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Analyzing The Equity Issues In Science Education: A Systematic Review

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ABSTRACT

This research is a systematic review of equity issues in primary science education. Papers published in peer reviewed reputed journals published between 2014-2025 were analyzed and included in this systematic review. The purpose of the review was to find out the typical features of the studies that have conducted and to consider the equity issues encounter in primary science education from different context. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) approach was applied to choose and analyze articles. After VOS analysis and manual screening thirteen research studies were found relevant. These studies were analyzed based on methodology, participants, area of issues and the nature of equity issues discussed. The review revealed common issues to include gender inequalities, language barriers, curriculum and assessment and absence of inclusive pedagogies. Furthermore, the research concludes that both systemic reforms and teacher preparation programs are critical to resolve these issues and enhance equity in primary science classrooms.

Introduction

During the recent years, there has been increasing global concern with equity issues in science education, particularly at the primary school level. Researcher have increasingly studied how science learning contexts can inadvertently reproduce social inequalities based on gender, language, race and socioeconomic status (Burton, 2024; Martell, 2021). One of the major aims of equity centered research is to reveal obstacles to effective participation and to develop pedagogical models that sustain

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inclusion, representation and fairness in science classrooms (Pierson et al., 2024). Specifically, researchers have underscored the need to address systematic factors like resource access, teacher bias and curricula that are culturally constraining which limit the opportunities of marginalized students to participate in science education (Miller et al., 2021). Equity in science education is a multifaceted concern rather than a single dimensional issue, numerous areas including gender equity (Xu et al., 2025), language diversity (Martell, 2021) and the digital divide (Jackson et al., 2021). For example, science instruction heavily reliant on language and sometimes it could be challenging for multilingual students (Martell, 2021). Researchers have indicated that systematic disparities also find expression in educational materials, assessments, teacher expectations and absence of role models with diverse backgrounds (Hussenius, 2014).

Several recent studies and special issues have emphasized the importance of reframing equity not only as an issue of "access" but as a transformation that remakes participation, belonging and justice in science education. For example, (Miller et al., 2021) explore how virtual project-based learning (PBL) during the COVID 19 pandemic present new challenges and opportunities for advancing equity in digitally mediated settings. Furthermore, Burton (2024) critique the historical STEM education exclusion of minoritized groups and promote including equity into what is taught in the curriculum and what is discussed in the classroom. Together these studies indicate that making science equitable demands systemic change both in teaching practices and in the broader structure of schooling as well.

Equity themes like culturally responsive teaching, gender sensitive curriculum planning and equity-oriented applications of educational technology have gained increasing attention in recent years (Hussenius, 2014; Martell, 2021). For example, Kurniawati (2021) highlighted the necessity of dialogic and culturally responsive instruction to increase the capacity of marginalized students, whereas Jackson et al. (2021) referred to how equity focused instructional design promotes culturally based science learning. Similarly, El-Hamamsy et al. (2023) discussed how science classrooms may facilitate multilingual learner identity formation through scaffold, language rich instruction. Pierson et al. (2024) examined the role of digital access and learning spaces on equity in science learning and Martell (2021) inspected the significance of language in teaching science and demonstrate how multilingual students can be empowered through translanguaging practices.

Drawing on these efforts, this paper reports a systematic review of recent studies that addresses equity issues in primary science education. Our goal is to identify the patterns, structures and gaps in the literature and the methodologies and contexts within which equity is being studied.

In this study thirteen peer reviewed articles were selected using the following objectives: (i) to examine the general characteristics of the studies, including methodologies, participants, instruments, publication years and countries of origin of the authors and (ii) to identify the particular issues related to equity reported in science teaching and learning at the primary level.

In recent times, the idea of equity within the realm of educational research within the sciences has emerged as a significant focus. Researchers have emphasized the importance of all educational systems, formal and informal, designed to support inclusive and socially just learning opportunities. One of the key areas of focus in this

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stream of work is the interconnectedness of equity in the teaching and equity in the learning. The demands of equity-based classrooms are impossible to achieve when teachers themselves become deprived of agency and professional autonomy because teacher empowerment is a key to the effective implementation of equitable practice (Adah Miller et al., 2024; Jurado de Los Santos et al., 2020).

Equity in Education

Equity in education has grown beyond equal resource access. It now encompasses acknowledgment of learners' varying needs, identities, and socio-cultural backgrounds (Martell, 2021). Equity is understood in most of the studies as treating people equally well in learning spaces (Kurniawati, 2021; Miller et al., 2021). Jackson et al. (2021) calls for equity to be transformational in nature, shifting focus to the redesigning of classroom norms, materials, and relationships, newer studies build upon this conceptualization with identity, representation, and lived experience as core equity dimensions (Kersting et al., 2025; Vithal et al., 2024).

Burton (2024) notes that when science teachers incorporate the cultures and languages of their multilingual students into classroom discourse, those students experience success as learners. This serves to demonstrate the importance of linguistic inclusion as a component of educational justice. In regard to pedagogical bias, Taddese et al. (2025) reports that digital technologies in early childhood education can be used to build inclusive environments that lower provisions for children with different linguistic abilities. Pierson et al. (2024) presents evidence that the redesign of certain science classrooms to be more equitable also enhances identity work, particularly for multilingual learners, many of whom experience exclusion from the convergent classroom discourse. The equity outcomes are also greatly influenced by the teachers' own positioning and language ideologies. Hussenius (2014) also promoted the use of socially situated STEM initiatives that involve children in addressing contemporary issues to advocate for justice in STEM, thus redefining equity in terms of access and power.

Equity Issues

The equity issues presented in the literature reveal multiple themes, such as gender disparities, language, teacher unpreparedness, digital divides, and inadequate cultural inclusive representation. Kurniawati (2021) emphasized that the field of science education traditionally does not attract students from working-class, ethnic minority, and female origins because of the current image of science as a White, male discipline. Miller et al. (2021) also noted how gendered expectations and lack of inclusive representation in learning resources affect learners' motivation and participation. Similarly, implicit teacher biases particularly related to gender and race reinforce inequalities at the classroom level (Kurniawati, 2021; Miller et al., 2021).

El-Hamamsy et al. (2023) stated that digital tools may be employed in order to make the learning process more personalized and engaging, but they should be used fairly and with a goal. Their study highlights that the use of digital resources is not the only way to establish equity, but teachers have to create diverse tasks that recognize and appreciate different opinions. Hughes et al. (2022) had discovered that in the context of the COVID 19 pandemic, not all children could access digital devices mostly those

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in remote areas or deprived or the internet. Educators were resourceful in the application of mobile phones, TV and home materials, demonstrating community based solutions to guarantee uninterrupted learning and reduce the impact of digital exclusion. Pierson et al. (2024) also prioritized the position of a teacher and self-awareness in resolving equity issues. According to their research, several instructors of science cannot resist power gaps accidentally because they do not consider the combination of classroom authority and race, language and gender.

Equity Issues in Science Education

Within primary science education, equity concerns arise in curriculum design, teaching methods, and resource availability. Research indicates that science programs are often not localized, thereby failing to reflect the cultural or lived experiences of marginalized children (Jackson et al., 2021; Kurniawati, 2021). This disconnect makes students perceive science as irrelevant to their lives and futures. Miller et al. (2021) observed that classroom dynamics and teacher expectations often exclude girls disproportionately from inquiry-rich activities. Similarly, Pierson et al. (2024) showed that equitable science teaching for multilingual learners requires not only linguistic access but also classroom environments that affirm diverse identities.

Xu et al. (2025) emphasized that teachers need professional development in both content and pedagogy, particularly in designing inquiry-based activities for students from diverse backgrounds. Without adequate preparation, teachers may resort to linear, one-size-fits-all teaching approaches that exclude culturally and linguistically diverse learners. Hussenius (2014) found that preservice teachers develop stronger equity perspectives when social justice themes and STEM materials are integrated, suggesting interdisciplinary instruction can advance equity. Yet, studies also highlight gaps in addressing how scientific tools, concepts, and classroom authority shape participation and exclusion, especially for children facing trauma, poverty, or systemic marginalization (Gilbert et al., 2024).

Furthermore, socio-economic status and rurality remain critical determinants of access to hands-on science experiences. Hughes et al. (2022) confirmed that during remote learning, many students could not engage in experiments due to lack of digital infrastructure. In informal STEM education (ISE), advantaged youth remain overrepresented, while marginalized students face barriers of cost, accessibility, and cultural exclusion (Godec et al., 2022). This has shifted the focus toward equity-oriented design strategies that transform ISE into welcoming environments (Godec et al., 2024; Hinojosa et al., 2021). Tools such as the Equity Compass are increasingly used to help educators reflect critically on their own assumptions, privileges, and positionalities to create socially just learning spaces (Archer et al., 2024). Yet, caution is noted in maker education, where despite claims of democratization, unchecked power relations risk reproducing inequities (Ioannou & Gravel, 2024).

Finally, the most recent literature expands the fundamental definition of equity in science and mathematics education. Beyond access and achievement, equity now involves identity, representation, and power (Kersting et al., 2025; Vithal et al., 2024; Hinojosa et al., 2021). This perspective recognizes that equity should not only focus on measurable outcomes but also on lived experiences, recognition, and meaningful engagement of diverse learners.

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Rationale for this view

A systematic review on equity issues in science education is needed. Based on the literature review a few gaps in existing research have informed the current systematic review. Most studies concentrate on the race, language, or gender, yet not many studies determine the way they intersect in science learning contexts. Although all the studies recognize the significance of inclusive approaches (e.g., inquiry based learning, STEAM integration), most of them do not contain the implementation of working models to promote equitable instruction in primary classes. Science education must foster inclusion and participation from all students, rather than excluding some, and simply transmitting knowledge. Without addressing inequitable representation, inequitable opportunities, and inequitable outcomes in science education, inequity will perpetuate and deepen within every level of the education system. This study seeks to deepen the conversation around equitable transformative practices in science education by grappling with the intersections and complexities of learner inequitable experiences.

Multiple research studies indicate that educational technology may support inequality when it is not ethically deployed especially among learners in linguistic and socio economically diverse environments. The current study seeks to explore systematically the existing empirical research on equity issues in science education. The study aims to highlight how factors including gender, cultural background, socioeconomic status, language and availability of resources impact students' access to engage with science education equitably.

Research Questions

The current systematic review study addressed the following research questions:

RQ1: What are the general characteristics of the reviewed studies (e.g., methodologies, participants, data collection tools, domains, publication years, authors' countries of origin and digital tools used in the studies)?

RQ2: What are the equity issues in teaching science, as reported in the reviewed studies?

Method

Literature search and manuscript selection process

In this study, following the latest PRISMA guidelines, a systematic review of previous review studies in science education was conducted. Specifically, the systematic-review (umbrella review) method supplemented by bibliometric analyses was used. The manuscript selection was processed under three stages: identification, screening and included.

Identification

On June 2nd (last access), researchers conducted an extensive literature search using the WoS electronic database, which includes publications in high-ranking peer-reviewed journals and is widely acknowledged as a primary source of review and bibliometric data that meet high quality standards. WoS facilitates effective literature searches, supports various information purposes and aids research topic mapping, trend monitoring as well as scholarly activity analysis.

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To comprehensively identify potentially relevant review studies in science education, researchers developed an inclusive search query targeting specific terms in the titles, abstracts and keywords of papers. The prompts used to select such relevant articles were:

(**TOPIC**) ((equity *OR equity issues* OR equity issues* OR equity* OR equity issues* OR equity* OR equity* OR equity issue *OR equity)) AND (**TOPIC**) ((science education* OR science* OR primary* OR primary science education* OR STEM education).

Based on these search strings, an online search was conducted that initially yielded records 384,669 (Taylor & Francis) and 240,698 (Springer Link).

Eligibility criteria

In this stage, data cleaning filters were applied based on the manuscript inclusion and exclusion criteria (see Table 1).

Table 1. Eligibility criteria for the review

Category	Inclusion criterion (IC)	Exclusion criterion (EC)
Language	IC1: studies published in English	EC1: studies not published English
WoS research field	IC2: research filed is education/ educational research, education, general, primary/elementary education, science education/ education science other topic science or inclusive other topics	EC2: research field is other than education/educational research, education, general, primary/ elementary education, science education/ education science other topic science or inclusive other topics
Document type	IC3: articles	EC3: other than review articles
Research focus	IC4: original papers and conference paper at all science education, including science as a service subject	EC4: original papers in discipline
Database	IC5: studies indexed Taylor & Francis and Springer Link (WoS)	EC5: studies not indexed in Taylor & Francis and Springer Link (WoS)

First, the identified records were electronically filtered based on language, resulting in the retention of 384,503 (Taylor&Fransic) and 239,176 (Springer Link) papers published in English. Subsequently, the selection was narrowed down to 477 (T&F) and 9,325 (Springer Link) papers using the following five categories of research areas within the WoS: ‘education, educational research, primary/elementary education, other topic inclusion and special educational needs (T&F) and ‘education, education, general, science education, education science, educational research other topic inclusive education (Springer Link)’. Following this categorization, further dataset was refined and accessing 430 (Taylor & Fransic) and 4,545 (Springer Link) within the ‘article’ categories of the WoS database. Further, records were categorized lacking

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publication date. Notably, to comprehensively capture publication trends, no restrictions were imposed on the publication years of the studies. In the subsequent phase, a meticulous manual screening of the titles, abstracts, and keywords of 430 (Taylor and Francis) and 4,545(Springer Link) papers led to the identification of 403 (Taylor and Francis) and 4,541 (Springer Link) studies in science education.

Included

Ultimately, after an extensive review of the full-text versions of initially identified 403(Taylor and Francis) and 4,541 (Springer Link) papers, four (Taylor and Francis) and nine (Springer Link) eligible review articles remained for analysis as these papers fulfilled our criteria comprehensively (see the list of included studies; see Fig. 1 for the flow diagram of the entire menu-script selection process). Afterward, as detailed below, the data analysis process commenced with the inclusion of these eligible review papers in science education

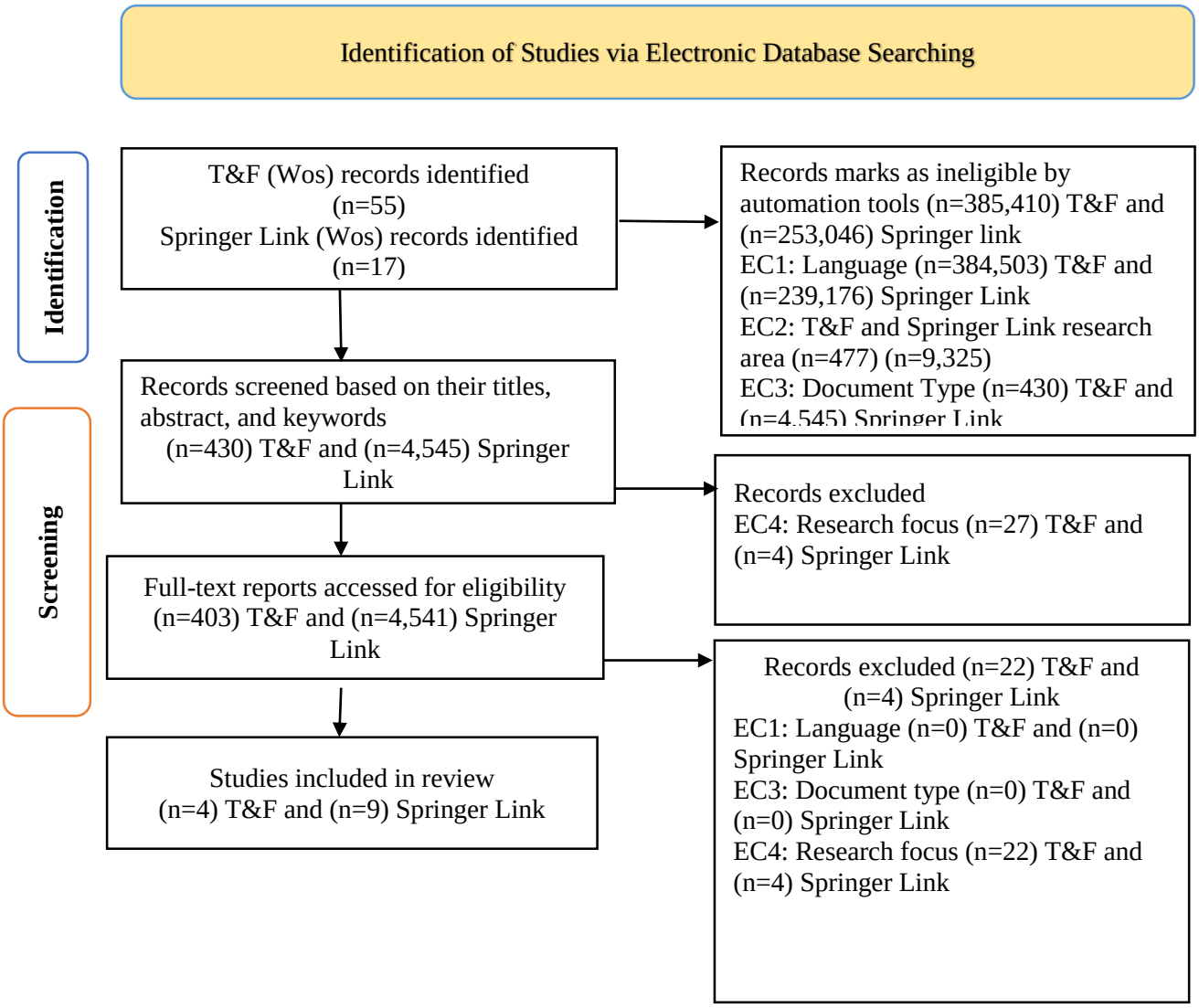

Figure 1. Flow diagram of the manuscript selection process

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Data analysis

After incorporating 13 studies into this meta-review and bibliometric analysis, the identified records was compiled into a marked list on WoS. Then, the records were exported into MS Word file formats for analysis. The analysis consisted of content analysis and bibliometric analysis (see Fig. 1).

For the content analysis, the records were meticulously organized using MS Word. The full-text versions of all included articles were scrutinized and coding them based on (1) publication year, (2) publisher, (3) review type, (4) number of included studies (sample size), (5) guidelines and protocols for the article selection process, and (6) the theoretical and conceptual framework of the studies.

Our coding manual, informed by prior studies, guided this process. After completing the content analysis coding procedure, 20% of the papers (n=52) were double coded based on the initial coding protocol. The intercoder reliability, gauged at 0.92, signifies the presence of a coding system that exhibits satisfactory reliability. Any discrepancies were addressed through discussions among the coders until consensus was reached.

For the bibliometric analysis, VOSviewer software (version 1.6.20) was used, which is widely recognized and extensively used in various fields, including the educational sciences. Chigbu et al. (2023) pointed out that the WoS database plays a key role in facilitating bibliometric analyses across various disciplines. These analyses help establish trends in the development and application of knowledge within specific subjects and disciplines. In this study, the bibliometric network presented in the results chapter consists of nodes and edges, with nodes representing entities such as publications, journals, researchers, or keywords. Edges denote relationships between pairs of nodes, indicating not only the presence or absence of connections but also conveying the intensity or strength of relationships (van Eck & Waltman, 2010). For distance-based approaches, the positioning of nodes in a bibliometric network reflects their approximate relatedness based on proximity.

Utilizing VOSviewer software, researchers conducted (1) co-authorship analysis (authors and countries) to elucidate collaboration patterns and contributions, (2) co-occurrence analysis (focusing Author Keywords) to scrutinize knowledge structures and the distribution and development of key research topics in mathematics education, and (3) citation analysis to probe deeper into research influences and citation networks, drawing insights from the documents and sources (Appendices C to K). This multifaceted approach allowed us to gain a comprehensive understanding of the bibliometric landscape and collaborative structures, thematic foci, and the influence of key works on science education. Figure 2 shows the analytical process of the study.

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Analysis process of a meta-review and bibliometric study on review studies in science education

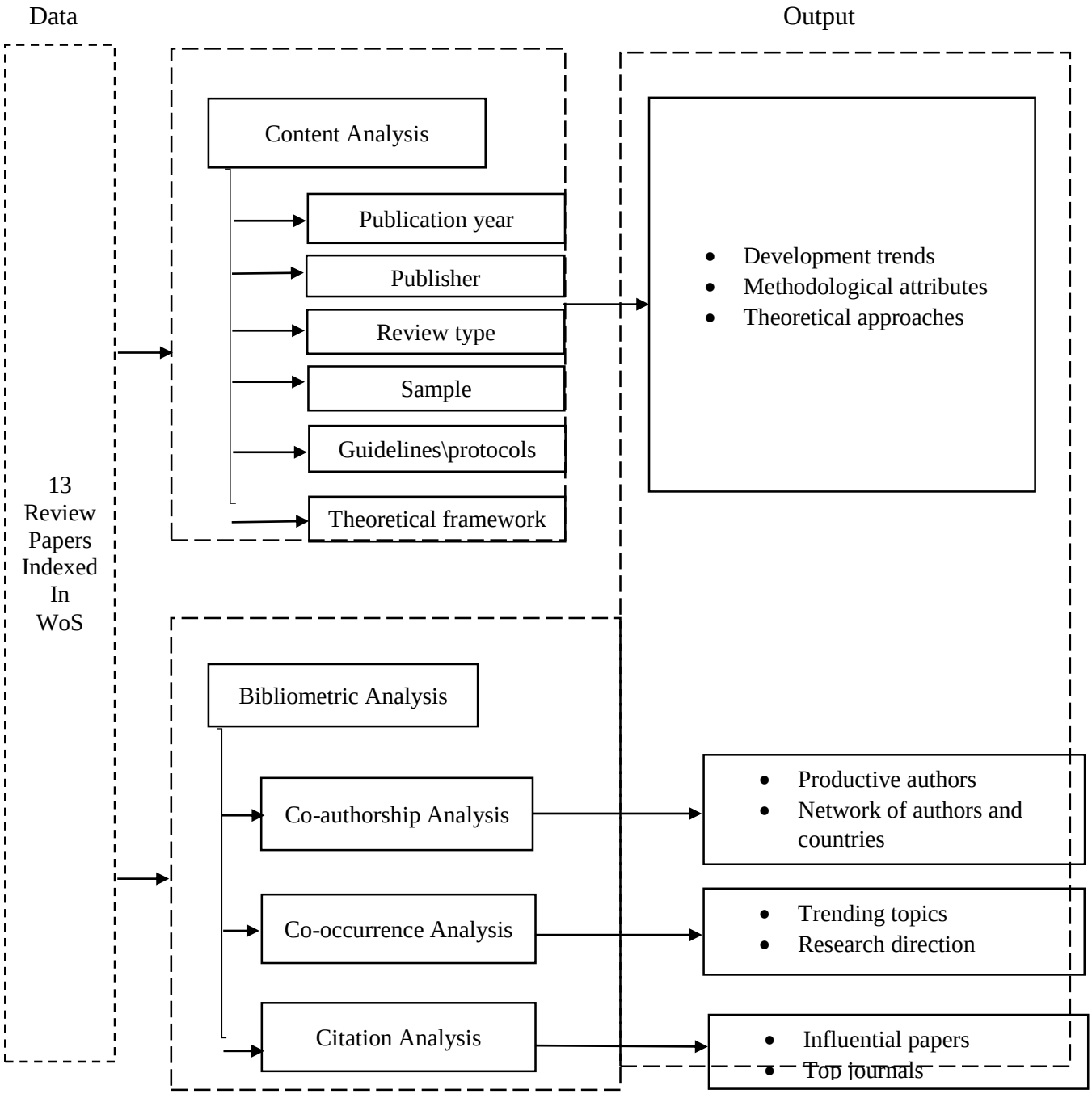

Figure 2. Analytical process for this Study

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Results

The review produced 13 peer reviewed research articles focusing on equity issues in primary science education. The majority of the studies (n = 9) in our review primarily indicating equity related science education, specially relating to worldwide changes in educational methods before, during and after the COVID 19 pandemic. One of study (Hussenius, 2014) represents earlier foundational work, offering long term insights into persisting challenges like teacher preparedness and language barriers. Articles like (Burton, 2024) and (Hussenius, 2014) conducted a comprehensive literature review on equity frameworks. Although, the focus is on primary education, there have been studies that included early childhood and lower secondary perspectives (e.g., (Burton, 2024) and (Kurniawati, 2021). This suggests that many studies have particularly concentrated on equity issues in primary science education.

RQ1: What are the general characteristics of the reviewed studies (e.g., methodologies, participants, data collection tools, domains, publication years, authors' countries of origin and digital tools used in the studies)?

Study characteristics

We gathered evidence that ranged from 2014 to 2025, with of the literature falling between 2019 and 2023 and the other published between 2024–2025. The majority of the articles (92%) were qualitative, usually employing case studies, conceptual frameworks, or content analyses, whereas only 7% employed a quasi-experimental design.

Sex of participants was rarely reported as 92% of studies did not break down by sex and only one study was conducted solely among female participants. None of the studies included in this review reported in-depth male vs. female comparison data. Multiple region research in United States (76%), with the rest of the studies concentrating on single regions like Portugal, Ethiopia, and Indonesia.

In terms of participant age, 38% of the studies worked with elementary-aged children (K–5), 30% worked with middle school students (grades 6–8), and 30% with early childhood (Pre-K). No studies specifically targeted high school students, but some indirectly mentioned K–12 systems. For results, there was only 7% of studies that clearly measured academic achievement and the rest looked at larger conceptual, equity, inclusive practices and STEM literacy.

Table 2. Study characteristics

Study characteristics	Count	%
Period		
2014-2018	1	8%
2019-2023	7	54%
2024-2025	5	38%
Sex		
Female and male	1	8%
Female only	12	92%
Region		
United states	10	76%

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Portugal	1	8%
Indonesia	1	8%
Central Ethiopia	1	8%
Age group		
Early education (Pre-K)	4	31%
Elementary (K-5)	5	38%
Middle school (6-8)	4	31%
Study design		
Quasi- experimental	2	15%
Qualitative	6	46%
Systematic review	2	15%
Comparative case study	2	15%
Editorial	1	8%
Outcomes measures		
Academics achievement	1	8%
Equity strategies	6	46%
Inclusive practices	3	23%
STEM literacy	3	23%

RQ2: What are the equity issues in teaching science, as reported in the reviewed studies?

All 13 empirical studies examined in this review reported the equity issues in teaching science. The most frequently described equity issues were access and inclusion barriers (n=3), gender and cultural bias (n=4), teacher preparedness and beliefs (n=5), language and communication (n=2) and curricular and assessment issues (n=3).

Access and Inclusion Barriers

Some of the surveyed papers reported that the equity issues in primary science education were due to access and inclusion (23%, n=3). According to Burton (2024) study stated that children in low-income families have 40 to 50% less exposure to STEM learning materials and activities compared to peers from more affluent socioeconomic status. The schools in economically poor location were less likely to have science labs, facilities, digital devices or interactive science kits, which possess limited hands-on engagement and create gaps in learning opportunities.

The students with disabilities face challenges when science teaching is not tailored to the needs of students and they are not provided equal learning opportunities. The curriculum and methodology lack inclusive planning, which causes students to become disengage and perform below expectation. The teachers find it difficult to successfully include all students, due to lack of preparation and lack of institutional emphasis on inclusive education (Jackson et al., 2021). According to Miller et al. (2021) approximately 30% of the students from marginalized area did not have access to internet or digital devices during pandemic 19 related online learning, impact their participation in virtual science lessons. According to the survey results, teachers found it difficult to engage students without access to technology, which decreased

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their engagement and achievement in science.

Gender and Cultural Bias

Science education is shaped by Eurocentric knowledge framework and male dominated norms. Girls and students from non-dominated cultures are excluded, which effects students' self-esteem, interest in science and involvement. The analysis revealed that gender and cultural bias is another equity issue in teaching science (30%, n=4). Hussenius (2014) discovered that classroom practices and science curriculum usually encourage male oriented viewpoints while neglect feminist insights.

Taddese et al. (2025) highlighted that more than 85% of the content in textbooks was Eurocentric, which prevented minority students from cultural connection and participation. Martell (2021) described how teacher expectations were affected by gender, with teachers unconsciously assuming boys were better at science. This causes bias in teacher student interactions and contributes to a girls' confidence gap in STEM subjects. Another issue highlighted by Baptista et al. (2023) is that the majority of professional development efforts fail to equip teachers to identify or respond to cultural or gender-based biases within the classroom. This deficiency in training reinforces unequal classroom dynamics and restricts inclusive pedagogy approaches.

Teacher Beliefs and Preparedness

Another issue reported in studies that teachers play an important role in delivering equitable instruction (38%, n=5). However, a lot of them are untrained in inclusive practices or have unconscious bias that influences how they interact with the students from different backgrounds. According to Martell (2021) the impact of teacher beliefs on equity in science education demonstrate that implicit teacher bias influenced expectation of students in gender and racial minorities whereas Baptista et al. (2023) found that majority of teacher’s preparation programs do not cover equity and cultural responsiveness topics and leaving teachers unprepared. Equity challenges in STEM teaching highlighted that the way untrained teachers fail to adapt science lessons for multilingual or culturally diverse pupils, instead reinforcing exclusion (Hussenius, 2014). It comes out to show that the majority of teachers are not prepared to use digital tools in an equitable manner; particularly when teaching students with special needs or those from underrepresented populations. The absence of professional development on inclusive technology uses existing disparities. Teacher unconsciously disengages students who require extra support or different learning formats (El-Hamamsy et al., 2023).

Xu et al. (2025) emphasizes that teachers require professional development not only on content but also on the methods of designing inquiry-based activities involving students from all backgrounds. Most teachers felt inadequately prepared to do so effectively. Without proper preparation, teachers might fall back to linear, one size fits all teaching approaches, which exclude students who learn differently or are culturally linguistically diverse.

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Language and Communication

One more challenge highlighted in reviewed studies that language and communication is also an equity issue in teaching science (15%, n=2). Multilingual students face difficulties with science learning when they are taught exclusively in the majority language (e.g., English). Some students in science classes may not speak English as their first language and many speak multiple languages. However, majority of science classes are only taught in English, using complex terms. This makes it hard for children to ask question, understand the instruction and explain their thoughts as results. This restricts their capacity to understand instruction and participate in scientific discourse. Kurniawati (2021) noted that language equity in science education if often overlooked, as language barriers are rarely used in science instruction, which marginalizes English language learners in disciplines with a lot of concepts. Teachers frequently fail to provide English Language Learners (ELLs) with additional support, such as visuals aids, translation or simple explanation. As a results, even if they are excellent in science, many bilingual students find it difficult to stay up in science studies. According to Hussenius (2014) teacher fails to provide adequate linguistic support, students who speak more than one language may participate less and score lower. This is not because they don't grasp the science, but they don't completely comprehend the language being utilized.

Curriculum and Assessment

Another issue reported in reviewed studies that curriculum and assessment inequities is also an equity issue in teaching science (23%, n=3). Exams and science classes are frequently created in one size fits all manner. The majority of textbooks concentrate on western concepts and examples. Students with varied learning styles or cultural background don't understand this. Because of this, many students, even those who are capable and interested, they misunderstand in science classrooms. A study by Taddese et al. (2025) state that science textbooks ignore local knowledge. They might never discuss how other culture perceive nature and instead exclusively teach science based on European discoveries. Students could argue that science has little impact on their communities, families or daily lives. Another study by Hughes et al. (2022) showed that the majority of science exams are created in a fairly fixed and traditional manner. These tests don't consider that some students may be intelligent but present their information in various ways. Students who speak multiple languages or come from diverse culture are particularly harmed by this. Xu et al. (2025) stated that there should be greater flexibility in how science is taught and assessed. They recommended groups talks, practical experiments and projects as alternative to written exams. Students can demonstrate their knowledge in a variety of ways using these "inquiry based" approaches, which is more equitable for everybody.

Limitations

The systematic review provides useful insights into issues of equity in primary science education, but a number of delimitations need to be noted. First, the analysis was restricted to just thirteen peer reviewed studies and so might limit the range and diversity of representation from various educational systems and national contexts. Second, the review confined itself to articles in the English language and thus

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excluded potentially valuable research published in other languages. Third, a significant proportion of included studies focused on educational disruption linked to the COVID-19 pandemic, which could disproportionately affect the representation of long-term equity issues in the literature. Lastly, the results for certain countries or regions might not be entirely generalizable to other settings due to differences in policy structures, infrastructure and pedagogical practices.

Discussion and Conclusion

This systematic literature review aims to explore and characterize inequity and inequity issues and inequity regarding some specific research studies on primary science education. The findings highlight the depth of inequity and inequity issues resulting from inequity embedded within the education system. Despite the inequity issues embedded within education systems, the inequity issues within primary science education, primary science education inequity issues, and within education systems inequity issues poses a complex, dynamic, and multifaceted challenge to the education system and involves the intersection of social class, gender, language, culture, and representation, and the preparedness of teachers. The studied literature illustrates that equity involves more than the equality of access, whereby the engagement, interaction, and relations of students toward science within multicultural and multilingual classrooms are required to undergo fundamental transformation (Jackson et al., 2021; Miller et al., 2021).

Several studies identified unequal access to resources, including science materials, laboratories, and digital tools, as one of the key issues. Disadvantaged areas and rural districts face a lack of basic infrastructure, which hinders the opportunity for students to engage in hands-on and inquiry-based science learning (Burton, 2024; Miller et al., 2021). Findings regarding the inequities in access to informal STEM education (ISE) are similar. Students who belong to more affluent communities are greatly overrepresented while marginalized young people face inequities of cost, access, and exclusion at a cultural level (Godec et al., 2022). Non-participation in these opportunities should not be attributed to lack of interest; more often, it is institutions that fail to provide fully inclusive opportunities (Hinojosa et al., 2021).

Teaching materials and curricula can show sociocultural biases. For example, science textbooks and teaching practices ignore traditional cultures and minoritized languages and lean toward Western dominance. Such neglect can affect students' identity and ability to connect to science, especially those belonging to minority and linguistically diverse populations. Conversely, students are more diverse linguistically and culturally than ever before, especially in science education. This requires more than language proficiency; culturally sustaining pedagogy, which values and builds on students' cultural and linguistic resources, is essential (Kersting et al., 2025; Vithal et al., 2024).

Another gap is the unpreparedness and lack of professional development for teachers, specifically in equity-oriented instructional practices. Teachers claimed that science content was unmodifiable for students with disabilities, and gender biases, as well as multilingual education, due to a lack of inclusive responsive pedagogy training (El Hamamsy et al., 2023; Xu et al., 2025). Archer et al. (2024) noted that the Equity Compass and similar tools aid practitioners in critically analyzing their positions and

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planning equity-focused pedagogy.

Language access is another equity issue that is under addressed. Academic language is central in science teaching, which becomes an obstacle for multilingual students as teachers do not use scaffolds or translanguaging practices (Kurniawati, 2021; Martell, 2021). This restricts the engagement of students who can understand scientific principles but are unable to articulate themselves in the prevailing learning language.

When it comes to creating learning plans and evaluating what students know, our current methods often fall short in promoting fairness. Many educational programs use a 'one-size-fits-all' approach, which unfortunately overlooks the diverse ways different students learn and what they need (Taddese et al., 2025). Standardized tests and learning materials that do not connect with students' cultural backgrounds often fail to truly show the scientific potential of students who come from various linguistic and cultural backgrounds. Xu et al. (2025) advocate for the adoption of more dynamic, inquiry-based assessment methods, such as group discussions and practical experiments, to provide students with multiple avenues for demonstrating understanding.

In addition, although most studies promote inclusive models such as culturally responsive pedagogy and STEAM infusion, there are limited ones that offer realizable implementation models (Gilbert et al., 2024; Hughes et al., 2022). There exists limited research studying the intersections of race, language and gender in science learning spaces when, in fact, such intersections strongly determine education outcomes. Simultaneously, the literature highlights that equity discussions are expanding to include identity, recognition, and representation, moving beyond access and achievement (Kersting et al., 2025; Vithal et al., 2024).

In spite of the acknowledgment of inclusive strategies such as inquiry based and contextual learning, they were frequently implemented randomly and inadequately supported. The educational gap gets worse by digital inequality, which was especially highlight during the COVID 19 pandemic. Although there were some innovative attempts (e.g., conducting experiments with households' item or television), most students were left behind because of no internet, devices or family support (Baptista et al., 2023). These findings align with broader equity research documenting that digital tools may reduce participation gaps when fairly deployed, but can reinforce inequality when access is uneven (El-Hamamsy et al., 2023; Hughes et al., 2022).

Teachers should be assisted with continuous professional training, curriculum writers need to integrate culturally nuanced content, and policymakers should invest in inclusive facilities and pedagogical innovation. Overall, the results highlight the need for systemic change rather than just removing personal obstacles in order to achieve equity in science education. Policymakers should invest in inclusive infrastructure and innovative teaching methods, curriculum designers must incorporate culturally relevant content, and teachers require support through continuous professional development (Baptista et al., 2023; Hussenius, 2014; Miller et al., 2021).

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Appendix A. The studies included in the current systematic review

Table A1. APA References of the Reviewed Study

[1]	Andrew Gilbert, J. S. (2024). Exploring the development of preservice teachers' visions of equity through science and mathematics integration. International Journal of Science and Mathematics Education, 23, 489-514.
[2]	Ashlyn Pierson, D. T. (2024). Designing to support

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	equity as transformation perspectives for multilingual science learners. Instructional Science, 52, 761-793.
[3]	Bradley S. Hughes, M. W. (2022). Integrating arts with STEM and leading with STEAM to increase science learning with equity for emerging bilingual learners in the United States. International Journal of STEAM Education, 9.
[4]	Burton, V. C. (2024). Breaking barriers: Utilizing a STEM equity framework

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	for analyzing primary picture books. Early Childhood Education Journal, 53, 1681-1692.
[5]	Christa Jackson, M. J.-S. (2021). Equity-oriented Conceptual Framework for K-12 STEM literacy. International Journal of STEM Education, 8.
[6]	Emily C. Miller, E. R. (2021). Supporting Equity in Virtual Science Instruction Through Project-Based Learning: Opportunities and Challenges in the Era of COVID-

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	19. Journal of Science Teacher Education, 32(6), 642–663.
[7]	Esayas Teshome Taddese, B. M. (2025). The practice of inclusive education in central ethiopia regional state: a case study of primary. Education 3-13.
[8]	Hussenius, A. (2014). Science education for all, some or just a few? Feminist and gender perspectives on science education: a special issue. Cultural Studies of Science Education, 9, 255-262.

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[9]	Kurniawati, F. (2021). Exploring teachers' inclusive education strategies in rural Indonesian primary schools. Educational Research, 63(2), 198-211.
[10]	Laila El Hamamsy, B. B. (2023). How are primary school computer science curricular reforms contributing to equity? Impact on student learning, perception of the discipline, and gender gaps. International Journal of STEM Education, 10(1).
[11]	Lihua Xu, J. S. (2025). A

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	conceptual framework for fostering gender equity in early years STEM education. International Journal of Science and Mathematics Education.

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Ref. No	Authors	Research Focus	Hardware	Software	Domain	Tracking System	Sample Size	Participants	Research Methods	Data Collection	Equity Issues
7	Esayas Teshome Taddese, Bereket Merkine	Equity	Not mention	Not mention	Science	Not mention	Not specified	Teachers	Qualitative case study	Interview and Classroom observation	Teachers training, Resource and Accessibili
8	Anita Hussenius	Equity	Not mention	Not mention	Science	Not mention	Not applicable	Not applicable	Systematic review	Literature review	Gender biases
9	Farida Kurniawati	Equity	Not mention	Not mention	Science	Not mention	40	Teachers and their students	Qualitative study	Observation and Interviews	Access equity
10	Laila El-Hamamsy, Barbara Bruno,	Equity	Not mention	Not mention	Science	Longitudinal design	5,781	Teachers and their students	Qualitative and Quantitative study	Pre-test, Post-test and Surveys	Genders gaps and Performance gaps
11	Lihua Xu, Jiqing Sun, Jan Van	Equity	Not mention	Not mention	Science	Critical literature review	Not applicable	Not applicable	Conceptual framework	Literature review	Gender stereotypes
12	Melissa A. Navarro Martell	Equity	Not mention	Not mention	Science	Not mention	6	Teachers and their students	Qualitative	Interview and Observation	Language
13	Monica Baptista, Estela Costa and Iva	Equity	Not mention	Not mention	Science	Not mention					

[12] Martell, M. A. (2021). Ciencias bilingües: how dual language teachers cultivate equity in dual language classrooms. International Journal of Bilingual Education and Bilingualism, 25(6), 2142-2158.

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[13]	Mónica Baptista, E. C. (2023). Equity in teaching science during times of crisis: a study with portuguese science teachers. Cultural Studies of Science Education, 18, 631-646.

Appendix B. Summary table of the included studies
Table B1. Study Summary Table

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Ref. No	Author Name	Research Focus	Hardware	Software	Domain	Tracking System	Sample Size	Participants	Research Methods	Data Collection	Equity Issues
1	Andrew Gilbert, Jennifer Suh and	Equity	Not mention	GoReact (record and review	Science	Video recording	14	Pre-service teachers	Qualitative study	Video recording and lesson	Access, Empowerment and Empathy
2	Ashlyn Pierson, D.Teo keifort, AdamBell, Andrea	Equity	Cameras and audio	Not specified	Science	Video recording	18	In-service school teachers	Case study	Written refection and Video recording	Access and Language
3	Bradley S.Hughes, Michel W.Coppiga	Equity	Not mention	Not mention	Science	Fields logs	108	Teachers and their students	Qualitative study	Pre-test, Post-test and Surveys	Language
4	Victoria Cardullo and Megan Burtoon	Equity	Not mention	Not mention	Science	Not mention	Not specified	Not applicable	Qualitative content analysis	Books selection	Access and Empowerment
5	Christa Jackson, Margaret J.Mohr-Schroeder, Sarah B	Equity	Not mention	Not mention	Science	Not mention	Not applicable	Not mention	Systematic review	Literature review	Access
6	Emily C.Miller, Emily Reigh, Leema	Equity	Laptops or desktop	Video conferencing tools	Science	Not mention	2	Teachers	Comparative case study	Interview and Observation	Access barriers, Limited support and

Appendix C.

Figure C1. Co-authorship and author networks

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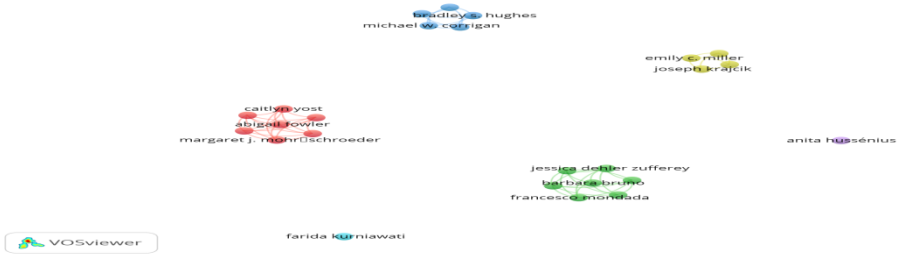
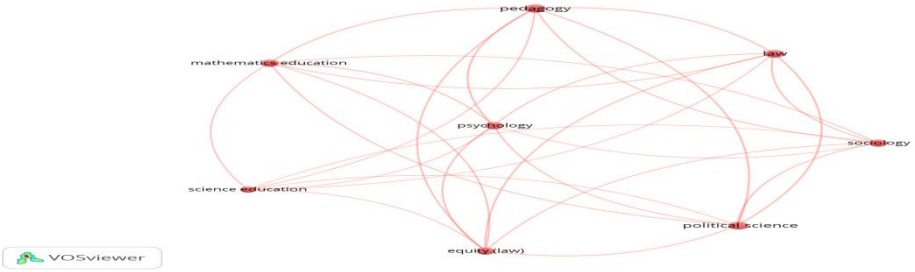


Appendix D.

Figure D1. Co-authorship and country networks

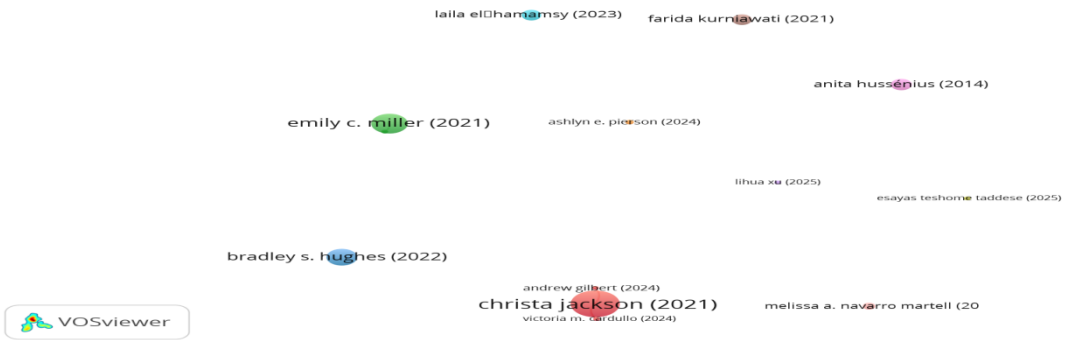
Appendix E.

Figure E1. Co-occurrence analysis of author keywords



Appendix F.

Figure F1. Citation and document analysis



Appendix G.

Figure G1. Citation and source analysis

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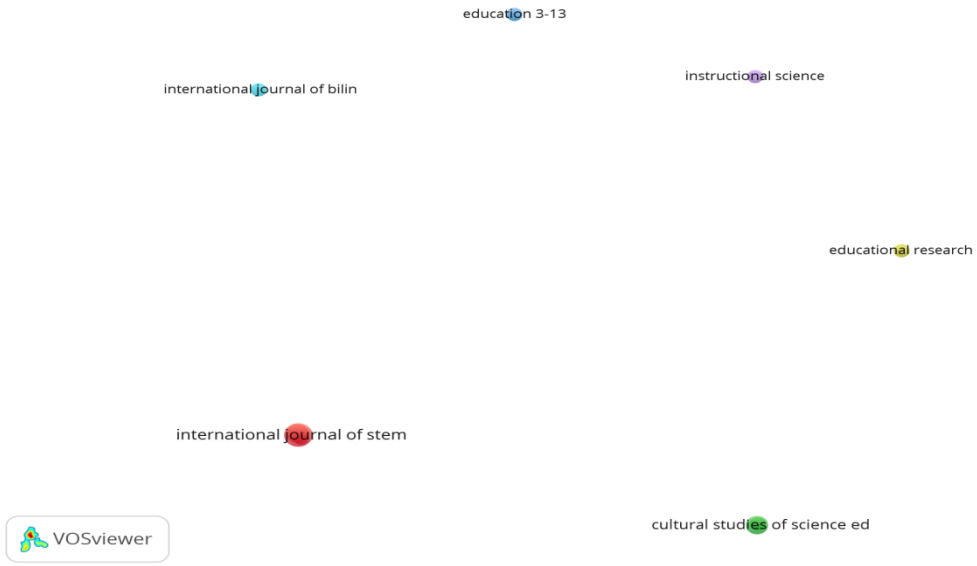

Appendix H.

Figure H1. Distribution of articles relevant to the survey (Articles per Year)

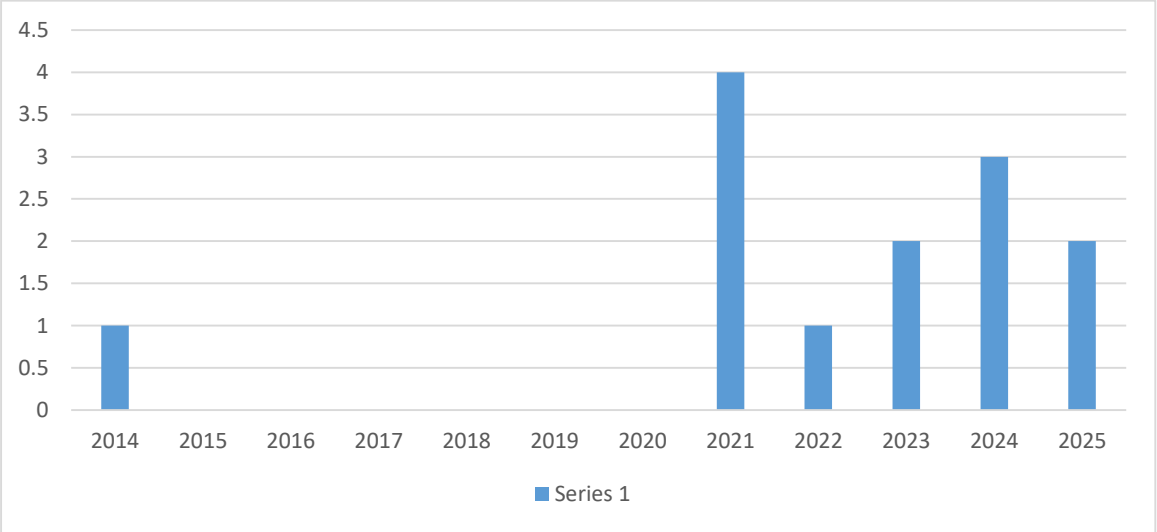

Figure H1 shows the number of articles published per year, distribution of articles relevant to the survey, highlighting the progression of research output over time in field of equity in primary science education. The first eligible publication was from 2014. The latest download was performed in June 2025. While on studies were published from 2015s to 2020s, by the mid-2021s dozens of studies were being added to the literature every year. From 2014, the growth appears nearly linear. While much of the growth is presumably due to the availability of new technologies, some appears to be driven by increased interest in this field.

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Appendix I.

Figure I1. Eligible Journals for the Survey

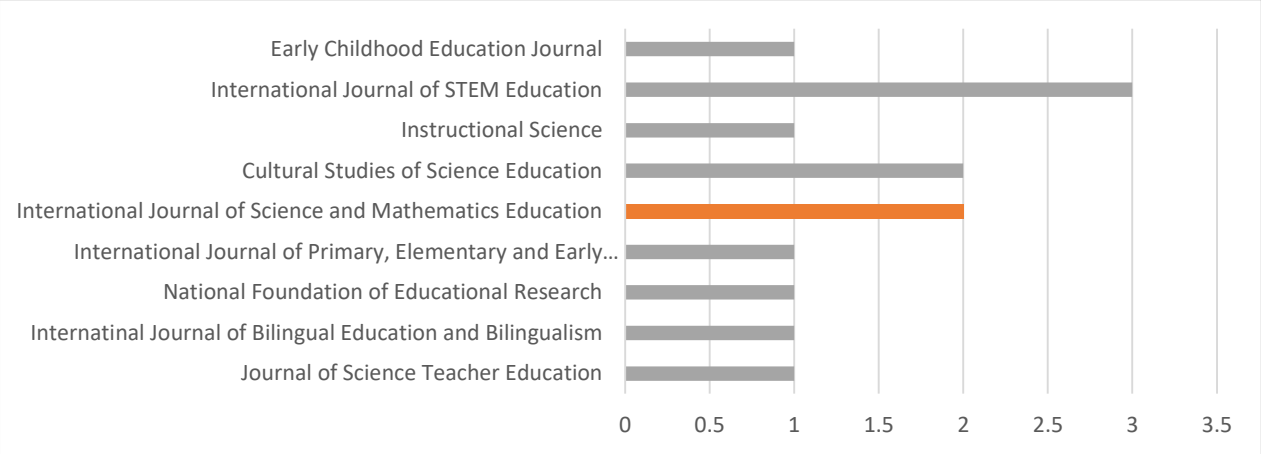

Figure I1 demonstrates that the largest number of articles (3) were published in the International Journal of STEAM Education, followed by Cultural Studies of Science Education (2 papers), International Journal of Science and Mathematics (2 papers), Early Childhood Education Journal (1 paper), Instructional Science (1 paper), International Journal of Primary, Elementary and Early Years Education (1 paper), National Foundation for Educational Research (1 paper), International Journal of Bilingual Education and Bilingualism (1 paper) and Journal of Science Education (1 paper). Our findings illustrate how infrequently equity issues appears in the field of primary science education: Of the 13 papers in our final sample, only 2 were published in mathematics education journals also (marked in orange in Fig. 9); nearly all were published in journals with an explicit focus on equity issues and primary sciences education.

Appendix J.

Figure J1. Researchers' contributions

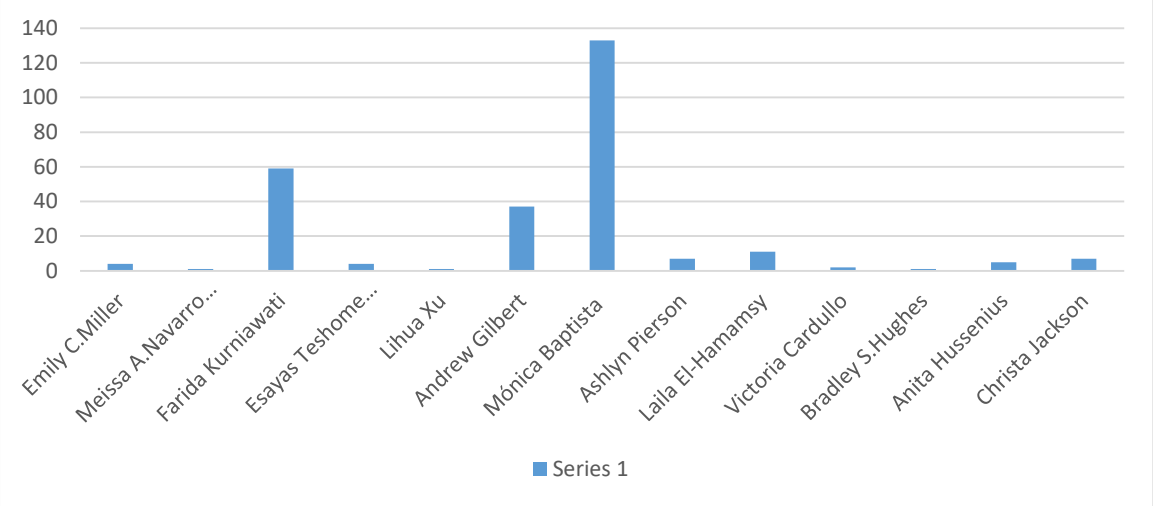

Figure J1shows four researchers had published more than 10 articles each. The

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researchers with the most articles in this field were Laila El-Hamamsy (11), Andrew Gilbert (37), Farida Kurniawati (59) and Mónica Baptista (133).

Appendix K.

Figure K1. Countries with more than one publications and over two citations

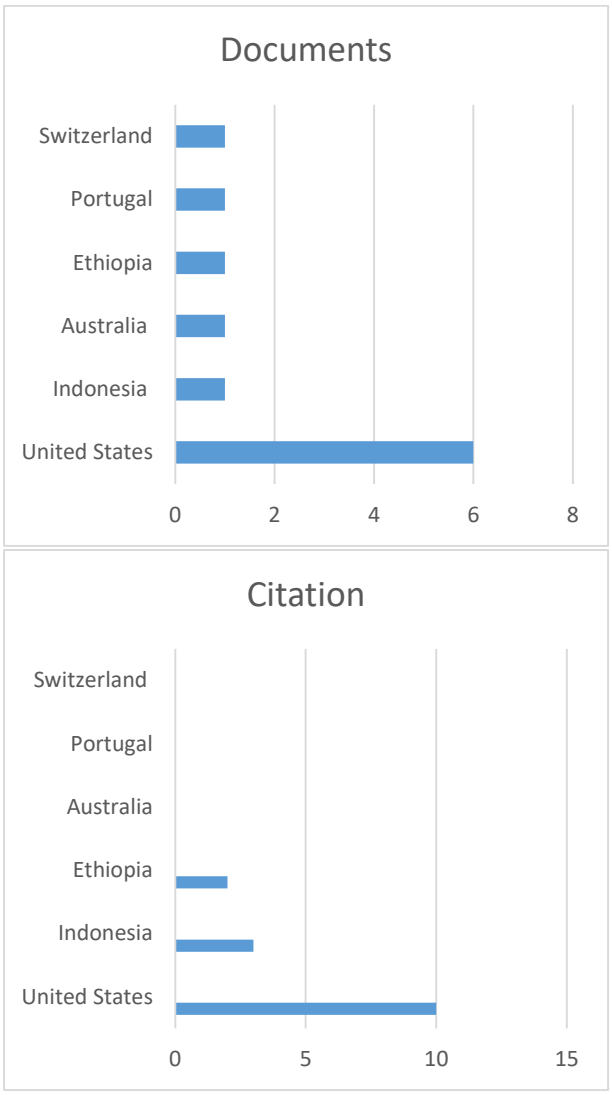

Figure K1 presents the countries of institution in which studies' co-authors worked. The US was in the lead with 6 research studies conducted in US institution, followed by Indonesia (1), Australia (1), Ethiopia (1), Portugal (1) and Switzerland (1).