

Supporting Preservice Elementary Teachers in Teaching Science for Equity and Justice: A Practical Framework

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Abstract

Preservice elementary teachers bring many strengths to science teaching but may not get extensive support in learning to work toward equity and justice in their science teaching. Drawing on four approaches to equity from a recent report from the National Academies of Sciences, Engineering, and Medicine (2022), this article presents a practical framework for helping preservice elementary teachers in this challenging work. The article first explores each approach, suggesting interpretive frames and teaching moves that preservice teachers could use in moving from a relatively abstract call for equity to making concrete decisions in elementary science instruction. A practical framework is developed based on that exploration, with a description of how the framework has been used instructionally in an elementary science methods class. Then, the article presents the results of a pilot study of 31 preservice elementary teachers' use of a pilot framework, illustrating how these participants' lesson plans readily reflected teaching moves focused on increasing children's opportunity and access to science learning and increasing achievement, representation, and identification but less often reflected moves oriented toward broadening what counts as science or bringing science and justice together. The article concludes by noting that research is needed to further explore the utility of this framework and how equity can be supported in science teacher education more generally. The article also urges the field to develop representations of practice and elementary science curriculum materials that would support teachers in this challenging, lifelong work to advance equity and justice.

Introduction

All children should experience the joy of science. Yet educational injustices, including opportunity gaps, lack of representation, and structural inequities, are widespread and apply across content areas, including elementary science. For example, some may assume that certain children who have been historically marginalized in science can't do sophisticated science or that their ideas aren't reasonable (e.g., Ladson-Billings, 2022; Lee & Stephens, 2020; Metz, 1995). Children of color and emergent multilingual learners may have limited opportunities to engage in science in school that connects with their communities (e.g., Bang et al., 2017). Children from marginalized groups often don't see themselves represented in images of science or see themselves as people who do, or can do, science (e.g., Calabrese Barton & Tan, 2020). Furthermore, elementary teachers mostly identify as White women, and thus teachers' backgrounds may diverge from the backgrounds of their students (National Academies of Sciences, Engineering, and Medicine [NASEM], 2022; Thompson et al., 2020).

Finally, structural inequities stemming from school funding mechanisms mean that systematically underserved schools lack the money, physical resources, curriculum materials, and time for science teaching (Baker & Corcoran, 2012; Banilower et al., 2018). In these schools, science is often put on the back burner while mathematics and English Language Arts are prioritized (Plumley, 2019). Students of color, in particular, are short-changed because of their overrepresentation in schools that are inadequately funded (NASEM, 2022). As a result of issues like these, teacher educators need to support teachers in many ways, from setting high expectations to valuing students' ways of knowing and being to developing critical consciousness. Table 1 presents areas of support recommended in the literature with example references for each.

Table 1

Supporting Teachers in Working Toward Equity and Justice in Science Teaching

Goal: Teachers need support in learning to	Examples of scholarship informing the goal
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With the goal of providing such support, in this article, I build on NASEM’s 2022 report *Science and Engineering in Preschool Through Elementary Grades: The Brilliance of Children and the Strengths of Educators*, which is focused on children’s science and engineering learning. In particular, I draw on the report’s “approaches to equity” (p. 23) to develop a practical framework for helping preservice elementary teachers as they work

toward equity and justice in science. By *teaching science for equity and justice*, I mean using equity- and justice-oriented interpretive frames and teaching strategies to provide every student with rich opportunities to learn science as well as antiracist pedagogies that work toward racial, economic, and social justice (Cochran-Smith, 2010; Morales-Doyle, 2017; Patterson Williams et al., 2020; Sleeter & Owuor, 2011).

Drawing on definitions in NASEM (2022), I use *equity* to refer to improving policies and practices to remove barriers to students' participation with the goal of working toward comparable levels of attainment, representation, identification, and participation in science. Again, drawing on the definition in NASEM (2022), I use *justice* to emphasize the imperative of overturning systemic oppressions, to seek fair treatment and opportunities for thriving for everyone. This can, in part, be worked on through expanding one's visions of what is valued in science and seeing science as part and parcel of the work of undoing histories of oppression. This is important because:

Historically marginalized learners in science and engineering, including Black, Brown, and Indigenous children and other children of color, children with learning disabilities and/or learning differences, emergent multilingual learners, and children marginalized on the basis of gender, all deserve the opportunity to engage with science and engineering to make sense of the natural and designed world. (NASEM, 2022, p. 21)

I use *historically marginalized learners* as a label, and there are limits to any label—most crucially, the risk of essentializing a group into a set of stereotypes or expectations. Within any given group, individual learners have multiple, intersecting identities that carry with them complex repertoires of practice (Gutiérrez & Rogoff, 2003). A framework must support teachers' work in general and their work with specific groups (such as emergent multilingual learners) and individuals.

The intention of the practical framework put forward in this article is to help preservice teachers move from (a) awareness of general, content-neutral educational justice issues such as they might learn about in a foundations class, to (b) identifying how those issues play out in science, and then on to (c) specific and concrete teaching moves they can employ in a science lesson to mitigate or disrupt each issue. Even small changes to one's teaching moves (e.g., varying participation structures) can support historically marginalized students (Patterson, 2019; Sleeter & Owuor, 2011). Some preservice teachers, though, may take on bolder work toward justice.

I am a tenured faculty member at a research-oriented, public, state university in the Midwestern United States. I am a White, cisgender woman with settler heritage from a privileged social and educational background. In some of these ways, I am typical of many teacher educators. This can impede my efforts to work toward justice, and I recognize the work I need to do around my own practice and critical consciousness (Sleeter, 2001; Thompson et al., 2020). Indeed, having science teacher educators of color can be crucial for

new teachers, perhaps particularly those who are people of color themselves (Mensah & Jackson, 2018). Most of the preservice elementary teachers in my classes identify as White women, many from middle-class backgrounds, and this, too, is typical of elementary teachers nationwide (Banilower et al., 2018). As a field, we must work to diversify the teaching and teacher educator workforce, and my program is actively engaged in these efforts, but we must also work on justice and antiracism with White women preservice teachers because they are the current reality of the incoming teaching force (Sleeter & Owuor, 2011). Thus, I present this article and its practical framework earnestly and with enthusiasm but also with humility. I also chaired the National Academies committee that developed the *Science and Engineering in Preschool Through Elementary Grades: The Brilliance of Children and the Strengths of Educators* report (NASEM, 2022), and therefore I was involved in conversations about these approaches to equity. In this article, and throughout my efforts to advance equity in elementary science, I build on the work of other scholars far more expert than I. I hope to contribute to the imperative of supporting elementary teachers in shifting their science instruction to be more equitable and just.

Using the Four Approaches to Equity to Develop a Framework for Working Toward Equity and Justice in Elementary Science Teacher Education

The recent National Academies report (NASEM, 2022) adapts work from Philip and Azevedo (2017) and Rodriguez (2015) to put forward four approaches to equity regarding elementary science. These include¹: “(1) increasing opportunity and access to high-quality science . . . learning and instruction; (2) emphasizing increased achievement, representation, and identification with science . . . ; (3) expanding what constitutes science . . . ; and (4) seeing science . . . as part of justice movements” (NASEM, 2022, p. 23). Each approach makes an important contribution, and they are not mutually exclusive. For example, a preservice teacher might learn ways to represent people from historically marginalized groups in science (addressing Approach 2) while also learning to “recognize and build on the values and ways of knowing and being” (NASEM, 2022, p. 26) that their students and their families bring to science learning, such as cultural norms for communication and sensemaking (addressing Approach 3). That said, these approaches also each have potential pitfalls to acknowledge and account for (NASEM, 2022; Philip & Azevedo, 2017; Rodriguez, 2015). Yet the four approaches, together, reflect a spectrum of opportunities for how educators can work toward equity and justice in their science teaching.

Elementary teachers care deeply about children and are inquisitive about science (NASEM, 2022) but often express a lack of confidence in science teaching (Banilower et al., 2018) and may show concern about or even resistance to working toward justice with their students (e.g., Rodriguez, 2005). Multicultural or foundations courses in teacher education (e.g., a course on the history of schooling) often raise issues but typically (and understandably) do not make justice issues content specific (Kavanagh & Danielson, 2020). With a spectrum of approaches and a practical framework for using those approaches, we may support teachers

in making meaningful changes in elementary classrooms. Enacting any of these approaches is complex for preservice teachers as well as practicing teachers. Each approach requires understanding how issues of equity always sit within systems of power.

The NASEM (2022) report provides examples of each approach, again drawing on Philip and Azevedo (2017) and Rodriguez (2015). In Table 2, I build directly from Table 1-2 in the NASEM report (2022), focusing explicitly on how elementary science teacher education can advance each approach. To move toward specifics, I focus on equity- and justice-oriented interpretive frames and concrete equity- and justice-oriented teaching moves. By *equity- and justice-oriented interpretive frames*, I mean the knowledge of and awareness, beliefs, commitments, dispositions, and goals related to issues of equity and justice (see Cochran-Smith, 2010). Examples include seeing educators as agents of change, recognizing students' (and others') assets and intersecting identities, valuing multiple ways of knowing, and focusing on students' sensemaking (e.g., Bang & Medin, 2010; Carlone et al., 2011; Cochran-Smith, 2010; Kang, 2021; Rivera Maulucci, 2013; Rosebery et al., 2016; Sleeter & Owuor, 2011). By *equity- and justice-oriented teaching moves*, I mean things teachers do in their instruction. This includes building relationships with students; making instruction relevant; building on students' resources; shifting epistemic authority; and making equity, inequity, respect, and disrespect explicit parts of the curriculum (e.g., Braaten & Sheth, 2017; Milner, 2010; Patterson, 2019; Sleeter & Owuor, 2011; Stroupe, 2014).

Table 2

Examples of How Elementary Science Teacher Education Can Support Approaches to Equity
(excerpted and adapted from NASEM, 2022)

Approach #1: Increasing opportunity and access to high quality science learning and
education

Note. This table is excerpted and adapted from Table 1-2 in *Science and Engineering in Preschool Through Elementary Grades: The Brilliance of Children and the Strengths of Educators* (NASEM, 2022, p. 25–27).

In the four subsections that follow, for each approach, I outline some frames and moves that preservice elementary teachers could develop and use in their science teaching. In doing so, I use italicized topics that draw directly on (and at times verbatim from) the bullets presented in Table 2, which in turn is excerpted and adapted from Table 1-2 in the NASEM report (2022). Thus, the following sections are designed as a way of elaborating and extending the report's Table 1-2 to focus explicitly on the pragmatics of elementary science teacher education. After I develop this foundation, in the next major section, I present a practical framework that grows out of this foundation, and I discuss how I have used earlier versions with my preservice teachers.

Approach 1: Opportunity and Access for Science Learning and Instruction

A key aspect of Approach 1, “increasing opportunity and access” (NASEM, 2022, p. 23), is to recognize so-called achievement gaps as opportunity gaps instead (Carlone et al., 2011; Patterson, 2019) and to work to *increase opportunities for children*, particularly children of color, to engage with science, as noted in Table 2 and NASEM (2022). To do so, preservice elementary teachers can learn to remind themselves that science should be taught in the elementary grades and that children should engage in sensemaking around investigations (National Research Council [NRC], 2012). They can remind themselves that children deserve to learn science not only for future job opportunities and decision-making but also to allow them to experience the wonder of science now. Preservice teachers can also learn teaching moves to increase children's opportunities for science, such as making science a long-term endeavor in elementary classrooms (e.g., through analysis of daily weather data) and using participation structures that give children opportunities for building on one another's ideas (Colley & Windschitl, 2016).

Similarly, Table 2 notes that Approach 1 involves *removing barriers* to children's participation in science (NASEM, 2022, p. 25). Toward this goal, preservice teachers can learn to ask themselves questions such as: Am I attending to my own and students' positioning in small and whole groups? A teaching move that helps to remove barriers is developing teacher and student talk moves to support science discourse (Michaels & O'Connor, 2012; Zembal-Saul et al., 2013) while ensuring that the children's use of the talk moves doesn't simply become another form of compliance. Introducing academic language after experiences with a phenomenon is another relevant move. Although students (including emergent multilingual

learners) benefit from learning tool names (e.g., thermometer) before starting an investigation, they should learn conceptual vocabulary (e.g., conductivity) after making meaning of the concepts (NASEM, 2022).

Finally, Table 2 notes that Approach 1 involves *using phenomena as ways of motivating children to engage in science practices* (NASEM, 2022, p. 25). Teaching moves here include providing shared experiences with phenomena to launch a science investigation (Windschitl et al., 2018), providing scaffolding for science practices, and ensuring that investigations are opportunities for sensemaking, not just hands-on experiences (Zemba-Saul & Hershberger, 2020).

Approach 2: Achievement, Representation, and Identification

Approach 2 focuses on increasing children’s “achievement, representation, and identification with science” (NASEM, 2022, p. 23). First, Table 2 shows this involves *increasing representation* in science across historically marginalized groups (NASEM, 2022, p. 26). Preservice elementary teachers might ask themselves, for example, whether they are making a range of images of who does science visible in their classroom (e.g., via books or posters). They might also ask themselves whether they are assuming that certain children won’t be good at or enjoy science or whether their orientation toward niceness (Castagno, 2019) is leading them to have low expectations for some of their students rather than pushing them for sensemaking (Ladson-Billings, 2022). In terms of teaching moves, preservice elementary teachers can position students as knowledge builders, doers, thinkers, and critics of science in authentic and age-appropriate ways, supporting children in and holding children accountable to disciplinary norms in the classroom (Agarwal & Sengupta-Irving, 2019; Engle & Conant, 2002). They can privilege investigation, make the science practices explicit by naming them, and draw parallels between the science practices and the work of scientists across cultures when appropriate. Finally, they can identify culturally relevant topics and contributions of individuals who don’t fit the standard (European, White, male) mold for scientists (e.g., Fitzgerald, 2018).

Table 2 notes that supporting Approach 2 also involves “connect[ing] science . . . learning with children’s *interests and identities*” (NASEM, 2022, p. 26). For example, preservice teachers can connect lessons to children’s lives by using everyday phenomena like clothes drying on a line or condensation forming on the bathroom mirror. Preservice teachers can consider what science identities students bring to the classroom (e.g., are they inquisitive, artistic, or environmentally conscious?) and how they can make those identities achievable for each student (Carlone et al., 2014). As noted in Table 2, supporting Approach 2 also involves *giving children choices* for conducting investigations (NASEM, 2022). For example, when possible, preservice elementary teachers can allow children the opportunity to make decisions about questions, investigation design, data collection, and data organization (Manz, 2015).

Approach 3: Broadening What Counts as Science

Approach 3 focuses on “expanding what constitutes science” (NASEM, 2022, p. 23). One way to support Approach 3, as noted in Table 2, is to “see and respond to the *richness in children’s sensemaking*” (NASEM, 2022, p. 26). This builds on Approach 2’s focus on interest, identity, and choice and further entails valuing children’s contributions even when they do not reflect what might be considered standard science or typical science norms or language (Bang et al., 2017; Rosebery et al., 2016). For example, preservice elementary teachers can ask: Am I working to understand children’s sensemaking in the context of the experiences of their families? In terms of teaching moves, they can design and set up meaningful “thinking” and “doing” roles for small group work for investigations or use science identity tokens (e.g., signifying that a child was a designer, a conservationist, or even an altruist that day; Mercier & Carlone, 2021) over time to support multiple ways of being knowledge generators, doers, and critics of science. These questions and moves can help to support children’s identities as people who do science while also expanding the idea of what good science entails.

As noted in Table 2, a related way to support Approach 3 is to *accept and encourage “multiple forms of expressing sensemaking”* (NASEM, 2022, p. 26). Preservice elementary teachers can ask: How can I hear the science in what my students are saying and recognize their ideas as reasonable (Bang et al., 2017)? They can ask children to write, draw, or demonstrate their ideas, to recognize and value multiple ways of knowing. They can invite a range of ideas and experiences from students through questions and tasks (Tekkumru-Kisa et al., 2015).

Table 2 notes that supporting Approach 3 can also involve “recogniz[ing] and *build[ing] on the values and ways of knowing and being* of their children and their communities,” as well as “*support[ing] students and their families*” (NASEM, 2022, p. 26). Teachers can ask themselves: What are my school’s families and communities already doing that is science? In terms of teaching moves, they can connect and partner with children’s families and communities and recognize and build on the resources they bring, including their knowledge and practices. For example, Wright (2019) described how Black youth brought a cultural practice of wordplay into their collective science sensemaking. Preservice teachers can come to recognize such practices and learn to use them instructionally rather than shutting them down as not being scientific. They can make content meaningful to students’ lives by using students’ out-of-school knowledge and experience (e.g., a grandparent’s garden). In connecting to children’s ways of knowing within school settings, they can integrate science with other subjects, breaking down silos among school subjects and making each more authentic (Stevens et al., 2005).

Finally, supporting Approach 3, as noted in Table 2, can involve adapting curricular materials to “*address local socioecological phenomena and the needs . . . of their children’s communities*” (NASEM, 2022, p. 26). Although this connects to Approach 4 (because

responding to local needs is one way of using science in meaningful justice work), it also illustrates that science can and should be used for issues and phenomena that matter to students and their families and communities; thus, it serves to expand for them what counts as science. Preservice teachers can ask themselves how to adapt a lesson plan to connect to their community—for example, by contextualizing a commercial curricular program within a local controversy, such as a proposed new development near a local aquifer (Cody & Biggers, 2020). A teaching move that can support connecting to local phenomena is to have students take pictures of or otherwise document how they see science in their lives (Tzou & Bell, 2010).

In these ways, preservice teachers can make science more epistemologically accessible for all students and reflect a more pluralistic perspective on science (Medin & Bang, 2014).

Approach 4: Bringing Science and Justice Together

Approach 4 focuses on “seeing science . . . as a part of justice movements” (NASEM, 2022, p. 23). Preservice elementary teachers can support Approach 4, as noted in Table 2, by recognizing the connections among their *power and positionality*, science, and school (NASEM, 2022, p. 27). They can ask themselves questions such as: Do I push back on inequitable policies (e.g., a curriculum materials review process that may not take equity seriously or the development of school schedules that limit opportunities for science)? Taking action on issues like these is hard, but learning to ask the questions is an important first step in working toward justice.

As noted in Table 2 and NASEM (2022), Approach 4 also involves learning about the “*connections among a science phenomenon . . . , instances of the phenomenon . . . , and implications for communities*” and “*the connections between the natural world and human actions and decision making*” (p. 27). To provide opportunities for students to work toward justice through science, in terms of teaching moves, they could learn about “hot spots” in the science curriculum where justice connections may occur—for example, in units on the environment, health or human body systems, and engineering (Carlone & Davis, in press, p. 1). They could also learn to help students become agents of change by writing letters, inviting community leaders to the classroom, or participating in a community event, after investigating issues related to scientific justice (e.g., Calabrese Barton & Tan, 2010).

Learning to support “children to *ask and answer their own questions about community-relevant issues*” (NASEM, 2022, p. 27) provides another way to support Approach 4, shown in Table 2. This involves investigating how the need to address those issues came about and exploring “should we” questions that get at ethical dimensions (Learning in Places Collaborative, 2020). Building on and extending Approach 2’s focus on student choice, this could involve starting with issues (not just problems) that are relevant to the community and

looking for ways that science can be a tool for working on those issues. For example, one upper-elementary teacher was able to use the nearby Flint water crisis as a context for her students' learning about water quality and water access (Davis & Schaeffer, 2019).

Finally, supporting Approach 4 should involve, as noted in Table 2, supporting children in using “*historicized lenses*” for examining issues (NASEM, 2022, p. 27). For example, when examining the effects of a new neighborhood housing development, preservice teachers could encourage children to ask questions such as: Who used to be here, and who will it benefit and not benefit? Being ready for this work involves learning to remind themselves (and, carefully, support children in learning) that (a) historically, science has been the realm of White men; (b) scientific knowledge has sometimes been, and continues to be, used to subjugate people of color; and (c) adults of color have a rightful presence in science and meaningfully contribute to knowledge building in science, as do students of color (Calabrese Barton & Tan, 2020).

Together, these frames and moves help to support preservice teachers in moving beyond Approaches 1–3 and truly working toward ethical futures and thriving and liberation for all. Because some of these frames and teaching moves involve classroom norms or longer sequences of instruction and are aimed at dismantling unjust systems and policies, Approach 4 may be more challenging for a preservice elementary teacher to make visible in their instruction, particularly given the power dynamics inherent in being a guest in a mentor's classroom.

A Practical Framework for Preservice Elementary Teachers

Synthesizing the recommendations from the previous sections allowed me to develop a practical framework. The framework is intended to support preservice elementary teachers in learning to teach science more equitably. The framework (see Figure 1) provides reminders of interpretive frames that can be helpful and practical teaching moves that can support applying the four approaches to equity in one's elementary science teaching (NASEM, 2022). In my elementary science methods class, I have weaved frameworks like this into each class session. My class has a focus on three-dimensional, investigation-based science learning and sensemaking (NRC, 2012). I use color coding in the framework and where it is referenced in my class (e.g., slides and assignments) to help preservice teachers cue on the different approaches to equity.

Figure 1

Practical Framework for Working Toward Equity and Justice in Elementary Science

Note. This framework draws from ideas cited throughout this manuscript (including most notably NASEM, 2022), and also: The Culture, Learning and Identity Framework from Learning in Places; stemteachingtools.org from Philip Bell and colleagues; Culturally and Linguistically Sustaining AST Practices and Teacher Education Pedagogies from Jessica Thompson and colleagues; Social Justice Standards from Teaching Tolerance; a Next Gen Navigator Social Justice in the Science Classroom blog post by Phil Bell and Deb Morrison; the Guide for Racial Justice and Abolitionist Social and Emotional Learning from Abolitionist Teaching Network; Guide to being an Ally to Transgender and Nonbinary Youth from The Trevor Project; and input from many colleagues and former students named in the acknowledgments section.

Because of the importance of conceptualizing the educational justice issues underlying the recommendations of the framework, the framework itself should be complemented with introductory explanatory text naming and unpacking those justice issues. Such text (not recapitulated in this figure) would synthesize, in a teacher-friendly way, ideas from the second, third, and fourth paragraphs of the introduction of this paper. Feel free to contact the author at betsyd@umich.edu for a version with this text.

I introduce the justice framework on the first day of class by simply handing it out and asking the preservice teachers to read through it as homework. The next week, we begin to explore it through discussion and dialog, focusing on discussing general educational justice issues, with which my preservice teachers are already mostly familiar from previous coursework, and how they manifest in science, which is new for them. From that point forward, we use the framework during every week of the class, but we generally use it as one of several tools and not as a central focus. I have used the framework as (a) a lens, or set of considerations, for reading a lesson plan; (b) a frame for discussions of educational justice issues in elementary science; (c) an analytic tool for deciding on changes to make to an existing lesson plan; (d) a language for preservice teachers to use as they tag their own lesson plans to indicate their intended support for equity and justice; and (e) a prompt for reflection. Here, I elaborate on some of these uses.

As an example of using the framework as a lens or set of considerations for reading a lesson plan or discussing science teaching, Figure 2 shows two images of a PowerPoint slide. This slide is taken from a set of course slides used each week to connect the dimensions of the justice framework to specific work being done in class that week. In this example, the focus of the class session was on the “Engage” portion of a lesson in which a teacher provides an anchoring phenomenon or initial experience with a phenomenon and elicits students’ initial ideas. In the pop-up box, I named specific teaching moves from the justice framework that the preservice teachers might reasonably incorporate in the Engage portion of a lesson. For example, one bullet stated, “carefully consider roles,” and we discussed Mercier and Carlone’s (2021) science identity tokens and how that idea can be extended to consider expanding students’ roles in group work to promote different dimensions of their science identities. In this case, I’m highlighting how frames or moves from the framework can appear within an everyday science lesson. In other cases, the preservice teachers would generate the connections themselves.

Figure 2

Slides Showing the Basics of the Justice Framework and Specifics From That Day

Note. These slides explore using the pilot justice framework as a set of considerations for reading a lesson plan and as a frame for discussions of specific educational justice issues in elementary science and how teaching moves can help address them. The slide on the left is the standard slide used throughout the course to remind preservice teachers of the “basics” of this pilot justice framework (which used a different set of related dimensions). The slide on the right shows a pop-up of some specifics related to the day’s focus (in this case, the “Engage” element of a lesson) that are keyed and color-coded to the dimensions of the pilot framework.

In Figure 3, I provide an excerpt of an assignment, which was due at the end of the semester, requiring preservice teachers to use the framework as an analytic tool for deciding on changes to make to a lesson plan. In the assignment, preservice teachers plan, enact, and reflect on a science lesson in their field placement. As part of their lesson planning, the assignment asks them to analyze the strengths and weaknesses of the lesson plan they are using as a base and to identify changes that would address the weaknesses. In the early version of the framework referenced here (and in Figure 2), two dimensions focused on addressing low expectations and opportunity gaps and making every child a doer of science, aligning largely to Approaches 1 and 2. For each dimension, the framework included sections naming “knowledge and frames” (a more teacher-friendly label for “interpretive frames”) and “moves” (i.e., teaching moves). I also include a section on “tools, frameworks, and activities” that make specific references to experiences from our class or the program more generally. For example, I reference an instructional framework we use in our class (Davis & Marino, 2020) and a powerful TED Talk that they have viewed in an earlier teacher education course (a 2009 video from Chimamanda Ngozi Adichie).

Figure 3

Using the Pilot Justice Framework as an Analytic Tool for Deciding on Changes to Make to an Existing Lesson Plan

Justice Framework Issue 1 Addressing Low Expectations and Opportunity Gaps

Throughout the semester, preservice teachers also use the framework to annotate their own lesson plans, showing how they intend to employ justice-oriented teaching strategies. In describing their instructional sequence, they can provide color-coded tags to link to the relevant dimension of the justice framework to indicate how they see their instructional decision as reflecting ideas and recommendations in the framework.

The framework can also serve as a structure for prompts for reflection. In the final assignment described above, preservice teachers were asked to respond to the following reflection prompt regarding their lesson enactment using the video record of their enactment:

To what extent do you feel that you were teaching toward justice? Describe two instances that demonstrate either strengths or missed opportunities. Please mark these on [your video]. . . . Consider how your use of one or more elements of the Justice framework supported you in promoting equitable learning opportunities.

Along with other prompts for reflection, this prompt continues the emphasis on grappling with issues of equity and justice every time one engages in science teaching.

Podcasts and texts complement the use of the framework throughout the semester. For example, during the COVID-19 pandemic, I started using NGS Navigators podcasts (at podcasts.apple.com) in lieu of the science methods text I had used extensively pre-pandemic.

Several of these (e.g., Episodes 27 with Enrique Suárez and 60 with Bryan Brown) have been powerful in helping preservice teachers in my class grapple with issues of equity and justice.

We treat the justice framework as an organic document. Toward the end of the semester, I dedicate a class session to improving it. Preservice teachers work in groups to discuss what they want to change, elaborate on, add, or even drop based on the experiences they had across the semester and what they've learned from their teacher education coursework and experiences. Then, as a whole class, we collect ideas for changes. (For example, one semester, this generated a conversation about “niceness,” which led to an elaboration on this point in the framework.) The following week, for the final class session, I provide them with a new version of the framework that reflects their changes with their class indicated as an author. I hope this helps them feel ownership, and their input certainly helps to improve the framework's practical utility.

Although practical utility is indeed the goal, it is vital that the framework does not devolve into a simple checklist (K. Gunckel, personal communication, June 14, 2022). The interpretive frames may be crucial for helping preservice teachers use the framework as a cognitive tool (Wertsch, 1998). Such cognitive tools can provide guidance as preservice teachers internalize key ideas (Patterson Williams et al., 2020; Windschitl et al., 2018). Building the framework into the fabric of the class across the semester's experiences should also help mitigate this concern.

For the many preservice elementary teachers who are White, working to advance equity and justice in elementary science teaching requires deeply reflecting on their own positionality and interrogating their Whiteness (Thompson et al., 2020; Watts et al., 2011). For preservice teachers of color or those with greater critical consciousness, the framework may help them recognize science, specifically, as a space for justice work. For all of us, working toward justice in our teaching is a lifelong endeavor, but a framework like this may help.

Methods for a Pilot Study and Results of Using a Pilot Framework

For a pilot study in my 9-week science methods course, I asked 31 preservice teachers to use existing (primarily commercially available or open-source) lesson plans as a starting point and adapt them to better reflect ideas from the course (e.g., engaging children in science practices to explore phenomena), including the justice work, which drew on an earlier version of the framework. Thus, the data sources for this small pilot study include 31 lesson plans collected as a routine aspect of the course. After completion of the class, I coded their plans using the frames and moves embedded in the framework shown in Figure 1. Analysis simply involved developing frequency counts for the codes associated with each approach to equity.

The results show that preservice teachers certainly showed an inclination toward moves that might enhance equity and justice, but these initial attempts were more oriented toward equity than justice (see Table 3). Almost all ($n = 30$) of the participants developed lesson plans that reflected at least basic equity moves (e.g., varying the participation structures to enhance children's opportunities to learn). The teaching moves incorporated most frequently were all in the realm of Approaches 1 and 2 (enhancing opportunity, access, achievement, identity, and representation). Less often, preservice teachers incorporated moves that supported Approach 3 (expanding what counts as science) when they used a range of roles in small group work or welcomed multiple ways of expressing sensemaking.

Table 3

Equity or Justice Moves Incorporated in Lesson Plans ($n = 31$)

Equity or justice move	Frequency	Approach to equity
Varying participation structures	22	1
Being explicit about science practices (to support learners in understanding how the work they were doing was making them into what they could recognize as people who do science)	17	2
Making every child a doer of science; providing opportunities for first-hand investigation for every child	13	1
Making a connection to the real world (e.g., a cup of hot chocolate cooling down or the school garden)	11	2
Providing children multiple ways of expressing their ideas (e.g., writing or drawing) or making the lesson multimodal to support a range of ways of accessing information and making sense	8	1, 3
Constructing innovative roles for investigative groups	7	3
Providing a shared experience with a phenomenon (usually at the start of the lesson)	7	1
Supporting children's agency and choice (e.g., in terms of determining how they would record data)	4	2
Supporting children with disabilities or emergent multilingual learners through specific forms of scaffolding	3	1

I was interested in how preservice teachers supported children in developing disciplinary affinities or identities as people who do and know science. A strategy discussed briefly in class was the idea of science identity tokens (Mercier & Carlone, 2021), which the class broadened to mean offering up innovative roles for investigative group work. This is in contrast to the typical roles outlined for group members, such as timekeeper or materials

manager. This teaching move supports Approach 3 while also contributing to Approach 2 in terms of helping children see themselves in science. Seven preservice teachers used a version of this teaching move. For example, for her lesson on composting, Lissa (all names are pseudonyms) set up “doing” roles that included recorders, trash measurers, and trash sorters and “thinking” roles that included questioners, collaborators, illustrators, and idea recorders. Luna used the roles of designers, writers, and connectors. Two others assigned the same “thinking” roles to everyone: team collaborators or innovative thinkers. These examples, and others, showed some initial uptake of a teaching move that could support a more just classroom with a more expansive view of what counts as and what matters in science—that science is more than managing materials and keeping time and that it centers on sensemaking not on compliance and completing school tasks.

In sum, this analysis shows that preservice teachers could readily incorporate some important equity-oriented teaching moves. Mostly, they focused on moves they might find more accessible as novices, such as varying participation structures or making connections to everyday phenomena. None of the participants incorporated moves supporting Approach 4, which likely would demand more extensive and focused support than I provided and may also be difficult to see within a single lesson plan, as noted above. Nonetheless, this analysis shows an example of what is possible: Preservice teachers were able to work on Approaches 1 and 2 with some ease, and a few took up teaching moves that focused on Approach 3.

Conclusion & Implications

The framework presented here requires further testing and refinement. I hypothesize that organizing a practical equity and justice framework around the four approaches will help preservice teachers push themselves toward the more sophisticated approaches (Approaches 3 and 4). That said, teacher educators need examples from the classroom, particularly of Approach 4, to help preservice teachers see what “seeing science . . . as a part of justice movements” (NASEM, 2022, p. 23) can look like at the elementary level. We also need curriculum materials that support both Approaches 3 and 4 to support novices (as well as experienced teachers) in doing this challenging work. Finally, further scholarship is needed to learn more about how to support preservice teachers in working toward justice in their elementary science instruction and seeing science as a place where justice work can happen. Excellent studies exist (e.g., Bottoms et al., 2015; Chen & Mensah, 2018; Hernandez & Shroyer, 2017; McLaughlin & Calabrese Barton, 2013; Mensah & Jackson, 2018; Settlage, 2011; Thompson et al., 2020), though a literature review found that a strong focus on equity remains largely absent in most of the scholarship in elementary science teacher education (Davis & Haverly, 2022). Making further progress is imperative for moving closer to an equitable and just world in which science supports community needs and every child can see themselves as someone who does science.

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