

HOW SCIENCE TEACHERS CAN EXPLORE SOCIAL JUSTICE WITH STUDENTS

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What is the role of social justice in science education? How can engaging with justice issues empower student learning, especially for learners who come from communities that have been traditionally excluded from science learning and careers?

"There is a need to prepare teachers and students for the new roles that they must play... Our vision of schooling, and by extension science education, is more aligned with participatory democracy where citizens actively collaborate... for future generations."—Mike Mueller.

"...this program made me feel that I belonged in the school, that I made a change, so I had to go to school, 'cause it helped me and it helped the school a lot."—Fatima, an elementary student who did 'action research' in school.

As our world continues to change along multiple dimensions (social, political, ecological, medical, digital, and economic), it is increasingly important for science teachers to provide students with the skills, knowledge, and opportunities to apply their learning to the increasingly complex world around them. This is

especially important for students who come from communities (like immigrant or ethnic minority communities) or backgrounds (like those who come from low-resource schools and neighbourhoods) that have been traditionally excluded from mainstream science learning and science careers. Science teachers who engage with the ethical, historical, cultural, and sociopolitical dimensions of scientific phenomena can empower their students with the agency and tools to confidently meet the challenges of the present and the future in ways that are important to them. One way in which they do this is through social justice-oriented science education.

Social justice-oriented science education

Science teachers who work for social justice use their teaching practice as a

tool of academic, social, and political empowerment for their students.

They teach their students how to navigate issues and challenges that involve science knowledge and practices as well as critically question or examine related social and political factors (see Fig. 1). Many teachers may already be navigating such issues, for example, in debating and deciding on family medical treatments, choosing meal ingredients to balance nutritional benefits and financial budgets, and questioning the environmental effects of governmental and corporate policies. Those who offer students the opportunity to engage with such issues recognize their learners as being whole people growing up in a complex world. Considering questions of social justice, such as the unfair costs of medical care, different food access problems in different neighbourhoods, governmental subsidies for corporations that produce toxic pollutants, etc., allows students to develop a critical perspective on the world and a sense of civic agency.

These teachers also help students see and use science as a tool for positive change. They encourage students to work in partnership with others to take actions that are directed towards making the world a fairer and more just place for everyone. The shared desire to make a specific positive change as a class can motivate student content learning. It activates their ownership (and not just absorption) of content to act themselves and/or to convince others in positions of power to create positive change. For example, families in my 2020 United States (US) study used World Health Organization (WHO) data sets and advice from nurses and relatives to collectively critique misleading statements made by their country's leaders about the COVID-19 pandemic. In Natalie Davis and Janelle Schaeffer's 2019 study, students learning about water developed epistemic agency and practised leadership skills when their teacher Janelle invited them to debate the public responsibilities and human



Fig. 1. Science education and social justice. An illustration capturing the idea of justice-centred science education as a unified whole that emerges from the development of healthy communities, open sharing of information and resources, and ecological restoration.

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rights dimensions of a regional water crisis. Similarly, in Kathleen Arada's 2023 study, students learning about artificial intelligence (AI) detection technology for skin cancer, critically considered the technology's failures with darker skin tones. This supported rigorous and reflective annotations of research articles about it.

These teachers make the science classroom a place where students can build skills and use knowledge in ways that mirror and/or speak back to what the real world already asks of them (and will continue to ask of them in the future). Such classrooms also give students the chance to practise enacting their agency under the guidance of supportive teachers before they independently enter that world of complexity and continual change.

What does the research say?

How do science teachers make science matter for their students? How do they provide students with leadership tools to take educated and meaningful

action with science? Teachers can meet this goal by experimenting with different ways to integrate social justice with their everyday science classroom practice. In one example, Professor Alexandra Schindel Dimick studied how Mr Carson, a high school science teacher, introduced social justice issues to his environmental science class.

Mr Carson presented his students with a local environmental problem—pollution and low water quality in a river that was a couple of kilometres from the school. The unit began with a class trip to the river. As students paddled canoes down the river, they noticed that its waters were dark, opaque, muddy and had a lot of floating garbage. They learned about pollutants in the water by collecting water samples and analysing their chemistry through lab experiments. Mr Carson taught them about the acidity levels, nutrient types and levels, and the human uses of water. Students summarized their science content learning on large poster papers and then took notes on their peers' posters. Finally, they completed group projects

to raise public awareness about their local waterfront environment. These projects took many forms, including a music video, a mixtape, and a public river clean-up.

In her observations of these classes and interviews with students, Alexandra found that they felt empowered when learning was directed towards co-determined justice goals. Science for these students was not a list of facts, but an important aspect of their developing relationship with the world. Mr Carson explained: "... [the students] are feeling empowered to change something that affects them and they are not depending on other people to make the change. They are the ones who are being affected; they are the ones that are trying to make the change".

However, not all of Mr Carson's students felt that their projects were a complete success. Alexandra explained that social justice-oriented science education is more successful when it empowers students socially, politically and academically. Students experienced disappointment when they did not feel supported in all three ways.

How can teachers become social justice science teachers?

What do we know about exploring social justice issues in science classrooms? Here are three actions that can help teachers teach science for social justice:

Guide 1: Support student agency and collaborative understandings (the social component)—After supporting whole-group discussions and lab activities about the water quality of the river they visited, Mr Carson asked students to vote on ideas for action before creating next-step plans. The teacher in the 2019 study, Ms Janelle, also incorporated a class trip to a river near school. The class then read news articles about a dangerous water crisis in a town one hour away from them. In a passionate whole-group

reflection on the social and political dimensions of the problem, Ms Janelle's students shared their emotional as well as scientific understanding, with statements like "that's not fair", and "[the governor] is trying to be a jerk".

How to implement: Build a culture of open conversations with students that encourage them to share not only their intellectual selves, but also their their emotional and social selves. Allow students to raise questions as well as share thoughts and stories that help them to connect to the class topic. Remind them to respect their peers' perspectives and experiences too. Give them opportunities to practise healthy collective sensemaking, including intellectual teamwork and compromise, within a supportive structure of group social expectations (see Fig. 2). One extra tip: it helps to invite students to co-determine a set of group social expectations in partnership with you at

the beginning of each school year and to remind students of these co-determined expectations at the beginning of each unit. Some examples of such decisions are: "If group decisions are difficult, we will vote" and "We will respect our peers' emotional perspectives". When I do this as a teacher, I always include some of my own expectations of students and I ask them to include their expectations of me.

Guide 2: Prepare students to plan and take action (the political component)—Mr Carson's class created a music video, a mixtape recording, and a public clean-up event to raise public awareness of a local environmental injustice. Ms Janelle's class created posters to educate their broader school community about an environmental injustice happening in a town an hour away. One quarantined learner in my 2020 study made a social media support group to share mental health information and to deliver



Fig. 2. Participatory engagement in a classroom context.

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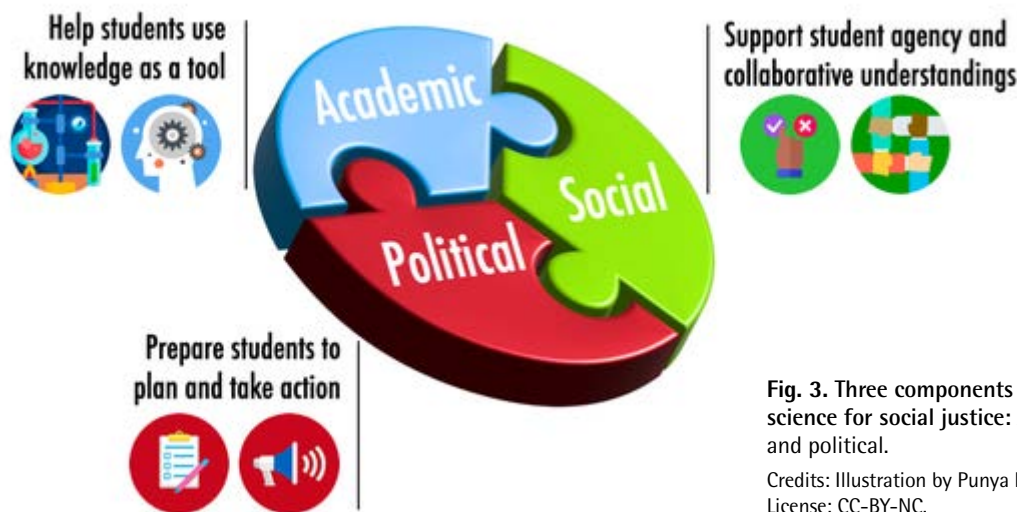


Fig. 3. Three components of teaching science for social justice: Academic, social, and political.

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messages of emotional support to peers who were experiencing COVID-19-related depression and anxiety. All of these are examples of how scientific and political learning informed the planning and implementation of actions to address injustice.

How to implement: Be an active part of student interactions and support them in choosing actions that create the kind of change that matters to them and their communities. Discuss the potential impacts of individual and collective actions; and help them to critically question structures of power in science practice and/or science policy that cause pain to people or contribute to the destruction of environmental systems. Help them discover the 'root causes of problems'—these often relate to social injustice, but can, in some ways, be better understood through scientific investigation. For example, science teachers could support their students by asking: how do a local school building's power outage problems relate to political debates on education budget proposals? Who profits from the use of coal energy and mining? How have the contributions of women to computer science been neglected in the histories of computing?

Guide 3: Help students use knowledge as a tool (the academic component)— Student empowerment can align with science education when social justice is the goal and science (knowledge and practice) is the tool. For students to feel empowered, teachers must actively facilitate student leadership experiences and provide supportive resources and information. But it is not enough to give students the opportunity to lead—science teachers must also provide students with the scientific skills and knowledge to take the action that they desire.

How to implement: Help students learn about how the actions they want to take can be supported with science learning and practice. Once they have a big goal in mind, help them break it down into smaller, more accessible goals. Have students lead a discussion together about what scientific information and skills they will need to learn to reach each smaller goal. As they achieve the small goals, continually check in with them to support their step-by-step progress. At the same time, help them see and take pride in how their repertoire of knowledge and skills grows in size and depth.

Parting thoughts

Social justice-oriented science teachers empower their students with opportunities to use science as a tool to solve real problems that affect them as well as the people and surroundings they love and depend on. Such teachers offer support and resources for students to use their understanding of science to combine their social, political, and academic growth towards taking action for social justice (see Fig. 3). However, this requires more than simply giving students permission to be powerful actors. Teachers need to continue supporting students as they take each step towards addressing bigger and more complex issues with their (scientific, social, and political) knowledge and tools.

Finally, social justice-oriented science teachers always begin with respect for their students' intellects, personalities, identities, cultures, families, and communities. They see their students' backgrounds, histories, and personal stories as resources to empower shared learning for everyone in the classroom. Other researchers and I have begun to describe this approach in general as 'justice-centered pedagogy'.

Research to Practice

MAPPING SOCIAL JUSTICE TO THE SCIENCE CURRICULUM

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Education either functions as an instrument which is used to facilitate the integration of the younger generation into the logic of the present system and bring about conformity or it becomes the practice of freedom, the means by which men and women deal critically and creatively with reality and discover how to participate in the transformation of their world.”

– Paulo Freire.

The United Nations defines social justice as: “*the fair and compassionate distribution of the fruits of economic growth.*”¹ The underlying principles of social justice include fairness, equity, equality, diversity, and human rights. This manifests in our lives when we remove barriers of gender, caste, class, race, ethnicity, religion, geography, or disability. In the article ‘Why science teachers should care about social justice’, Day Greenberg suggests that teachers can use science knowledge and skills to make the world fairer and more just by integrating social justice into their classroom practice. How can teachers do this?

Science allows us to understand the world around us, the interconnectedness of all life and the state of the Earth. Any activity that impacts the environment, impacts the life of the humans (and other life-forms) who live there. Scientific knowledge and skills help us examine and understand the nature and magnitude of this impact and arrive at ways to mitigate or adapt to these impacts. However, all people do not have equal access to the necessary knowledge, technology, economic means, social and community support systems. This is when an environmental issue becomes a social justice issue.

Here are some topics from the National Council of Educational Research and Training (NCERT) middle school science syllabus that offer possibilities for students to examine social justice issues:

Grade	Topics in the NCERT textbook	Possible activities or projects
VI	Components of food, deficiency, and diseases	Students could investigate the most common deficiencies and diseases prevalent in their family, school, and community and explore their underlying causes. To support this, teachers could facilitate conversations between students and medical practitioners, nutritionists, food scientists, public health or community health professionals, or health workers in anganwadis or balwadis.

Grade	Topics in the NCERT textbook	Possible activities or projects
VI	Separation techniques	Students could investigate food adulteration and work on a project to communicate this to others as a way of spreading awareness. To support this, teachers could encourage students to apply their knowledge and skills of separation techniques (to any edible oil—coconut, mustard, or groundnut) and understanding of chemical changes (like those in milk and milk products, spices). Teachers and students may find this manual of test methods useful: https://www.fssai.gov.in/upload/uploadfiles/files/Manual_Methods_Testing_Adulterants_18_10_2019.pdf/ .
VI	Physical and chemical changes	To design the awareness programme, data on the current level of awareness among their families, friends, schoolmates, teachers, and other staff in the school, as well as nearby restaurants or dhabas could be collected through a questionnaire-based survey. This could be used to teach and build science communication skills for specific target audiences.
VII	Heat	Students could explore the topic of heat in the context of temperature changes over time in their area. This resource from the Palluyir Trust may be useful in developing activities or projects: https://palluyirtrust.org/download/heat-why-is-it-getting-hotter/ .
VIII	Air pollution	Students could investigate air pollution in their area: What are the main pollutants in their area? Who gets most affected by these pollutants and why? What knowledge and skills from their science classroom can they use to learn about the level of air pollution in their area, the health effects of these pollutants, and ways of mitigating it? Who can students talk to in their ward, municipality, or corporation to learn more about how the level of pollution is measured and how it is being addressed?

Grade	Topics in the NCERT textbook	Possible activities or projects
VII and VIII	Waste management	Students could investigate waste management in their area. This resource from the Palluyir Trust could help design activities and projects around this topic: https://palluyirtrust.org/download/consumption-and-climate/ .
VIII	Force	Students could explore the topic of force through an investigation of the Silkyara tunnel collapse in Uttarakhand.
VIII	Crop production and management	Students could investigate the effect of: (a) Synthetic fertilizers and pesticides on the health of farmers in their area. Stories like these could be used to connect the syllabus to real-life situations: https://ruralindiaonline.org/en/articles/the-soil-does-not-need-poison-to-kill-pests/ ; and https://ruralindiaonline.org/en/articles/pomegranates-are-losing-their-shine/ . (b) Natural phenomena such as lightning. Why does lightning strike kill people working in fields?
VIII	Microorganisms: Friend and foe	Students could investigate the most common infectious diseases prevalent in their area. What are the main causes of these diseases? Who is most likely to fall sick from these diseases and why? For example, is the likelihood of catching these infections related to their age, gender, where they live, access to clean water, sanitation, and healthcare? How do they treat their illness? For example, do they go to a registered medical doctor or do they try other methods and what might these be?

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Key takeaways

- Social justice science education can be integrated into every type of science classroom where teachers respect students' abilities to make change in the world.
- It is helpful to begin with very local or familiar contexts of scientific issues (social, political, environmental, industrial, residential, cultural, etc.). Teachers can choose such issues, research their local contexts, and introduce them to students. Or they can ask students to share issues that are already important to them and their communities. Once a relevant local issue has been identified, teachers can listen to and incorporate related perspectives and experiences of students (and their families).
- Students want to feel supported by their teachers as they explore how to confront and address the social justice dimensions of complex scientific phenomena. This support includes sharing helpful relevant content knowledge, providing opportunities to practise new relevant skills, and facilitating access to necessary resources to complete desired justice-oriented science learning and projects.



Notes:

1. This article was first published in *iwonder...*, February 2017, pp. 70-73. The original draft can be found here: <https://publications.azimpremjiuniversity.edu.in/1270/>. The version included in this issue has been reviewed and modified for school teachers. It includes new material and one teacher's guide.
2. The original version of this draft was edited by Dr. Punya Mishra (email: punya.mishra@asu.edu; web: punyamishra.com), who works as an Associate Dean of Scholarship & Innovation at The Mary Lou Fulton Teachers College, Arizona State University, and Dr. Angela Calabrese Barton (email: acb@msu.edu; web: barton.wiki.educ.msu.edu), who works as a Professor in the College of Education, Michigan State University. The version included in this issue has been reviewed by Dr. Punya Mishra.
3. Credits for the image used in the background of the article title: Cudrefin-justice, Roland Zumbuehl, Wikimedia Commons. URL: <https://commons.wikimedia.org/wiki/File:Cudrefin-justice.jpg>. License: CC-BY-SA.

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