International Society of the Learning Sciences

A Core Set of Practices for Justice-Centered Ambitious Science

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Abstract: Core teaching practices, consisting of strategies, routines, and tools, are effective supports for teachers in developing competence with pedagogical practice that centers collaborative student sensemaking with disciplinary ideas and practices. Though these practices can nurture diverse students' access, achievement, and identities in science, they stop short of meeting more critical demands of equity, namely that of challenging and expanding what counts as science and using science as part of social justice movements. The Justice-Centered Ambitious Science Teaching framework presented below was empirically developed yet theoretically aligned with the current priorities related to justice-centered teaching. This framework offers teachers core practices as scaffolds for centering justice in planning and instruction for science learning.

Urgent need for centering justice in science education

The time to address the "United States' legacy of institutional neglect and lack of care for the lives of Black" and other marginalized youth is long overdue (deRoyston, et al., 2017, p.1). While the Next Generation Science Standards (NGSS) promises more rigorous understanding, achievement, increased interest, and identity development, all important equity goals, the focus falls short in justice aims that transform a discriminatory system (Philip & Azevedo, 2017). Addressing the urgent need to center justice, we seek to expand what counts as science and engineering and to recognize the roles science and engineering can play as part of justice movements. While they offer the potential for troubling white hegemonic versions of Western/Eurocentric science, these two equity goals have largely gone unmet. Though 44 states have adopted the NGSS or similar standards and are, in some ways, making progress in increasing access to high-quality instruction, only a limited amount of attention and resources are available for addressing more pressing societal challenges attributable to a systemically racist system (e.g., Learning in Places, 2021). If we are to meet the more pressing needs and challenges of today and the future in ways that are just and address historical and ongoing systems of oppression, frameworks like the JuST framework propose here are needed to support teachers and learners.

The justice-centered ambitious science teaching (JuST) framework

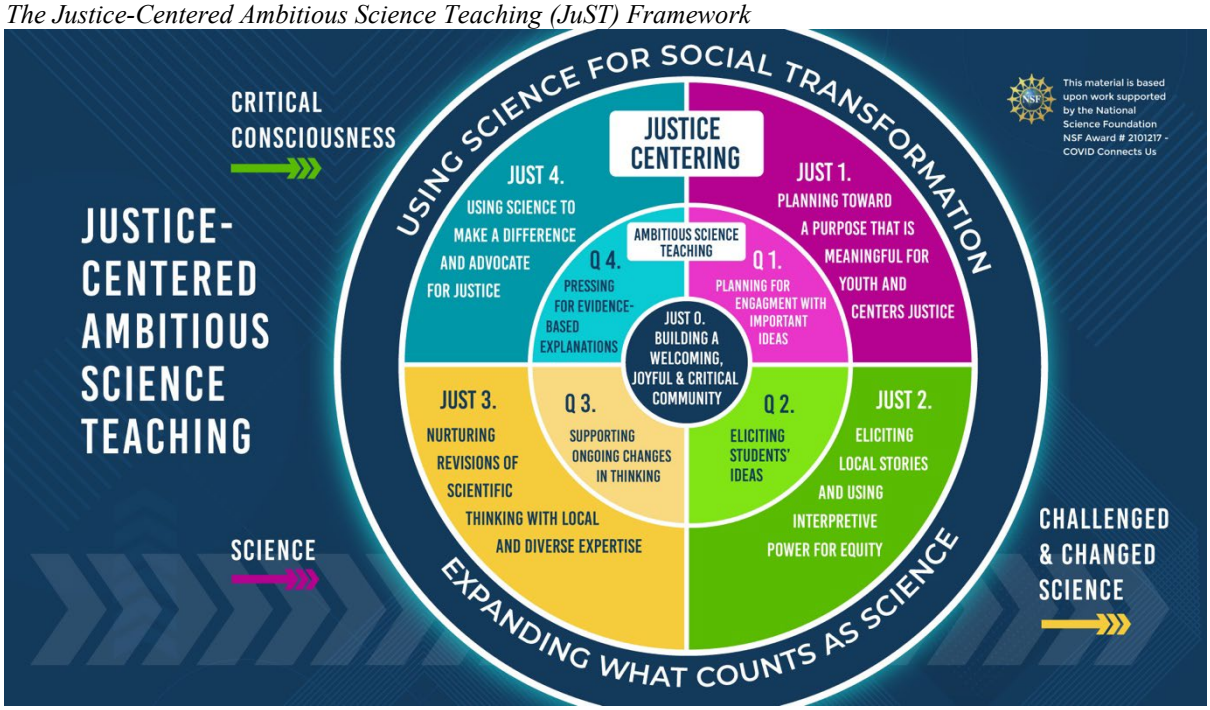
Decades of researchers have theorized what it means to teach in justice-centered ways (e.g. Ladson-Billings, 1995), yet there is a lack of concrete practices for teachers to try out, practice, and adapt within the particular contexts of their classrooms. The JuST framework we are proposing addresses this need by identifying core practices that meet the varied and more critical demands of equitable science teaching. Philip and Azevedo (2017) offer language to distinguish between justice work that aims to make science teaching and learning inclusive for all students (equity discourses 1 and 2) versus that which challenges and transforms the discipline of science, science classrooms, and society (equity discourses 3 and 4). It is within equity discourses 3 and 4 that teachers challenge the dominant paradigm. Building on the Ambitious Science Teaching framework (AST) (Windschitl et al., 2018), which focuses on equity discourses 1 and 2, we offer the JuST framework as a set of practices to guide teachers in developing a justice-centered and ambitious science teaching repertoire of practice.

The JuST Framework consists of four quadrants, a center, and a foundation focusing on teachers' needed background and development (see Figure 1). The top hemisphere of the JuST Framework focuses primarily on Philip and Azevedo's (2017) equity discourse 4, as teachers plan for and enact science learning that students use to make a positive difference in their communities as a way to enact social transformation. The lower hemisphere addresses equity discourse 3, where teachers challenge and expand dominant discourses in the discipline of science. Using AST's existing four quadrants of planning, eliciting ideas, revising thinking over time, and pressing for evidence-based explanations, the JuST Framework further shapes what the teacher is doing to expand and honor diverse sensemaking repertoires as a way to reorient the ultimate aims of science teaching and learning. Notably, enacting the JuST framework requires teachers to develop their own critical consciousness and create a classroom environment that is welcoming, joyful, and critical. These practices extend the purpose of science

education beyond the accountability measures of a classroom, erasing the need for students to plead for answers to the age-old question, "Why do we have to learn this?" Science and science education can and needs to matter to students (Kang & Nation, 2023).

Figure 1

The Justice-Centered Ambitious Science Teaching (JuST) Framework



JuST 1: Planning toward a purpose that is meaningful for youth and centers justice

The first quadrant of the framework calls for centering justice when planning for engagement with ideas. JuST 1 extends planning to be "meaningful" to youth, requiring planning to extend outside of the classroom and into the local and global community. As learners of local culture, teachers invest time and energy in and with community, conceptualized here as the lived experiences of the students in their classes (Ladson-Billings, 1995). Morrales-Doyle (2017) highlights the value of partnering with community members to identify relevant social justice science issue (SJSI), and Freire (1970) recommended that educators be critically aware of the issues impacting learners. Choosing phenomena that are local and/or current may require teachers to develop additional content knowledge as well as social and historical understanding related to community context. Drawing on AST's emphasis on a gapless causal explanation, JuST 1 requires that teachers supplement their scientific understanding with social and historical knowledge. For example, Crabtree and Stephan (2022) describe professional development that engaged teachers in a local, historical phenomenon connecting pellagra disease to epigenetics and environmental justice.

When teachers are well-versed in their students' cultures, they can choose anchoring phenomena that invite students to act. A meaningful and relevant phenomenon can provide a backdrop for students to see how science can be applied to issues that students care about (Kang & Nation, 2023; Morales-Doyle, 2017; Philip & Azevedo, 2017). Mensah (2011) described an elementary class where preservice teachers taught a unit about air pollution and health. This focus resulted in students brainstorming ideas to reduce emissions and making posters to communicate the importance of this local problem.

JuST 2: Eliciting local stories and using interpretive power for equity

Expanding AST 2, which focuses on eliciting students' ideas, JuST 2 calls for drawing out students' science experiences as they relate to their cultures and communities. These connections can help to broaden normative ways of thinking about science, inviting typically excluded from knowing and doing science because of marginalized identities while also benefiting science (Lee et al., 2014). To elicit non-dominant ways of thinking about science in the classroom (e.g. through storytelling) teachers need to use their interpretive power (Roseberry et al., 2016) to make space for unexpected as well as expected contributions as worthy and worthwhile.

JuST 2 encourages teachers to use student and community stories as data for scientific sensemaking, challenging the Eurocentric nature of science. Local stories can help students connect their personal experiences with other types of scientific data, increasing their interest, deepening their understanding, and ultimately unsettling limiting and exclusive discourses in science. JuST 2 prioritizes elevating experiences from students from minoritized groups when adapting future instruction to nurture cultural plurality for all students (Paris & Alim, 2017), expanding the AST 2 practice of adapting instruction based on students' science ideas. Listening deeply to students' sense-making allows teachers to identify access points for all students, especially those from marginalized communities. For example, in response to a teacher request to name examples of weathering they see in their lives, students complained about the sidewalks outside their school, stating that it showed that their district did not care to make their school look nice.

JuST 3: Nurturing revisions of scientific thinking with local and diverse expertise

JuST 3 builds on the practices of AST related to supporting students in revising their thinking over time using intentionally more contextualized engagement with science. Seeking out non-traditional forms of expertise relevant to science from students' families or broader communities offers youth a new, asset-based lens on the familiar, which can nurture a sense of local pride for both students and community members whose expertise is legitimized as scientifically valuable (Luehmann, 2007; Luehmann et al., 2024). As well, contesting Western/Eurocentric notions of expertise as decontextualized and detached from context helps attend to positioning, power, and privilege in decision-making. As an example, a local farmer can offer powerful insights into pollination.

As students are introduced to new scientific ideas, JuST 3 highlights the value of re-embedding these ideas in the historical and situated nature of these scientific discoveries. This context invites more accurate and critical considerations of the situated nature of the discipline. Understanding that science is not divorced from the culture surrounding it at the time of discovery can nurture healthy skepticism about the role that inequitable systems play in science and can thus challenge deficit views of such outcomes such as lack of representation in science (Crabtree & Stephan, 2022).

JuST 3 also calls out the need to honor and encourage translanguaging in sensemaking (Suárez & Otero, 2023). In a recent study, a migrant farm worker and a science camper who share the same primary language of Spanish engaged in animated discussions of soil health and care using gestures, Spanish, and some English. Though most of the camper's team and leaders did not share this rich multilingual expertise, the camper shared what he learned, and the science and scientists benefited (Luehmann et al., 2024). When justice is centered, cultural plurality is honored as an important outcome of its own (Paris & Alim, 2017). Thus, JuST teachers invite and employ all of the students' linguistic tools, as well as cultural community resources for both sensemaking and action-taking (Tan & Barton, 2023).

JuST 4: Using science to make a difference and advocate for justice

Including and expanding on the last ambitious science teaching set of core practices, pressing for evidence-based explanations, JuST 4 involves using scientific explanations for a purpose. Teachers are encouraged to consider authentic summative assessments that position students as transformative intellectuals related to social justice science issues (Morelas-Doyle, 2017). Authentic SJSI assessments engage learners in activities beyond academic formats. Examples include students employing their knowledge about COVID-19 transmission to create a plan to safely reopen their school (Luehmann, et al., 2020). Authentic assessments can also involve students communicating their science to audiences that can include friends, family members, politicians or others who matter to them, nurturing science identities while also pressing students to author implications of their learning and potentially acting on them (Luehmann et al., 2024). In this manner, students act as knowledge producers who contribute to the narratives of local networks and have an opportunity to "reflect on their agency to impact issues in their community and in the broader world" (Morrales-Doyle, 2017, p. 1055). JuST 4 challenges teachers to surface the role science plays in social justice issues and justice plays in science issues. It is worth noting that rather than start with the science and look for ways science can be used as a remedy to social justice issues, JuST explores how social movements intersect with everyday science, and reveals the role science learning plays in social change (Philip & Azevedo, 2017). In our work, a teacher worked with her students to explore tree equity issues in a local area, and students learned about the role science can play in the advancement of social transformations, namely arguing for more equitable access to trees in urban communities.

JuST 0: Building a welcoming, joy-filled, and critical science community

Missing from AST, but necessary for the work described in JuST 1 through 4 is an intentional focus on the classroom community. JuST practice represents a dramatic shift from what typically happens in classrooms. Inviting students to share and build on their cultural backgrounds and use unique sensemaking repertoires requires

them to trust that these contributions will not be harmfully used against them. Working together to reconfigure interactions and flatten power hierarchies requires classrooms to work as a community of learners in ways likely unfamiliar and potentially unnerving. Thus JuST 0 serves as the core of the framework.

JuST 0 prioritizes nurturing relationships where students feel cared for as a necessary precursor for classroom communities to engage in explicitly anti-oppressive work (Darling-Hammond, 2017). JuST 0 involves exposing the role of power and the presence of injustices in the ways classrooms work together, in the socio-historical aspects of science as a discourse, and in the challenges that science is used to address. Finally, JuST 0 welcomes and nurtures the expressions of emotions, especially joy, in the classroom. Emotions are resources youth use to engage in scientific reasoning. More importantly, Griffith (2013) highlights the connections between joy and pedagogical relationships.

Significance

Centering justice in science education requires a paradigm shift for many teachers. Ensuring that our most vulnerable students see themselves in the practices and purposes of science requires importantly different investments by teachers at each stage of practice. The JuST Framework is offered as a means to draw together the value of AST as core practices with the theoretical clarity and urgency of the literature on justice-centering in (science) education, offering teachers explicit scaffolds for this challenging but necessary work.

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Acknowledgments

This work was funded by the National Science Foundation, grant number 210217.