to enact CWP, but there are common themes. First, CWP does not concern itself with the who of white supremacy but instead focuses on how white supremacy matters in contexts (Levine-Rasky, 2000; E. T. Miller &

Tanner, 2019; Tanner, 2018). This means CWP explicitly rejects the idea that if we identify White privileges (e.g., McIntosh, 2008), white supremacy would be stopped (Lensmire et al., 2013). In lieu of identifying White privileges, CWP has people, especially White people, "play" and "be confused" about white supremacy (Tanner, 2018). By "play" and "be confused," we are referring to participation that creates opportunities to relate to the classroom community as we collectively explore, take risks, question, improvise, try new things, and disrupt the status quo in making sense of and dismantling white supremacy and whiteness. In this way, CWP has people participate in difficult, honest conversations focused on systemic elements of white supremacy, the emotionality of white supremacy, and the paradoxes and double binds contained in white supremacist societies or communities. These conversations and other activities require people to practice taking on responsibility for white supremacy and antiracism (Matias & Mackey, 2016). CWP often requires improvisation (Tanner & McCloskey, 2023) and the realization, on the part of the person using CWP, that emotions such as anger, shame, and ambivalence are not resistance but assets because they are necessary parts of learning to be antiracist, especially for White people (Marx & Pennington, 2003; McIntyre, 1997).

Adopting Critical Whiteness Pedagogy

We merged CWP with our practice-based approach to teaching AST because we believed integrating CWP would address how social justice is often not practiced in teacher education courses (Kavanagh & Danielson, 2020). We believe ambitious, justice-oriented, and anti-racist teaching is learned; teaching is not a skill people are born with. Teachers need opportunities to learn teaching through practice, and we argue that social justice is no different. Given the ample evidence that practice-based teacher education supports novice teachers in taking up complex repertoires of practice (Haverly et al., 2020; Stroupe et al., 2022; Thompson et al., 2016), we believed that providing PSTs with explicit opportunities to practice social justice, through CWP, would help them learn to be more socially just educators. Although practice-based teacher education can create more opportunities to engage PSTs with social justice, it is not explicitly designed to do so. We acknowledge the critiques that practice-based teacher education fails to address issues of justice and equity (Daniels & Varghese, 2020; Philip et al., 2019), and it is partially for this reason that we infused our practice-based teacher education with CWP. In what follows, we highlight key design features associated with our 2021–2022 conjecture map that supported the PSTs in becoming novice critical whiteness ambitious science teachers. Our intent is not to describe every aspect of the program or design but to provide an overview of key elements that demonstrate how the program supports PSTs in being more justice-oriented science teachers.

Being Successful in Justice-Oriented Science Teaching

To be novice critical whiteness ambitious science teachers, we agreed with Luehmann (2007) that PSTs needed to be successful with the kinds of pedagogy we were asking them to enact. Therefore, we designed SCIED 411W and 412 to help the PSTs be successful in critical whiteness ambitious science teaching. An example of our desire to have the PSTs experience success with critical whiteness ambitious science teaching is an activity in which we had the PSTs participate in an improv workshop. During the improv workshop, PSTs embodied and made sense of the relationship between white supremacy and science education to practice being more critically conscious, a key attribute of most justice-oriented and asset-based pedagogies (e.g., Gay, 2018; Ladson-Billings, 1995; Madkins & Nazar, 2022). Because improv relies on unscripted moments and an ethos requiring people to "(1) honor the affirmational philosophy of 'yes, and,' (2) work in service to the collective, (3) share power with others, (4) participate without evaluation, and (5) perceive, accept, affirm, and build off the offerings of others" (Tanner & McCloskey, 2023, p. 6), there were no "right" answers, allowing the PSTs to be successful being more critically conscious no matter what they did.

Other ways we ensured the PSTs experienced success with critical whiteness ambitious science teaching is by having the PSTs participate in an iteratively revised self-ethnography and justice-focused clinics and having them teach alongside experienced mentors. Starting with the 2020–2021 iteration, the self-ethnography focused specifically on having PSTs participate in racialized storytelling (Johnson, 2017). By having PSTs use racialized storytelling, they were able to make sense of their racialized lives in ways that critiqued and made sense of white supremacy. Racialized storytelling provided a chance for PSTs to practice being critically conscious by understanding their personal experiences, as rooted in historical and political systems, while they navigated the messy terrain of the past, present, and future in their writing (Johnson, 2017). Additionally, storytelling is central to racial justice projects. Having the PSTs participate in this tradition gave them a chance to practice being a part of a much larger tradition handed down by scholars and intellectuals such as Richard Delgado, James Baldwin, Toni Morrison, Ralph Ellison, and others in an authentic way. To ensure that the PSTs were successful participating in rehearsals, clinics, or teaching in classrooms, we treated their teaching as rehearsals and frequently stopped them in "teacher timeouts." These moments were used to have PSTs think about whether what they were doing was equitable or not. If it was not, they tried again. If it was, they tried something different. These actions ensured that the PSTs had chances to successfully make sense of white supremacy and justice. It also provided opportunities for PSTs to translate those experiences into successfully enacting pedagogies the community agreed were equitable, justice-oriented, and antiracist. We grounded this process in the community of SCIED 411W and 412 because we believe critical whiteness ambitious science teaching is not a one-size-fits-all approach to science teaching but a purposeful, creative, and improvisational (Philip, 2019) approach to teaching that is intended to address and push back against white supremacy.

Taking on the Burden of White Supremacy

The PSTs needed to take an active role in addressing white supremacy in schools and society to be novice critical whiteness ambitious science teachers. We wanted the PSTs to reflect on white supremacy and turn their reflection into action. Matias and Mackey (2016) describe this phase as “a space of self-advocacy and self-agency” (p. 37). Although the PSTs participated in activities and assignments intended to help them make sense of white supremacy (e.g., the self-ethnography), the socioemotional justice project required PSTs to transform talk into action. Inspired primarily by the scholarship and teaching of Jeanine Staples (2016) as well as work by Resmaa Menakem (2017) and Don Miguel Ruiz (1997), the socioemotional justice project was designed to have PSTs do something, on their own, in relation to justice. Through each class and assignment, we rarely, if ever, told the PSTs what was justice-oriented or not. We forced them to figure it out, or as Matias and Mackey (2016) state, we had them “sharing the burden” of social justice in order to be antiracist teachers rather than do antiracist teaching (Ladson-Billings, 2006). In the end, numerous projects emerged. Some of the projects created included a workbook of narratives designed to help others think critically about white supremacy, art projects representing learning around numerous course concepts, research projects such as noticing peoples’ reactions to playing Thandeka’s (1999) “Race Game,” protests, and personal journaling. One PSTs organized and facilitated conversations with other White men to discuss race, ultimately developing what they referred to as the “Apathy to Advocate Social Justice Model” for White people based on the conversations and his own research into White identity.

The Importance of Playing and Being Confused

A key component of the pedagogy in the program was creating opportunities for the PSTs to play and be confused related to white supremacy to support them in taking on the burden of white supremacy. To do this, we embraced the ethos of improv (Tanner & McCloskey, 2023) to create spaces in which PSTs were forced to take risks and go off script *because we refused to* provide answers to their dilemmas. For example, during the 2020–2021 iteration of SCIED 411W, a group of PSTs was trying to identify a phenomenon that would connect with “any student from any cultural background” for their clinic lesson. Prior to this class, the PSTs had discussed and read articles about how to plan more equitable science lessons. One of their conclusions was that an antiracist scientific phenomenon had to be “culturally relevant” (Ladson-Billings, 1995). For a phenomenon to be considered culturally relevant, the PSTs decided that students needed to understand the phenomenon and that it had to be something students could “relate to.” However, they struggled with justifying why the phenomenon they picked was antiracist. The phenomenon they chose was, in their words, “a reaction in a bag. You mix a few things[,] and it changes color, gets really hot, and it expands[,] and all this stuff is happening.” In response, Jonathan referred the PSTs back to other phenomena the class had positioned as high-quality phenomena: sugar burning, a train tanker car imploding, and one ball bouncing while another one does not. Jonathan then

asked them to use those phenomena to help justify why the reaction in a bag might be antiracist. After a moment, one of the PSTs said, “Everyone is at the same place. Nobody has seen it.” Laughing, another preservice teacher gestured to a third preservice teacher, “That is what you said! Either everyone relates, or nobody relates.” This short vignette demonstrates the PSTs taking on the burden of social justice by being confused and playing with race because, throughout the entire exchange, Jonathan did not provide an answer to their dilemma. Instead, the PSTs had to work through their confusion, albeit with guidance from Jonathan. Rather than provide a concrete definition of what makes a particular phenomenon antiracist, the PSTs had to play with ideas such as equality and equity to determine what it means for a phenomenon to be antiracist. In other words, by having the PSTs participate in an activity that required them to take risks with and practice antiracist teaching in the form of a planning practice, the PSTs developed a common understanding and language to help guide their practice (Windschitl et al., 2012).

The confusion and play of the PSTs eventually gave them beginning clarity on how to enact critical whiteness ambitious science teaching. When developing a unit in SCIED 412 around COVID-19, some of the same PSTs from the narrative above grounded their lesson in the lived experiences of the high school students they were teaching. Their actions mirrored their stance that either everyone relates, or nobody relates. This time, the PSTs opted for everyone relating to the phenomenon. During the lesson, the PSTs had students reflect on how their lives changed because of the pandemic and share stories and resources to discuss the value of different forms of scientific evidence. After the conversation moved toward the racialized inequities of the pandemic’s impact, the PSTs asked the students if there was information they would like to investigate more. Each teaching move that the PSTs used grounded the overarching phenomenon and the activity they were leading in the lives of the students in the class. The talk moves also gave the students space to make sense of race, their communities, and science in relation to COVID-19. In this way, we argue that by providing the PSTs with space to try out justice-oriented science teaching, they were able to figure out their version of critical whiteness ambitious science teaching. Their version of critical whiteness ambitious science teaching included having students draw upon their own knowledge, use data to make sense of their experiences, and make decisions about their own lives and how they should live based on the data they reasoned with.

Enacting Critical Whiteness Pedagogy in Science Methods Courses

A key component of our enactment of CWP was to ask questions rather than make declarative statements. We tried to do this no matter what the PSTs said. We would ask questions if a student said something others would interpret as racist or antiracist. Everything a preservice teacher said or did was questioned and explored. We rarely explained anything ourselves. For example, after the improv workshop mentioned above, one PST suggested, in a written reflection in an online document that was shared between the student and Jonathan, that the workshop was “racist” because “being asked to walk around the

classroom like a White person or being asked to portray an image of whiteness in science and therefore asked to generalize a people group [group of people] based on race was racist." Given that it was common practice for Jonathan to make comments and have conversations with PSTs in their journals, at this moment, Jonathan could have explained why he disagreed with the PST. However, recognizing this PST's contribution as a risk, as an emotionally charged point of confusion, and as a moment to have the PST play with race to take on the burden of social justice, Jonathan asked the PST to explain their thinking more thoroughly. Jonathan responded to a part of the PST's reflection in which they spoke about having resistance to "being in the conversation about race because I feel I have such a wildly different approach to the topic than what I sense a lot of people in class do." Jonathan responded to the PST by saying, "Tell me more about this approach! I am interested to hear about it." A days-long exchange in the shared online reflection journal ensued. The preservice teacher would share their thoughts, and Jonathan would ask questions. Throughout their responses, the PST took risks, explored contradictions, and had space to play. In one instance, the PST seemed to recant a statement in which they argued they were not "privileged" by admitting their ideas may be the result of their "(maybe privileged) background" or "not noticing its [whiteness's] effects on my experience in the world." The interaction ended the moment Jonathan mistakenly made a lengthy declarative statement explaining how he was interpreting the preservice teacher's most recent comment where he told the PST, "I can tell you that race has impacted your life in some way . . ." and prompted the PST to identify how race "might matter" in specific events that took place in their life after telling a racialized personal story about taking the SAT. Although we have no way of knowing how the PST interpreted Jonathan's action, we know they did not respond to his comment. Therefore, given how Jonathan deviated from our use of critical whiteness pedagogy, we assume Jonathan's use of a statement, rather than questions, negated the explorative space created initially. In fact, this pattern remained through SCIED 411W and 412. By opening and extending the conversation with questions and adhering to our practices of critical whiteness pedagogy, there were more opportunities for learning because PSTs were able to make sense of the role of white supremacy in society, schools, and science teaching, but when we deviated from our typical practice by explaining things through declarative statements, for example, the PSTs often responded with silence or disengagement.

The Potential of Critical Whiteness Pedagogy in Science Teacher Education

White supremacy often hides implicitly within science learning contexts (McCausland, 2022). This means that without an explicit focus on white supremacy in how we prepare teachers, we will fail to fully address the inequities and oppressions perpetuated in and by science education (Le & Matias, 2019). For example, it is white supremacy that produces "science as White property," which marginalizes students and Teachers of Color in science education (Mensah & Jackson, 2018, p. 9). It is also white supremacy that creates contexts in which White people are able to claim STEM education for themselves in ways that harm

communities of Color (Bullock, 2017). Additionally, white supremacy informs oppressive pedagogies that work to reinforce white supremacy in science (McCausland, 2022), creates "settled expectations" in science education (Bang et al., 2013, p. 303), and causes other sciences outside the Western, White forms of science to be supplanted until deemed worthy enough to be assimilated into Western, White sciences (Sammel, 2009), among other things. By ignoring white supremacy, educators may fail to notice and address the racialized ways science is learned and taught. CWP provides a framework to develop more antiracist teachers in ways that are different from more traditional teacher education methods. For instance, teacher education around white supremacy, especially for White people, often takes the form of acknowledging and noticing White privileges (Lensmire et al., 2013). This is a simplistic and flat treatment of white supremacy that will not, in our opinion, come close to solving the problem of white supremacy in science education. By embedding the secondary science program at Penn State with CWP, PSTs had opportunities to practice social justice in ways that required them to take on the burden of white supremacy (Matias & Mackey, 2016; Tanner, 2018). PSTs had to go beyond only acknowledging White privileges. By providing assignments and activities throughout the program intentionally having the PSTs practice being antiracist, the PSTs got better at being antiracist. In other words, the PSTs learned to be novice critical whiteness ambitious science teachers.

Teachers cannot only be told about justice and equity or be "filled" with critical consciousness as if they are empty vessels. By integrating CWP with practice-based teacher education, we were able to have the PSTs embody what they imagined an antiracist science teacher to be. By having time to talk and think about and practice being an antiracist science teacher, the PSTs were able to actualize a vision they had for themselves and science education. Although the PSTs' journeys and our own are ongoing, we believe our program's redesign can act as a part of the foundation for how to prepare the socially just science teachers of the future.

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