INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES

Vol 16, Issue 11, (2026) E-ISSN: 2222-6990

Integrating Environmental Justice into Secondary Science Education: A Systematic Literature Review (2016–2026)

Zhao Zhifeng, Chuzairy Hanri

Faculty of Educational Sciences and Technology, Universiti Teknologi Malaysia, Malaysia

Email: zhifeng@graduate.utm.my

Corresponding Author Email: chuzairy@utm.my

DOI Link: http://dx.doi.org/10.6007/IJARBSS/v16-i11/29282

Published Date: 12 November 2026

Abstract

Environmental justice connects science learning with questions of fairness. This systematic review examined how environmental justice has been integrated into secondary science education, which dimensions of justice the teaching addressed and what student outcomes were reported. Following PRISMA 2020, Scopus and Web of Science were searched for English-language empirical journal articles published from 2016 to October 2026. Twelve reports of 11 studies were included, two of them as boundary cases. Place- and community-based learning was the most common approach, followed by socio-scientific issues, inquiry and citizen science, project-based learning and online modules. Distributive justice was explicit in 10 studies, procedural justice in four and recognition justice in six. Cognitive, affective and behavioural or civic evidence appeared in 10, 11 and 10 reports. Most of this evidence was qualitative or self-reported. Only two studies reported significant pre-post test gains, and neither used a control group. Quality appraisal found incomplete quantitative outcome data and weak control of confounding. Ten studies were conducted in the United States. The review offers an analytical framework that links pedagogical approaches, justice dimensions and outcome domains. Future research should move beyond the United States and measure scientific literacy and civic participation with validated instruments.

Keywords Environmental Justice, Secondary Science Education, Pedagogical Approaches, Student Learning Outcomes, Systematic Literature Review

Introduction

Background

Environmental problems such as water pollution, air pollution and toxic waste affect the daily lives of young people. Science education is expected to help students understand these problems and respond to them. Target 4.7 of the Sustainable Development Goals calls for education that promotes sustainable development and human rights (United Nations, 2015).

The OECD (2019) defines scientific literacy as the ability to engage with science-related issues, and with the ideas of science, as a reflective citizen.

In secondary science, environmental topics are often taught as technical problems. Lessons explain how pollutants form and how they can be removed. They seldom ask who lives near the sources of pollution or who decides where those sources are placed. In the United States, Morales-Doyle (2017) proposed justice-centred science pedagogy to address the inequities that conventional science teaching leaves untouched. The same gap is visible elsewhere. Learners in Peru and Uganda reported that the notion of justice was largely absent from their school environmental education (Wilder, Nuwategeka, Monge, & Bazan Talavera, 2024).

Environmental Justice and Its Relevance to Science Education

Environmental justice refers to the fair distribution of environmental burdens and benefits across social groups. Research in this field has shown that pollution and environmental hazards often fall on low-income communities and communities of colour (Bullard, 2005). Schlosberg (2004, 2007) argued that environmental justice also has procedural and recognition dimensions. Procedural justice concerns fair participation in environmental decisions. Recognition justice concerns respect for the identities, histories and knowledge of affected groups. This review uses these three dimensions as its analytical lens.

Environmental justice suits science education for two reasons. It links scientific concepts, such as the chemistry of pollutants and exposure, to real problems in students' communities. It also asks students to use evidence when they discuss fairness and decision-making. Several approaches support this kind of teaching. Socio-scientific issues teaching engages students in reasoning about contested issues that involve science (Zeidler, Sadler, Simmons, & Howes, 2005). Place-based education connects learning to students' local environments, and its critical form adds questions of power (Gruenewald, 2003). Justice-centred science pedagogy organises science teaching around social and environmental justice issues identified by communities (Morales-Doyle, 2017).

Research Gap

Empirical studies on environmental justice in secondary science have appeared over the past decade. They are spread across journals in science education, environmental education and STEM education. They also differ in setting, pedagogy and the outcomes they report. Some studies took place in chemistry classrooms (Morales-Doyle, 2017), while others took place in community programmes (Schneller et al., 2022). This variety makes it difficult for teachers and curriculum designers to see what has been done and what it has achieved.

Two reviews have covered related ground. Guevara-Herrero, Bravo-Torija, and Pérez-Martín (2024) reviewed educational practice in early childhood, primary and teacher education. Miles, Schindel, Haq, and Aziz (2025) reviewed environmental justice education from primary to post-secondary level, and some of their studies also appear here. The contribution of this review is a focused synthesis of secondary science education. It separates pedagogical approaches, the three justice dimensions and the type and strength of outcome evidence. This separation lets teachers compare instructional choices without treating every reported outcome as evidence of effectiveness.

Motivation for the Review

Three considerations motivated this review. The academic consideration is the gap described above. The studies exist, but no synthesis has separated what was taught, which dimensions of justice were addressed and how strong the outcome evidence is for secondary science.

The theoretical consideration concerns how environmental justice is understood. Schlosberg (2004, 2007) showed that justice involves procedure and recognition as well as distribution. Science lessons can present pollution as a question of who is exposed and stop there. Whether science teaching reaches the other two dimensions is an open question that a three-dimensional lens can answer. The review also examines a central claim of justice-centred science pedagogy, that justice goals and canonical science learning can be pursued together (Morales-Doyle, 2017).

The practical consideration comes from curriculum work. Target 4.7 of the Sustainable Development Goals asks schools to teach for sustainability and human rights (United Nations, 2015). National standards are adding local environmental tasks, such as the water quality practice in the Chinese chemistry standards (Ministry of Education, 2022). Teachers who want to add a justice perspective to such tasks need to know which approaches have been tried and what they produced.

Purpose and Research Questions

This review aims to synthesise empirical research on environmental justice in secondary science education published between 2016 and 2026. The main question is how environmental justice has been integrated into secondary science education and what student learning outcomes have been reported. Three research questions guide the review.

RQ1. What pedagogical approaches have been used to integrate environmental justice into secondary science education?

RQ2. Which dimensions of environmental justice do these approaches address?

RQ3. What student learning outcomes have been reported in these studies, and how strong is the supporting evidence?

Significance of the Review

This review makes three contributions. Theoretically, it applies the three dimensions of environmental justice to organise a scattered body of research. Practically, it gives teachers evidence on how environmental justice can be taught in science and what outcomes can be expected. For policy, it informs curriculum developers who wish to include justice and sustainability in science standards. This includes those working on units about water and pollution in China (Ministry of Education, 2022).

Methodology

Research Design

This study adopted a systematic literature review (SLR) design. The review was reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement (Page et al., 2021). The review followed five steps. These were formulating the review question, searching the databases, screening the records, extracting and appraising the data, and synthesising the findings. The included studies differed in design,

setting and outcome measures, and most of them used qualitative methods. For this reason, a narrative synthesis was used instead of a meta-analysis.

Formulation of the Review Question

The review question was developed with the PICo framework (Lockwood, Munn, & Porritt, 2015). PICo stands for Population, Phenomenon of Interest and Context, and it is suited to reviews that include qualitative evidence. In this review, the population was secondary school students. The phenomenon of interest was instruction that explicitly integrates environmental justice. The context was science education in school or out-of-school settings (Table 1). Each element formed one concept block in the search strings.

Table 1
Formulation of the Review Question Using the PICo Framework

Element	Description	Application in this review
P	Population	Secondary school students (lower and upper secondary, aged approximately 11 to 18)
I	Phenomenon of interest	Instruction that explicitly integrates environmental justice (EJ), meaning the fair distribution of environmental burdens and benefits, and fair participation and recognition in environmental decision-making
Co	Context	Science education, including chemistry, biology, physics, environmental science and integrated STEM, in school-based or out-of-school settings

Identification

Two databases were searched. These were Scopus and the Web of Science (WoS) Core Collection. Both databases index peer-reviewed journals in education and the social sciences. Both also support advanced searches with field codes and Boolean operators, which allows the searches to be repeated. The search covered articles published from January 2016 to the search date of 21 October 2026. The starting year was chosen because the Sustainable Development Goals were adopted in 2015. Target 4.7 of these goals calls on education to prepare learners for sustainable development and human rights (United Nations, 2015).

The search strings combined three concept blocks with the operator AND (Table 2). The first block contained terms for environmental justice, the second contained terms for science education and the third contained terms for secondary education. Synonyms within each block were joined with OR, and truncation was used to capture variant word forms. The searches were limited to English-language journal articles. The search returned 53 records from Scopus and 50 records from WoS, giving a total of 103 records.

Table 2

Search Strings for Scopus and Web of Science Core Collection

Concept block	Search terms (OR within blocks, AND between blocks)
1. Environmental justice (I)	"environmental justice" OR "environmental injustice*" OR "environmental equity" OR "environmental inequit*" OR "environmental racism" OR "socio-environmental justice" OR "justice-centered" OR "justice-centred" OR "justice-oriented"
2. Science education (Co)	"science education" OR "science teaching" OR "science learning" OR "science classroom*" OR "science curricul*" OR "chemistry education" OR "chemistry teaching" OR "chemistry classroom*" OR "biology education" OR "physics education" OR "environmental science" OR "STEM education" OR "STEM learning" OR "environmental education" OR "sustainability education" OR "education for sustainable development"
3. Secondary level (P)	"secondary school*" OR "secondary education" OR "secondary student*" OR "lower secondary" OR "upper secondary" OR "high school*" OR "middle school*" OR "junior high" OR "senior high" OR adolescen* OR "K-12"
Scopus	TITLE-ABS-KEY (block 1 AND block 2 AND block 3) AND PUBYEAR > 2015 AND PUBYEAR < 2027, limited to English-language journal articles (n = 53)
Web of Science Core Collection	TS=(block 1) AND TS=(block 2) AND TS=(block 3) AND PY=(2016–2026) AND DT=(Article) AND LA=(English) (n = 50)

Note. Searches were conducted on 21 October 2026.

Eligibility Criteria

Table 3 presents the inclusion and exclusion criteria. Only peer-reviewed empirical journal articles were included. Reviews, conceptual papers, conference papers and book chapters were excluded. Studies had to involve students at lower or upper secondary level. Studies with mixed samples were included only when the results for secondary students were reported separately. Studies also had to take place in science education, environmental education or the science component of STEM, and they had to report student learning outcomes.

Environmental justice was defined as the fair distribution of environmental burdens and benefits (Bullard, 2005). Following Schlosberg (2007), it also includes fair participation in environmental decision-making and the recognition of affected groups. A study was eligible when this focus was built into the instruction. Studies that addressed only climate justice, health justice or multispecies justice were excluded. These fields overlap with environmental justice, but each has its own body of research. Limiting the review to environmental justice allowed one construct to be examined in depth. Studies that surveyed students' perceptions without any instruction were also excluded.

Table 3
Inclusion and Exclusion Criteria

Criterion	Inclusion	Exclusion
Literature type	Peer-reviewed empirical journal articles	Reviews, conceptual or position papers, editorials, conference papers, books and book chapters
Language	English	Non-English
Timeline	2016–2026	Before 2016
Education level	Secondary (lower and upper). Mixed samples only if secondary results are reported separately	Primary, higher education, pre-service or in-service teachers only
Subject context	Science, environmental science or the science component of STEM	Non-science subjects (e.g., mathematics, computer science) and non-educational studies
Focus	EJ explicitly integrated into instruction (curriculum, unit or programme)	Climate, health or multispecies justice without an EJ focus. Perception surveys without instruction
Outcomes	Student learning outcomes reported	Only teacher-, curriculum- or school-level outcomes

Study Selection

The records from both databases were imported into a reference manager. Duplicates were identified by digital object identifier (DOI) and by title. A total of 44 duplicates were removed, which left 59 records for screening.

Screening took place in two stages. In the first stage, the first author screened the titles and abstracts against the criteria in Table 3. Records with insufficient information were kept for full-text assessment. This stage excluded 39 records. Of these, 8 did not involve secondary students and 11 did not report student data. Two were not set in science education, 9 had no environmental justice content and 9 were not empirical studies.

In the second stage, all 20 remaining reports were retrieved in full text. Each report was assessed against four requirements. Environmental justice had to be integrated into the instruction, and student learning outcomes had to be reported. Results for secondary students had to be separable from those of other groups, and the methods had to be described in enough detail for appraisal. Eight reports were excluded. Seven did not integrate environmental justice into the instruction, and one did not report student outcomes. Supplementary Appendix C lists these reports and the reasons. The second reviewer checked all 59 title and abstract decisions and all 20 full-text decisions. Disagreements were discussed with reference to the full text.

The synthesis included 12 reports of 11 studies (Figure 1). Morales-Doyle (2017, 2018) reported the same chemistry course and the same students and was counted as one study. Two studies were included as boundary cases. De Freitas, do Nascimento, de Castro, Motokane, and Reis (2023) used a planned, mediated argumentation activity, but the justice dimensions emerged in discussion rather than being stated instructional objectives. Oyewole

(2023) described planned food justice teaching and student-led environmental activities in school gardens. Student responses supported its inclusion, whereas the accounts of adult garden leaders were treated as contextual evidence. Both cases were kept in the main synthesis, and a sensitivity analysis examined the results without them.

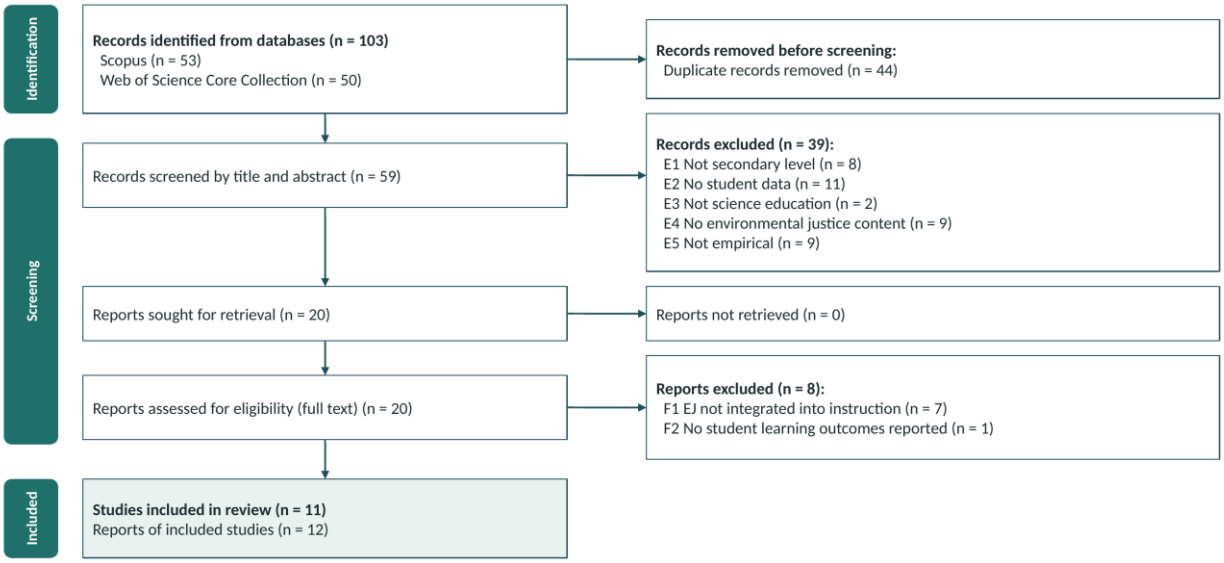


Figure 1. PRISMA 2020 Flow Diagram of Study Selection

Data Extraction

Data were extracted by the first author with a standard form (Table 4) and checked by the second reviewer. The form recorded study information, context and sample, and research design. For RQ1, it recorded the pedagogical approach and the environmental justice issue. For RQ2, it recorded the dimensions of justice addressed and how each was coded. For RQ3, it recorded cognitive, affective and behavioural or civic outcomes, together with the measures used. Supplementary Appendix A summarises the extracted data.

Table 4
Data Extraction Framework

Category	Extracted items
Study information	Author(s) and year, country, journal
Context and sample	Education level and grade, sample size, subject and setting (in-school or out-of-school)
Design	Research design, data sources and instruments, analysis method
RQ1 Approach	Pedagogical approach and EJ issue addressed
RQ2 Dimensions	EJ dimensions (distributive, procedural, recognition), each coded as explicit, partial or absent
RQ3 Outcomes	Cognitive, affective and behavioural or civic outcomes, measurement and strength of evidence

Quality Appraisal

Methodological quality was appraised with the Mixed Methods Appraisal Tool (MMAT) version 2018 (Hong et al., 2018). Each study was rated on the two screening questions and on

the five criteria for its design category as yes, no or can't tell. The mixed methods study was also rated against the qualitative and quantitative non-randomised criteria, and its mixed methods rating drew on all three sets. No overall score or quality rank was calculated, as the developers advise. Missing information was recorded as can't tell rather than as no. Derrien et al. (2020) was classified as quantitative non-randomised because its open-ended responses were reported descriptively and not analysed as a separate qualitative strand. The first author's ratings were checked by the second reviewer. No study was excluded on the basis of quality. Table 5 presents the ratings, and the component ratings for the mixed methods study appear in Supplementary Appendix B.

Table 5
Methodological Quality of Included Studies (MMAT 2018)

Study	Category	S1	S2	Q1	Q2	Q3	Q4	Q5
Kozan et al. (2017)	Qualitative	Y	Y	Y	Y	Y	Y	Y
Morales-Doyle (2017, 2018)	Qualitative	Y	Y	Y	Y	Y	Y	Y
Derrien et al. (2020)	Quantitative non-randomised	Y	Y	CT	CT	N	N	Y
Gallay et al. (2021)	Qualitative	Y	Y	Y	Y	Y	Y	Y
Schneller et al. (2022)	Qualitative	Y	Y	Y	Y	Y	Y	Y
Bradford et al. (2023)	Mixed methods	Y	Y	Y	Y	Y	Y	N
de Freitas et al. (2023)	Qualitative	Y	Y	Y	Y	Y	Y	Y
Oyewole (2023)	Qualitative	Y	Y	Y	CT	CT	CT	CT
Shendell et al. (2023)	Quantitative descriptive	Y	Y	Y	N	CT	CT	Y
Stewart et al. (2024)	Qualitative	Y	Y	Y	Y	Y	Y	Y
Meade et al. (2026)	Quantitative non-randomised	Y	Y	CT	CT	N	N	CT

Note. Y = yes. N = no. CT = can't tell. S1 and S2 are the screening questions. Q1 to Q5 are criteria 1.1 to 1.5 (qualitative), 3.1 to 3.5 (quantitative non-randomised), 4.1 to 4.5 (quantitative descriptive) or 5.1 to 5.5 (mixed methods). Component ratings for Bradford et al. (2023) appear in Supplementary Table B2.

Data Synthesis

The synthesis had four parts. First, descriptive statistics summarised the year of publication, country, education level, setting, research design and environmental justice issue of each study.

Second, the pedagogical approaches were coded to answer RQ1. Coding began with four predefined categories, namely project-based learning, socio-scientific issues, place-based learning and inquiry-based learning. Approaches outside these categories were coded inductively. Each study was assigned to its main approach.

Third, to answer RQ2, the studies were coded against the three dimensions of environmental justice proposed by Schlosberg (2004, 2007), which are distributive, procedural and

recognition justice. A dimension was coded as explicit when it formed part of the planned instruction. It was coded as partial when it appeared in the activities or discussions without being a planned focus. It was coded as absent when it did not appear. Coding was at study level. A dimension counted as explicit when a documented programme included it by design, even if not every site did so. Procedural justice included supported student voice in environmental decisions. Recognition justice concerned respect for the identities, histories or knowledge of affected groups. General references in the introduction of an article were not treated as instructional content. These rules mattered most for the multi-site garden study and the mediated bee discussion.

Fourth, the reported outcomes were analysed through thematic synthesis to answer RQ3 (Thomas & Harden, 2008). Outcomes were grouped into cognitive, affective and behavioural or civic domains. A report was counted in a domain when it reported evidence relevant to that domain. This count does not mean that the teaching improved the outcome. Civic evidence included perceived barriers and agency as well as enacted participation. Student accounts and work were separated from adult accounts, and school-level achievement data were recorded as contextual evidence. One report could contribute to more than one domain. The first author carried out extraction and coding, and the second reviewer checked all reports. Disagreements were resolved through discussion. A sensitivity analysis repeated the descriptive counts without the two boundary studies.

Ethical Considerations

This review analysed published studies only. No human participants were involved, so ethical approval was not required.

Results

Characteristics of the Included Studies

The 12 included reports were published between 2017 and 2026 (Figure 2). No report from 2016, 2019 or 2025 met the criteria. The number of reports per year remained small. The highest number appeared in 2023, with four reports, and every other year produced two reports or fewer.

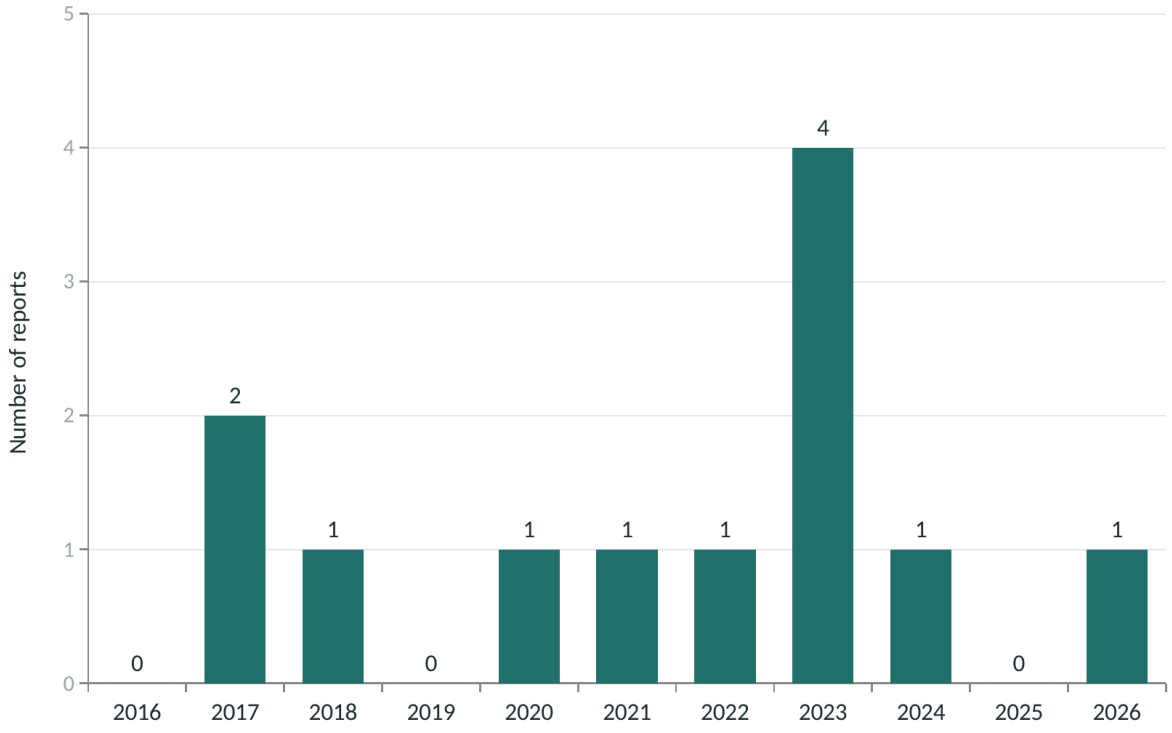


Figure 2. Distribution of Included Reports by Publication Year (2016–2026)

Note. Publication year as recorded in Scopus or Web of Science. Stewart et al. and Oyewole were published online in 2022 and are listed by issue year (2024 and 2023).

Table 6 summarises the characteristics of the included reports. Ten of the 11 studies were conducted in the United States. The remaining study took place in a rural public school in Brazil (de Freitas et al., 2023). Most studies were set in urban communities of colour that faced local environmental hazards. Examples include the Flint water crisis (Stewart, Burke, & Askari, 2024) and industrial pollution in Africatown, Alabama (Meade et al., 2026).

Seven reports focused on upper secondary students, two on lower secondary students and three on mixed secondary samples. Five reports were set in school science classes. Four were set in other school-based contexts, namely an environmental justice elective, civic science projects, school gardens and an online course. Three were set in out-of-school programmes. Qualitative designs dominated, with eight reports. Three reports used quantitative designs and one used mixed methods. Air pollution was addressed in three reports, and food injustice combined with urban pollution was also addressed in three. Soil contamination by heavy metals appeared in two reports. Drinking-water contamination, local industrial pollution, biodiversity loss and general environmental justice concepts each appeared once. Supplementary Appendix A gives the details of each study.

Table 6

Characteristics of the Included Reports (n = 12)

Characteristic	Category	n	%
Country	United States	11	91.7
	Brazil	1	8.3
Education level	Upper secondary (high school)	7	58.3
	Lower secondary (middle school)	2	16.7
	Mixed secondary	3	25.0
Setting	School science class	5	41.7
	Other school-based (EJ elective, civic science projects, school gardens, online course)	4	33.3
	Out-of-school programme	3	25.0
Research design	Qualitative	8	66.7
	Quantitative	3	25.0
	Mixed methods	1	8.3
EJ issue	Air pollution	3	25.0
	Food injustice and urban pollution	3	25.0
	Soil heavy-metal contamination	2	16.7
	Drinking-water contamination	1	8.3
	Industrial pollution in the local community	1	8.3
	Biodiversity loss and agribusiness	1	8.3
	EJ concepts in general	1	8.3

Note. Counts are by report. Morales-Doyle (2017, 2018) are two reports of one study.

Pedagogical Approaches (RQ1)

Five types of pedagogical approach were identified across the 11 studies. Place- and community-based learning was the most common, with five studies. Socio-scientific issue (SSI) based pedagogy was used in two studies, and inquiry-based learning and citizen science in another two. Project-based learning (PjBL) and online modules each appeared in one study. Several studies combined more than one approach. For example, the class described by Stewart et al. (2024) was place-based and also involved student-directed projects. Each study was therefore classified by its main approach. The justice dimensions that each approach addressed are reported under RQ2.

Place- and Community-Based Learning (n = 5)

Five studies started from an environmental problem in the students' own community. They connected learning to the local context and, in several cases, to community partners and action. Meade et al. (2026) worked with community environmental justice organisations to develop five modules for a middle school in Africatown, Alabama. The modules covered aquaponics, recycling, composting, weather monitoring and water pollution, and they linked these topics to industrial pollution near the school. Schneller et al. (2022) described a summer programme at an urban environmental justice centre. High school students studied environmental justice in class, mapped environmental amenities and hazards in their neighbourhood and worked on an urban farm. Stewart et al. (2024) reported a high school

elective on environmental justice set against the Flint water crisis. Students took control of the curriculum and presented their own projects to the public on Change Day. Gallay, Pykett, and Flanagan (2021) studied place-based civic science projects in two urban areas of Michigan. Students worked on issues such as stormwater runoff, food injustice and air pollution from nearby industry. Oyewole (2023) examined school gardens in 11 middle and high schools in Brooklyn. Some programmes included food justice lessons, and one school taught soil remediation at a former oil spill site. At another school, students were asked to identify a community waste problem, worked on cafeteria composting and met the head of the cafeteria. One programme invited a Quechua farmer to teach Indigenous Ecuadorian farming knowledge.

SSI-Based Pedagogy (n = 2 studies, 3 reports)

Two studies organised teaching around a contested socio-scientific issue. Morales-Doyle (2017, 2018) described an Advanced Placement (AP) chemistry course that he taught in an urban high school. In the soil project, students examined whether two closed coal power plants had contaminated neighbourhood soil with heavy metals. They collected soil samples, prepared them in university laboratories and analysed the resulting data. A neighbourhood organisation that campaigned against environmental racism facilitated the project. Students then presented their results to about 125 community members. The course linked canonical chemistry content, such as chemical reactions and quantitative analysis, to environmental racism in the community.

De Freitas et al. (2023) worked with nine second-year students at a rural public high school in Brazil. Two videos about the disappearance of bees opened a mediated argumentation activity. Students discussed the consequences of bee loss and the use of robot bees. Their arguments linked biodiversity to citizenship, technology and corporate responsibility. The two studies differed in scope. The chemistry course ended with student action in the community, whereas the Brazilian activity remained a classroom discussion.

Inquiry-Based Learning and Citizen Science (n = 2)

Two studies engaged students in investigations with real data. Derrien et al. (2020) involved 26 young people in grades 8 to 12 in a community civic science project in Seattle. Students used moss growing on street trees to measure heavy metals in the air near industrial areas. They collected and prepared samples of usable quality. Bradford, Gerard, Tate, Li, and Linn (2023) co-designed an Air Quality and Asthma unit with middle school teachers. Students compared asthma rates across cities and examined pollution maps alongside historical redlining maps. They used this evidence to explain why some communities are more exposed to air pollution.

Project-Based Learning (n = 1)

Kozan et al. (2017) studied an out-of-school STEM programme for urban high school students. Students used geographic information systems to map access to healthy food in their neighbourhoods. They then designed STEM solutions such as hydroponic growing systems. This was the only study organised as PjBL.

Online Modules (n = 1)

Shendell et al. (2023) developed an asynchronous online course for high school students in New Jersey. Environmental justice formed one of five modules, and the whole course took about two hours. Each module presented written content followed by a knowledge check.

Environmental Justice Dimensions Addressed (RQ2)

Figure 3 shows how the three dimensions of environmental justice were coded across the 11 studies and within each pedagogical approach. Distributive justice was explicit in 10 of the 11 studies and partial in one. Procedural justice was explicit in four, partial in six and absent in one. Recognition justice was explicit in six, partial in two and absent in three. Four studies addressed all three dimensions explicitly (Morales-Doyle, 2017, 2018; Oyewole, 2023; Schneller et al., 2022; Stewart et al., 2024).

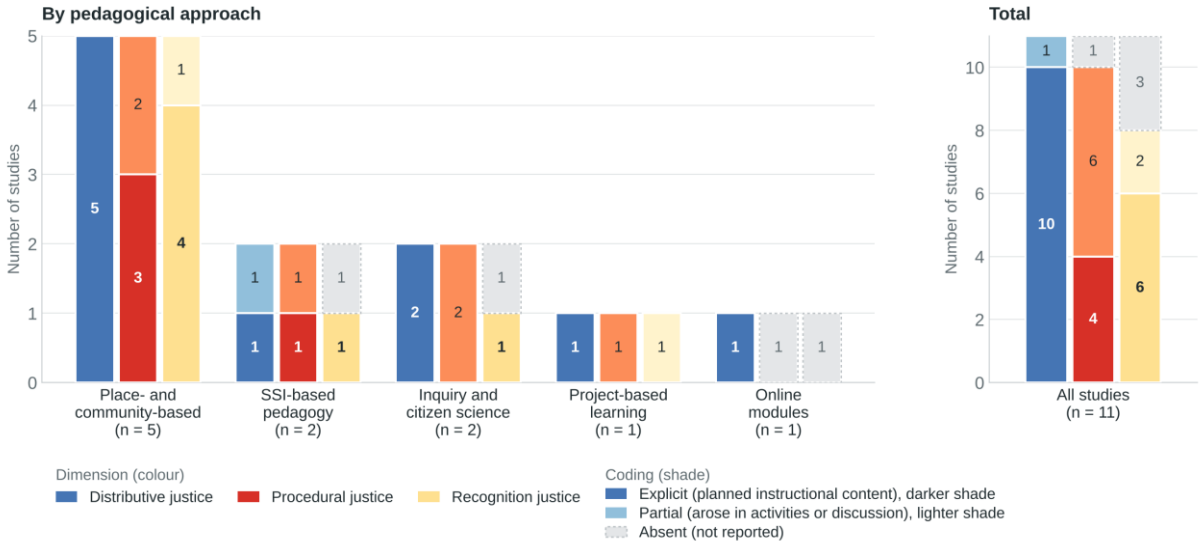


Figure 3. Pedagogical Approaches by Environmental Justice Dimension

Note. Counts are by study (n = 11). Explicit = planned instructional content. Partial = appeared in activities or discussion without a planned focus. Absent = not reported. Dimensions follow Schlosberg (2004, 2007). Oyewole (2023) and de Freitas et al. (2023) are boundary cases. In Oyewole (2023), the explicit practices occurred in some of the 11 school programmes.

All five place- and community-based studies addressed distributive justice explicitly. Procedural justice was explicit in three of them, in which students took part in decisions or public action (Oyewole, 2023; Schneller et al., 2022; Stewart et al., 2024). It was partial in Gallay et al. (2021) and Meade et al. (2026). Recognition justice was explicit in four studies (Meade et al., 2026; Oyewole, 2023; Schneller et al., 2022; Stewart et al., 2024) and partial in Gallay et al. (2021). The four explicit cases drew on local histories of race and community struggle or on Indigenous knowledge. In Oyewole (2023), these practices took place in some programmes and not in all 11 schools.

The two SSI studies were coded differently. The chemistry course of Morales-Doyle (2017, 2018) addressed all three dimensions explicitly. It examined who bore the contamination, ended in a public presentation and worked with a local campaigning organisation. In de

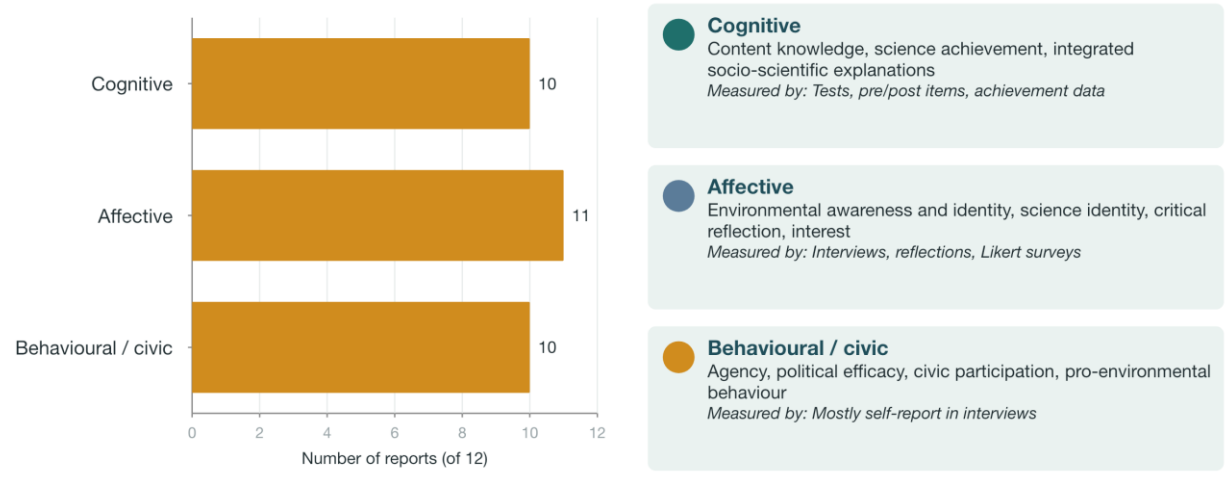
Freitas et al. (2023), students raised unequal access to the benefits of technology and their own limited say in decisions, so distributive and procedural justice were coded as partial. The activity did not address the identities or knowledge of particular groups, so recognition justice was coded as absent.

Both inquiry and citizen science studies addressed distributive justice explicitly. Procedural justice was partial in both, as student participation in environmental decisions appeared in the activities but was not a planned focus. Bradford et al. (2023) addressed recognition justice through the history of racist housing policy, whereas Derrien et al. (2020) did not address it. In Kozan et al. (2017), distributive justice was explicit through the mapping of food access, and procedural and recognition justice were partial. The online modules of Shendell et al. (2023) addressed only distributive justice.

Without the two boundary studies, nine studies and 10 reports remain. Distributive justice is then explicit in all nine. Procedural justice is explicit in three, partial in five and absent in one. Recognition justice is explicit in five, partial in two and absent in two. Place-based learning remains the most frequent approach, with four studies, and every remaining study is from the United States. The imbalance across dimensions therefore holds with or without the boundary cases, whereas the international coverage depends on them.

Reported Student Learning Outcomes (RQ3)

Cognitive, affective and behavioural or civic evidence appeared in 10, 11 and 10 of the 12 reports (Figure 4). These are counts of reports with relevant evidence, not counts of successful interventions. Bradford et al. (2023) contributed affective evidence through student interviews. De Freitas et al. (2023) contributed discussion performance and civic perceptions. Oyewole (2023) contributed to all three domains through student responses. Meade et al. (2026) contributed school-level achievement data as context rather than a participant-level effect.



Note. Counts indicate reported domains, not demonstrated benefits. Includes civic perceptions, student self-report and school-level contextual evidence; adult accounts are identified separately.

Figure 4. Reported Student Learning Outcomes by Domain

Note. A report can contribute to more than one domain. Counts include performance, perceptions and contextual achievement evidence.

Cognitive Outcomes (10 reports)

Cognitive outcomes included content knowledge, academic achievement and the ability to explain environmental inequalities with scientific evidence. Two studies measured knowledge with tests. In Derrien et al. (2020), the total knowledge score of the nine students who completed all tests rose from 73.3% to 82.6% ($p = .002$). In Bradford et al. (2023), 211 middle school students improved their explanations of why pollution affects people unequally ($t = 5.55$, $p < .0001$, $d = 0.38$). The share of students who referred to race in their explanations rose from 0.5% to 13.3%. Morales-Doyle (2017) analysed student work against the Next Generation Science Standards and AP standards. He reported achievement that exceeded the expectations of a typical high school chemistry course. Shendell et al. (2023) reported mean scores between 4.4 and 5.0 out of 5 on the environmental justice knowledge check. This check was given only after the course. Meade et al. (2026) reported school-level science proficiency over several years as context and did not measure a participant-level effect. The other studies reported cognitive outcomes from interviews or written work (de Freitas et al., 2023; Gallay et al., 2021; Kozan et al., 2017; Oyewole, 2023; Schneller et al., 2022).

Affective Outcomes (11 reports)

Affective outcomes included environmental awareness and identity, science identity, critical reflection and interest in STEM. Gallay et al. (2021) found that students formed environmental identities and came to see links between the local environment and community health. Kozan et al. (2017) reported growth in critical reflection, as students became more aware of environmental problems in their communities. In Schneller et al. (2022), 10 of the 14 students planned to study environmental subjects after the programme. In Meade et al. (2026), agreement that science can help people fix problems rose from 69% to 78%. The change in survey means, however, was not significant. Morales-Doyle (2018) identified three standpoints that former students took towards the chemistry curriculum, and five of the nine had entered science majors. Oyewole (2023) reported pride, calm and a sense of connection among students who worked in school gardens. Bradford et al. (2023) also described students' feelings of urgency about environmental racism in interviews.

Behavioural and Civic Outcomes (10 reports)

Behavioural and civic outcomes included agency, political efficacy, civic participation and pro-environmental behaviour. Stewart et al. (2024) found that students developed personal, academic and political agency, and many wished to take part in local democratic processes. Students in Schneller et al. (2022) adopted pro-environmental behaviours and showed more interest in civic engagement. In Morales-Doyle (2017), students presented soil data to their community and positioned themselves as knowledgeable local youth. Six of the nine students in Morales-Doyle (2018) were involved in community or social justice organisations after graduation. Student responses in Oyewole (2023) described collaboration and contribution to the community. Adult accounts of cafeteria critique, composting plans and meetings were treated as context and not counted as student outcomes. Civic outcomes were not always positive. Kozan et al. (2017) found more evidence of critical reflection than of critical action. De Freitas et al. (2023) reported that students named several obstacles to their participation in social change, so the civic evidence there concerns perceived barriers rather than behaviour. Some students in Stewart et al. (2024) felt anxious about their projects and frustrated by the lack of change in Flint.

Strength of the Evidence

Eight reports used qualitative designs, and most outcomes came from interviews, reflections or self-report. Only Bradford et al. (2023) and Derrien et al. (2020) reported significant pre-post test gains, and neither used a control group. The gain in Derrien et al. (2020) was based on nine paired participants. Bradford et al. (2023) taught 386 students, of whom 211 completed the paired assessment. Meade et al. (2026) reported 108 pre-survey and 79 post-survey responses without identifying the paired sample. Shendell et al. (2023) assessed knowledge only after the course. De Freitas et al. (2023) recorded performance during one discussion. The MMAT ratings in Table 5 point to the same weaknesses. The two quantitative non-randomised studies had incomplete outcome data and no control of confounding, and the mixed methods study shared these weaknesses in its quantitative component. The descriptive study used a sample that was not representative of the target population. Oyewole (2023) gave too little information on sampling, measurement and analysis to judge four of the five criteria. These limitations restrict causal claims, but they do not add up to a single quality score.

An Integrative Framework

Figure 5 brings the findings together in an analytical framework. The left column shows the five pedagogical approaches identified for RQ1. The middle column shows the three dimensions of environmental justice and how often each was addressed, which answers RQ2. The right column shows the three outcome domains identified for RQ3. The base of the figure lists the contextual factors that shaped the studies. These are the local environmental justice issue, the community partners and the setting of the instruction. They also include the role of teachers as researchers or designers and the concentration of studies in the United States. The arrows show associations found across the studies, not tested causal pathways. Dimension counts are by study and outcome counts are by report.

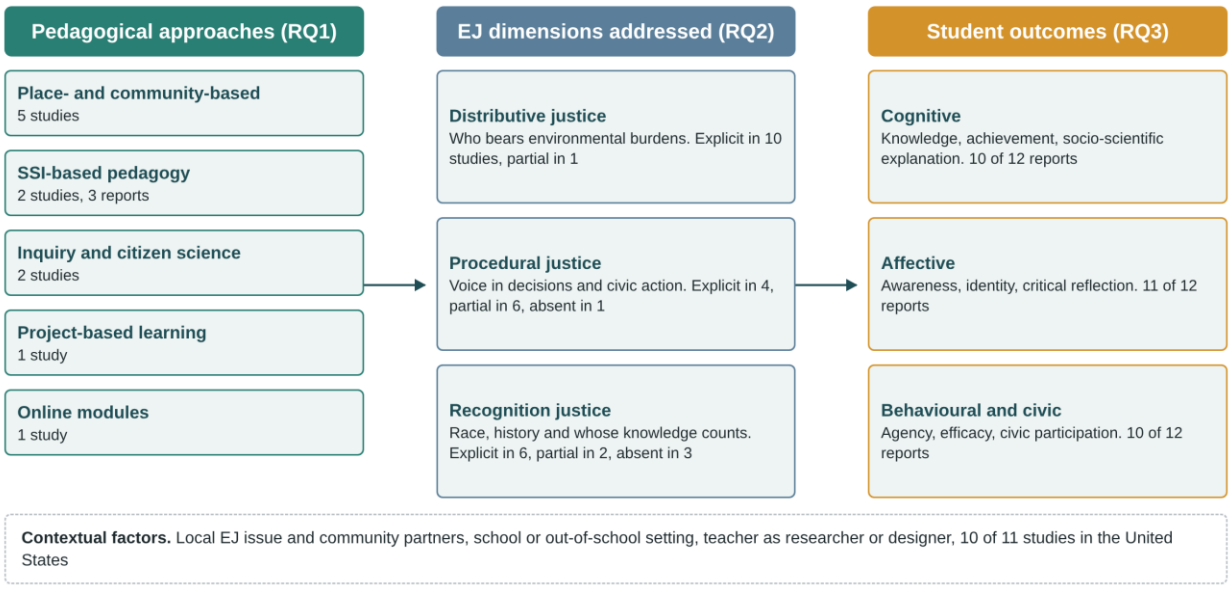


Figure 5. Analytical Framework of the Review Findings

Discussion

Pedagogical Approaches for Integrating Environmental Justice

This review found that place- and community-based learning was the most common way of integrating environmental justice into secondary science. This pattern reflects the nature of

environmental justice. Environmental burdens fall on specific places and specific groups (Bullard, 2005). A local issue therefore gives students direct evidence of who is affected and why. Gruenewald (2003) argued that a critical pedagogy of place connects ecological learning with questions of power in students' own communities. The reviewed studies followed this logic. Students investigated soil, air and water in their neighbourhoods (Derrien et al., 2020; Meade et al., 2026; Morales-Doyle, 2017). In some studies, they also shared their findings with local people (Morales-Doyle, 2017; Stewart et al., 2024).

A quarter of the reports came from out-of-school programmes. In schools, standards and examinations limit the time available for local issues. Morales-Doyle (2017) described the tension between a prescribed AP chemistry syllabus and a curriculum that responds to the community. Chemistry was the focus of only one study, although many environmental justice issues involve chemical pollutants. Ten of the 11 studies also came from the United States. Studies from Africa and South America point to the same gap in schools elsewhere. Learners in Peru and Uganda experienced environmental injustice in daily life, yet their school environmental education seldom addressed justice (Wilder et al., 2024). In Tanzanian secondary schools, environmental education relied mainly on theoretical teaching (Kayombo, Iftekhar, & Mashaza, 2025).

Coverage of the Justice Dimensions

Coverage of the three justice dimensions was uneven (Figure 3). Distributive justice was explicit in 10 of the 11 studies, whereas procedural justice was explicit in four and recognition justice in six. Distributive questions fit well with standard science content, such as pollutant levels, exposure and health effects. Procedural and recognition justice require students to examine decision-making, history and race. These topics take more time and place greater demands on teachers. The four studies that addressed all three dimensions explicitly shared two features. Students presented their work to, or made decisions with, people outside the classroom, and the teaching drew on the history or knowledge of the local community. Bradford et al. (2023) showed that teachers' choices shaped whether students discussed systemic racism. Jones (2024) described how a physics teacher had to learn new content and renegotiate the boundaries of the subject to teach environmental justice.

Learning Outcomes and the Strength of Evidence

Affective evidence appeared in 11 reports, and cognitive and civic evidence in 10 each. These counts include perceived and contextual outcomes as well as measured performance. The balance across domains matches the aims of justice-centred science pedagogy, which seeks to develop critical consciousness and the capacity to act (Morales-Doyle, 2017). Students in several studies came to see links between pollution, health and inequality in their own communities (Bradford et al., 2023; Gallay et al., 2021). Some also took part in public action (Schneller et al., 2022; Stewart et al., 2024).

The evidence for these outcomes is limited. Most outcomes were reported through interviews, reflections or self-report surveys. Only two studies showed significant gains on a test, and none used a control group. Civic outcomes were also mixed. Students often showed stronger critical reflection than critical action (Kozan et al., 2017). Some named barriers to participation (de Freitas et al., 2023), and some felt anxious when their efforts did not change local conditions (Stewart et al., 2024). In Ghana, students' limited knowledge of

environmental law weakened their ability to advocate for environmental justice (Asaah-Junior & Agyiri, 2026). These findings indicate that awareness of injustice does not lead to action by itself. Students also need to understand how decisions are made and need real opportunities to take part.

The review also shows that justice goals and science learning can be pursued together. Students in Morales-Doyle (2017) learned canonical chemistry while they investigated environmental racism. Students in Bradford et al. (2023) improved their scientific explanations of pollution and health. These outcomes are closely related to scientific literacy. The PISA framework defines scientific literacy through three competencies. These are explaining phenomena scientifically, evaluating and designing scientific enquiry, and interpreting data and evidence scientifically (OECD, 2019). Few of the included studies measured these competencies directly.

Implications for Practice

Teachers can start from a local environmental issue that students already know. The included studies used local soil, air and water, which made the injustice visible and the science concrete (Derrien et al., 2020; Morales-Doyle, 2017). Core content can be taught through this issue. For example, the chemistry of heavy metals and combustion can be taught with local pollution data (Bradford et al., 2023; Morales-Doyle, 2017). To address procedural justice, teachers can plan for students to present their findings to community members or local decision makers.

Curriculum designers can connect environmental justice to existing science content. The Chinese Chemistry Curriculum Standards for Compulsory Education (2022 edition) include interdisciplinary practice on water quality testing and building a simple water purifier (Ministry of Education, 2022, Appendix 4). A justice-oriented extension could ask whose water is most affected, how access to treatment differs and whose knowledge informs decisions. The standard does not require an environmental justice perspective, so this would be a local adaptation.

Teacher education also needs attention. Teachers in the included studies needed new content knowledge, local partners and support for discussing race and history (Bradford et al., 2023; Jones, 2024). Co-design with researchers and community organisations provided this support (Bradford et al., 2023; Meade et al., 2026).

Directions for Future Research

Six directions for future research follow from this review. First, studies are needed outside the United States, especially in Asia and the Global South. Second, more studies should focus on specific subjects such as chemistry and link environmental justice to the curriculum standards of those subjects. Third, valid instruments are needed to measure scientific literacy and justice-related outcomes together. Fourth, quasi-experimental and longitudinal designs would show whether learning gains last after instruction ends. Fifth, instructional designs should target procedural and recognition justice, which were less consistently explicit than distributive justice. Sixth, research should examine how teachers' knowledge, beliefs and working conditions shape the way environmental justice is taught. One application is a project-based chemistry module on local water issues that assesses scientific explanations, participation opportunities and respect for community knowledge separately. Such a design would need to be tested in its own curriculum context.

Limitations

This review has several limitations. Only two databases were searched, and only English-language journal articles were included. Studies in other languages, theses and grey literature may have been missed. Ten of the 11 studies were conducted in the United States, and without the Brazilian boundary case the corpus is entirely American. The narrow definition of environmental justice excluded studies of climate, health and multispecies justice and made some eligibility decisions difficult. In de Freitas et al. (2023), justice emerged in discussion rather than as a planned objective, and the sensitivity analysis shows how far the counts depend on this case. Screening, extraction and coding were carried out by the first author. The second reviewer checked all 59 title and abstract decisions, all 20 full-text decisions and all extracted and coded data. This was sequential verification rather than independent duplicate review, so no inter-rater agreement statistic is reported. Adult accounts and school-level achievement data were separated from direct student measures. The designs and outcomes were too varied for meta-analysis. The comparison with earlier reviews covered two reviews only.

Conclusion

This systematic review examined how environmental justice has been integrated into secondary science education and what student learning outcomes have been reported. Twelve reports of 11 studies published between 2017 and 2026 were included, with two boundary cases examined in a sensitivity analysis. For RQ1, place- and community-based learning was the most common approach. SSI-based pedagogy, inquiry and citizen science, PjBL and online modules were also used. For RQ2, distributive justice was explicit in 10 of the 11 studies, procedural justice in four and recognition justice in six. Only four studies addressed all three. For RQ3, the studies reported cognitive, affective and behavioural or civic outcomes. Most of this evidence came from qualitative and self-report data, and only two studies reported significant gains on tests.

This synthesis builds on earlier reviews of environmental justice education and concentrates on secondary science. Its analytical framework links pedagogical approaches, justice dimensions and outcome domains for use in curriculum design. The findings offer design options and research questions rather than a ranking of interventions by effectiveness.
The most pressing need is research beyond the United States that uses stronger designs to measure effects on scientific literacy.

Acknowledgements

The authors received no specific funding for this work.

References

Asaah-Junior, S. K., & Agyiri, F. O. P. (2026). Climate change and legal literacy consciousness: The untold stories from Ghanaian high schools. Australian Journal of Environmental Education. Advance online publication. doi:10.1017/aee.2026.10171

Bradford, A., Gerard, L., Tate, E., Li, R., & Linn, M. C. (2023). Incorporating investigations of environmental racism into middle school science. Science Education, 107(6), 1628–1654. doi:10.1002/sce.21824

Bullard, R. D. (Ed.). (2005). The quest for environmental justice: Human rights and the politics of pollution. San Francisco, CA: Sierra Club Books.

de Freitas, A. C., do Nascimento, L. A., de Castro, R. G., Motokane, M. T., & Reis, P. (2023). Biodiversity and citizenship in an argumentative socioscientific process. Sustainability, 15(4), Article 2987. doi:10.3390/su15042987

Derrien, M. M., Zuidema, C., Jovan, S., Bidwell, A., Brinkley, W., López, P., … Blahna, D. J. (2020). Toward environmental justice in civic science: Youth performance and experience measuring air pollution using moss as a bio-indicator in industrial-adjacent neighborhoods. International Journal of Environmental Research and Public Health, 17(19), Article 7278. doi:10.3390/ijerph17197278

Gallay, E., Pykett, A., & Flanagan, C. (2021). "We make our community": Youth forging environmental identities in urban landscapes. Sustainability, 13(14), Article 7736. doi:10.3390/su13147736

Gruenewald, D. A. (2003). The best of both worlds: A critical pedagogy of place. Educational Researcher, 32(4), 3–12. doi:10.3102/0013189X032004003

Guevara-Herrero, I., Bravo-Torija, B., & Pérez-Martín, J. M. (2024). Educational practice in education for environmental justice: A systematic review of the literature. Sustainability, 16(7), Article 2805. doi:10.3390/su16072805

Hong, Q. N., Fàbregues, S., Bartlett, G., Boardman, F., Cargo, M., Dagenais, P., … Pluye, P. (2018). The Mixed Methods Appraisal Tool (MMAT) version 2018 for information professionals and researchers. Education for Information, 34(4), 285–291. doi:10.3233/EFI-180221

Jones, J. (2024). Contesting the boundaries of physics teaching: What it takes to transform physics education toward justice-centered ends. Science Education, 108(4), 1015–1033. doi:10.1002/sce.21862

Kayombo, J. J., Iftekhar, S. N., & Mashaza, L. G. (2025). Integrating environmental education for sustainability: Bridging theory, practice, and political engagement in Tanzanian secondary schools. Nordic Journal of Comparative and International Education, 9(2). doi:10.7577/njcie.6033

Kozan, S., Blustein, D. L., Barnett, M., Wong, C., Connors-Kellgren, A., Haley, J., … Wan, D. (2017). Awakening, efficacy, and action: A qualitative inquiry of a social justice-infused, science education program. Analyses of Social Issues and Public Policy, 17(1), 205–234. doi:10.1111/asap.12136

Lockwood, C., Munn, Z., & Porritt, K. (2015). Qualitative research synthesis: Methodological guidance for systematic reviewers utilizing meta-aggregation. International Journal of Evidence-Based Healthcare, 13(3), 179–187. doi:10.1097/XEB.0000000000000062

Meade, M., Jennings, D. H., Holifield, R. R., Gawronski, V. T., Hazelhoff, R., Jacobs, L. C., … Hayden, K. L. (2026). STEMMing the tide: Addressing educational inequities and environmental justice through STEM education in Africatown, Alabama. Discover Education, 5, Article 301. doi:10.1007/s44217-026-01187-5

Miles, M., Schindel, A., Haq, K., & Aziz, T. (2025). Advancing environmental justice education: A critical review of research and practice. Environmental Education Research, 31(7), 1461–1480. doi:10.1080/13504622.2025.2483443

Ministry of Education of the People's Republic of China. (2022). Yiwu jiaoyu huaxue kecheng biaozhun (2022 nian ban) [Chemistry curriculum standards for compulsory education (2022 edition)]. Beijing, China: Beijing Normal University Press.

Morales-Doyle, D. (2017). Justice-centered science pedagogy: A catalyst for academic achievement and social transformation. Science Education, 101(6), 1034–1060. doi:10.1002/sce.21305

Morales-Doyle, D. (2018). Students as curriculum critics: Standpoints with respect to relevance, goals, and science. Journal of Research in Science Teaching, 55(5), 749–773. doi:10.1002/tea.21438

OECD. (2019). PISA 2018 assessment and analytical framework. Paris, France: OECD Publishing. doi:10.1787/b25efab8-en

Oyewole, M. T. O. (2023). Liberatory practices and potentials in Brooklyn school gardens. Capitalism Nature Socialism, 34(1), 48–68. doi:10.1080/10455752.2022.2103443

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ, 372, Article n71. doi:10.1136/bmj.n71

Schlosberg, D. (2004). Reconceiving environmental justice: Global movements and political theories. Environmental Politics, 13(3), 517–540. doi:10.1080/0964401042000229025

Schlosberg, D. (2007). Defining environmental justice: Theories, movements, and nature. Oxford, England: Oxford University Press.

Schneller, A. J., Lacy, G., Kellogg, S., Pettigrew, S. M., Denny, C., Feldman-Schwartz, G., … Bardin, I. (2022). Urban ecojustice education: Transformative learning outcomes with high school service learners. The Journal of Environmental Education, 53(3), 127–140. doi:10.1080/00958964.2022.2063784

Shendell, D. G., Black, L. F., Way, Y., Aggarwal, J., Campbell, M. L. F., & Nguyen, K. T. (2023). Knowledge, attitudes, and awareness of New Jersey public high school students about concepts of climate change, including environmental justice. International Journal of Environmental Research and Public Health, 20(3), Article 1922. doi:10.3390/ijerph20031922

Stewart, K. D., Burke, C. J. F., & Askari, E. (2024). Change day: How a high school environmental justice class inspired student agency and prompted civic action. Race Ethnicity and Education, 27(7), 970–988. doi:10.1080/13613324.2022.2069744

Thomas, J., & Harden, A. (2008). Methods for the thematic synthesis of qualitative research in systematic reviews. BMC Medical Research Methodology, 8, Article 45. doi:10.1186/1471-2288-8-45

United Nations. (2015). Transforming our world: The 2030 Agenda for Sustainable Development (A/RES/70/1). New York, NY: United Nations General Assembly.

Wilder, R., Nuwategeka, E., Monge, C., & Bazan Talavera, A. (2024). Environmental justice in education for climate action: Case studies from Perú and Uganda. Children & Society. Advance online publication. doi:10.1111/chso.12899

Zeidler, D. L., Sadler, T. D., Simmons, M. L., & Howes, E. V. (2005). Beyond STS: A research-based framework for socioscientific issues education. Science Education, 89(3), 357–377. doi:10.1002/sce.20048