International Journal of Learning, Teaching and Educational Research
Vol. 24, No. 10, pp. 1-29, October 2025
https://doi.org/10.26803/ijlter.24.10.1
Received Aug 4, 2025; Revised Sept 2, 2025; Accepted Sept 10, 2025

A Systematic Literature Review on Teacher Leadership Practices in Science and Mathematics Education (2019-2025)

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Abstract: This systematic literature review synthesises empirical research on teacher leadership practices in science and mathematics education published between 2019 and June 2025, addressing the main research question: What are the dominant research themes, theoretical frameworks, methodological trends, and enactment contexts of teacher leadership practices in science and mathematics education during this period? A total of 34 peer-reviewed articles indexed in Scopus, Web of Science, ERIC, and EBSCOhost (Education Source) were analysed using the PRISMA 2020 framework and PICOS eligibility criteria. The review aimed to identify dominant research themes, theoretical frameworks, methodological trends, and the enactment of teacher leadership in instructional, assessment, and systemic contexts. Eight dominant themes emerged, with professional development, instructional practices, and leadership identity being the most prevalent. Teacher leaders were found to play critical roles in mentoring, curriculum design, assessment reform, and equity advocacy. Theoretical frameworks such as Communities of Practice, Teacher Leadership Identity Theory, and Transformational Leadership Theory were frequently employed to conceptualise leadership. The review highlights significant gaps in three areas: leadership for marginalised groups is often informal and under-supported (equity and inclusion), insufficient studies from the Global South (global representation), and there is little quantitative or longitudinal research to measure impact (methodological diversity). This review contributes to the field by synthesising current scholarship, identifying critical gaps, and proposing recommendations for expanding methodological approaches, magnifying student and teacher voices, and reinforcing equity-driven, context-responsive leadership practices.

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Keywords: equity; leadership identity; PRISMA; professional development; science & mathematics education; teacher leadership

1. Introduction

The concept and practice of teacher leadership have been the focus of sustained research in established democracies such as the United States (US), the United Kingdom (UK), Canada, and Australia for several decades (Grant, 2019). Over the past four decades, the notion of teacher leadership has significantly evolved, particularly within science and mathematics education. Though initially confined to formal administrative roles, school leadership has increasingly been reconceptualised to include teachers as central actors in instructional and systemic reform (Darling-Hammond, 1998; York-Barr & Duke, 2004).

This shift emerged alongside the limitations of top-down educational reforms, especially during the standards-based movements of the 1980s and 1990s. Frameworks such as the National Council of Teachers of Mathematics (NCTM) and Curriculum and Evaluation Standards (CES), and related science reforms demanded that teachers not only implement curricula but also act as collaborative, inquiry-oriented leaders shaping learning and institutional practices (National Council of Teachers of Mathematics, Commission on Standards for School Mathematics, 1989; Spillane, 2005).

In the 21st century, teacher leadership has become a cornerstone of educational transformation, particularly in science and mathematics (Baker-Doyle, 2017). Though teacher leaders do not occupy formal leadership positions in school, they perform different professional roles, regarded as informal leadership (Blose & Khuzwayo, 2023). These roles encompass mentoring, curriculum design, leading instructional reform, and facilitating school-wide learning initiatives (Amador, 2019; Murphy, 2022).

In Science, Technology, Engineering, and Mathematics (STEM), teacher leaders do more than transmit knowledge; they engage in sophisticated professional practices such as eliciting and analysing learners' thinking, supporting curriculum design, mentoring colleagues, and leading school-wide initiatives (Akiba & Liang, 2016; Fairman & Mackenzie, 2015). Importantly, teacher leaders in science and mathematics are no longer viewed as extensions of top-down mandates but as change agents whose work is embedded in classroom practice, shaped by professional agency, identity, and community (Margolis & Doring, 2013; Poekert et al., 2016).

Hence, teacher leadership in science and mathematics education is particularly crucial given the complexity of the content, the demands of inquiry-based instruction, and the imperative to foster learners' engagement in science and mathematics pathways (Loucks-Horsley et al., 2010; Windschitl et al., 2012). We use the concept of teacher leaders in this paper to refer to teachers acting in informal leadership roles such as subject heads, master teachers, teachers who serve as mentors and coaches within schools, who are agents of change, promote professional learning, lead in and outside the classroom, and influence their

colleagues and the community through collaborative work to improve learning (Blose & Khuzwayo, 2023; Grant, 2019; Shen et al., 2020; Yow et al., 2021). This shift in how teacher leadership is conceptualised has offered new paths for research, but it has also caused contradictions between historical narratives of leadership and the realities of today's classrooms. While early reforms emphasised the importance of teachers as instructional leaders, current research shows that their contributions are still unevenly appreciated and understudied. This historical context is closely related to the current research problem: despite acknowledging the value of teacher leadership, empirical studies in science and mathematics continue to prioritise formal leadership roles over teachers' ground-level practices

Despite increased scholarly interest, the literature on leadership in science and mathematics education remains uneven and fragmented. Much of the research (Adams, 2022; Cunningham et al., 2023; Munje et al., 2020; Tan, 2023), to date, has concentrated on the role of school principals, deputy principals, and departmental heads as instructional leaders, particularly in managing curriculum reform and accountability pressures in science and mathematics education. While these studies have provided valuable insights into formal leadership practices, they often marginalise teachers' critical, ground-level contributions as leaders within their classrooms.

The limited attention given to teachers as agents of instructional change reflects a persistent gap in understanding how leadership is enacted by teachers who work directly with learners and curriculum daily. This is despite the identified need for research to investigate subject-specific leadership practices to improve teaching and learning in subjects such as science and mathematics (Lochmiller & Cunningham, 2019).

Addressing this gap has the potential to broaden the understanding of how teacher leadership can improve instructional quality, promote equitable STEM participation, and influence policies that recognise teachers as significant participants in education reform. By emphasising teachers' ground-level leadership, this study contributes not only to academic scholarship but also to practical initiatives for professional development, curriculum innovation, and sustainable education policy.

The global educational issues of post-pandemic learning recovery, STEM participation equity, classroom digital transformation, and continuous curriculum revisions, which align with 21st-century skills, mark this topic timely. Policy frameworks such as national STEM educational strategies from different countries and the UN Sustainable Development Goal 4 (quality education) further highlight the significance of enhancing teacher leadership as a lever for both instructional innovation and systemic change (United Nations, 2023).

This systematic literature review study, therefore, aims to examine existing empirical research on teacher leadership practices in science and mathematics education. The goal is to provide a comprehensive understanding of how teacher

leadership is enacted, supported, and sustained in science and mathematics education, and to inform future research, policy, curriculum design, and practice. In that pursuit, the systematic literature review was guided by the main research question: what are the dominant research themes, theoretical frameworks, methodological trends, and enactment contexts of teacher leadership practices in science and mathematics education?

The review aimed to answer these sub-questions:
1. How does the global distribution of research on teacher leadership in science and mathematics education vary by region and publication source, and what does this suggest about knowledge production and representation in the field?
2. Which theoretical frameworks and conceptual models underpin recent studies on teacher leadership in science and mathematics education?
3. What research methodologies are commonly employed to investigate teacher leadership practices in science and mathematics classrooms?
4. What are the dominant research themes in teacher leadership within science and mathematics education between 2019 and June 2025?
5. How is teacher leadership enacted across instructional practices, assessment, and beyond-classroom roles in science and mathematics education?
6. What gaps exist in the literature regarding equity, access, inclusion, and representation of diverse learners and contexts in studies on teacher leadership in science and mathematics education?

2. Conceptual Framework

This review is guided by an integrated conceptual framework developed from the most frequently used theories in studies of teacher leadership in science and mathematics education. While five dominant frameworks emerged from the papers reviewed, namely, Communities of Practice (CoP), Teacher Leadership Identity Theory, Transformational Leadership Theory, Distributed Leadership, and Socio-transformative Constructivism (STC), this review draws on three: CoP, Teacher Leadership Identity Theory, and Transformational Leadership Theory. They offer complementary perspectives on how teacher leadership is constructed, enacted, and sustained within science and mathematics education.

CoP theory, developed by Wenger (1998), provides a sociocultural lens to understand how teachers learn and lead through participation in shared professional activities. The theory is grounded in three interdependent elements: a domain of shared interest, a community that fosters mutual engagement, and a practice built around shared tools and experiences (Wenger,1998). In educational contexts, CoPs illuminate how teacher leaders co-construct knowledge, negotiate meaning, and build professional identities through collective reflection and sustained collaboration. In this review, the theory enabled us to explain how science and mathematics teachers develop and maintain leadership within professional learning communities, school networks, and curriculum reform efforts.

Teacher Leadership Identity Theory focuses on how teachers perceive themselves as leaders. Leadership is viewed not as a fixed role but as an evolving identity

shaped by experiences, interactions, institutional contexts, and self-reflection (Akkerman & Meijer, 2011; Beauchamp & Thomas, 2009). This perspective emphasises that leadership emerges through participation, recognition, and agency, and is deeply tied to teachers' sense of self and professional legitimacy. The framework was instrumental in understanding how science and mathematics teachers perceive themselves as leaders and how this identity evolves through practice, peer recognition, and engagement with wider systems. Transformational Leadership Theory (Bass, 1985) conceptualises leadership as inspiring change through shared vision, intellectual challenge, and individualised support. Bass (1985) outlines four key dimensions: idealised influence, inspirational motivation, intellectual stimulation, and individualised consideration.

In teacher leadership, this framework highlights how teachers can motivate peers, model reform-minded practices, and build collective capacity for innovation in science and mathematics instruction. This theory shaped our understanding of teacher leaders as those who motivate and empower students in their classrooms while simultaneously influencing colleagues, shaping pedagogical practices, and contributing to systemic change.

The integrated framework offers rich insights into teacher leadership as a collaborative, identity-driven, and empowering practice, but its limitations lie in insufficient attention to power, equity, structural constraints, and cross-cultural variability. Recognising these gaps highlights opportunities for future studies to complement this framework with perspectives that foreground justice, diversity, and system-level leadership dynamics. The Distributed Leadership and Socio-transformative Constructivism framework were excluded for specific reasons.

While Distributed Leadership has been widely applied in educational leadership research, it primarily emphasises the organisational distribution of responsibilities (Spillane, 2006) rather than the evolving identity and agency of individual teacher leaders, which was central to this study's focus. Socio-transformative Constructivism (STC), on the other hand, foregrounds equity, power, and critical social justice in science and mathematics education (Rodriguez, 1998). Although important, it was less directly aligned with the review's aim of understanding how teacher leadership is enacted within professional practice and identity development.

Figure 1 is a compiled conceptual framework drawing from the three theories. It underpinned the study and grounded our understanding of teacher leadership in science and mathematics education, as teachers lead in the classroom, among peers, and outside the classroom. These theories offer a holistic lens to analyse teacher leadership as a dynamic, identity-driven, and context-responsive practice that transcends classroom boundaries.

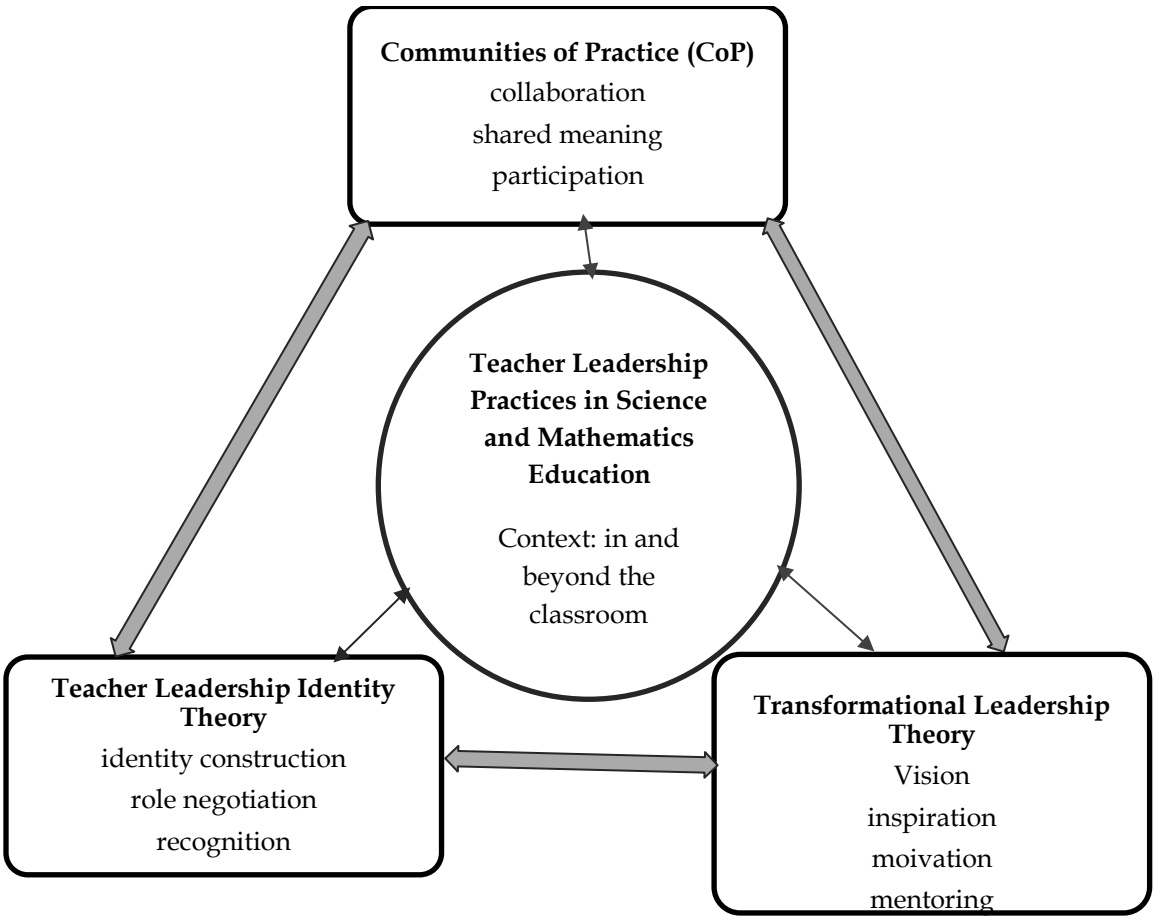

Figure 1: Conceptual framework of teacher leadership practices in science and mathematics (compiled by authors)

3. Research Methods

3.1 Design and Review Protocol

In conducting the Systematic Literature Review [SLR] in this paper, we employed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses [PRISMA] framework (Page et al, 2021). We followed this protocol to ensure methodological transparency, replicability, and rigorous synthesis (Page et al., 2021; Swartz, 2021) of empirical studies on teacher leadership practices in science and mathematics education. Although the review protocol was not formally registered (e.g., in PROSPERO), all review procedures, including search strategy, inclusion criteria, screening, and appraisal tools, were pre-defined and adhered to PRISMA standards.

3.2 Eligibility Criteria

During the planning stage, the five authors discussed and agreed on the databases to be used, the type of articles to be extracted, the period, and the eligibility criteria, and they formulated the search strings. The eligibility criteria agreed upon and used were the Population, Intervention, Comparison, Outcome, and Study [PICOS] framework (Amir-Behghadami & Janati, 2020). We applied the PICOS as our guiding framework for the eligibility criteria as follows:
Population: Teacher leaders, mentors, and primary or secondary school coaches.

Intervention: instructional and assessment practices in science and mathematics education, including leadership practices outside the classroom.
Comparison: Studies with or without control groups qualified for inclusion.
Outcome: Studies reported teacher leadership practices in science and mathematics teaching, assessment practices, and outside the classroom.
Study: Eligible studies included qualitative, quantitative, and mixed methods empirical studies published in peer-reviewed academic journals between 2019 and June 2025.

The review included peer-reviewed and published journal articles between 2019 and June 2025. The focus was on currently published articles on teacher leadership practices in science and mathematics education in major databases. Only articles published in English were included.

3.3 Exclusion criteria

Literature reviews and systematic review papers were excluded. Articles focusing on the higher education context were excluded. Research on the leadership practices of formal school leaders, such as the principal, deputy principal, and departmental heads, was excluded. All articles published before 2019 were excluded. Unpublished research, comments, editorials, book chapters, theses, and dissertations were excluded. Non-English publications were excluded due to translation limitations, a constraint that may have led to the omission of valuable perspectives, particularly from Latin America, Africa, and East Asia. Future reviews may incorporate multilingual teams or translation tools to address this gap. All studies that did not meet the PICOS eligibility criteria explained above were excluded.

3.4 Data Sources and Search Strategy

Systematic searches were conducted on four databases widely recognised for coverage in education and social sciences: Scopus, Web of Science (WoS), ERIC, and EBSCOhost (Education Source). The search was limited to studies published between January 2019 and June 2025. Two members of the research team independently conducted searches in all databases. The following search string was adapted to the syntax of each database:
("teacher leadership" OR "teacher leader" OR "teacher leading")
AND ("science education" OR "mathematics education" OR "science teaching" OR "mathematics teaching")
AND ("school" OR "secondary school" OR "high school")
NOT ("pre-service teachers" OR "systematic review" OR "literature review")

This structure ensured that all articles included:
1. A teacher leadership focus ("teacher leadership" OR "teacher leader" OR "teacher leading")
2. A disciplinary anchor in science or mathematics education ("science education" OR "mathematics education" OR "science teaching" OR "mathematics teaching")
3. A school-level context ("school" OR "secondary school" OR "high school")
4. Excluded irrelevant categories (e.g., "pre-service teachers", "systematic review", "literature review").

The initial search yielded 85 articles from Scopus, 685 from WoS, 501 from ERIC, and 338 from EBSCOhost, totalling 1,609 articles. Following automatic deduplication and pre-screening, 1,378 articles were removed as they focused on teacher leadership generally without addressing science or mathematics contexts. The remaining 231 records that were saved on EndNote proceeded to the screening stage.

3.5 Screening and Selection Process

A total of 231 articles from the four databases were screened. The articles were exported from EndNote to Rayyan for the screening process. Rayyan was used to manage the screening process, where the reviewers could include and exclude articles, indicating reasons for inclusion or exclusion (Johnson & Phillips, 2017). The two authors responsible for the search served as reviewers. One of the reviewers created an account on Rayyan and added the other reviewer. The exclusion and inclusion criteria were loaded on Rayyan. Each article's title and abstract were used for screening to assess eligibility based on the PICOS framework and relevance. At this stage, 186 were excluded due to their focus on higher education, school formal leaders such as the principal, and the literature review papers. The two reviewers also had meetings to discuss and concur on the articles to be excluded. All discrepancies were resolved during these meetings. In cases where consensus was not reached, a third reviewer (one of the authors) was consulted to make a final decision. A total of 45 empirical research articles met the inclusion criteria; however, 11 duplicates were removed, leaving 34 articles for the review. A PRISMA 2020 flow diagram (Figure 2) outlines the full selection process with explicit documentation of exclusion.

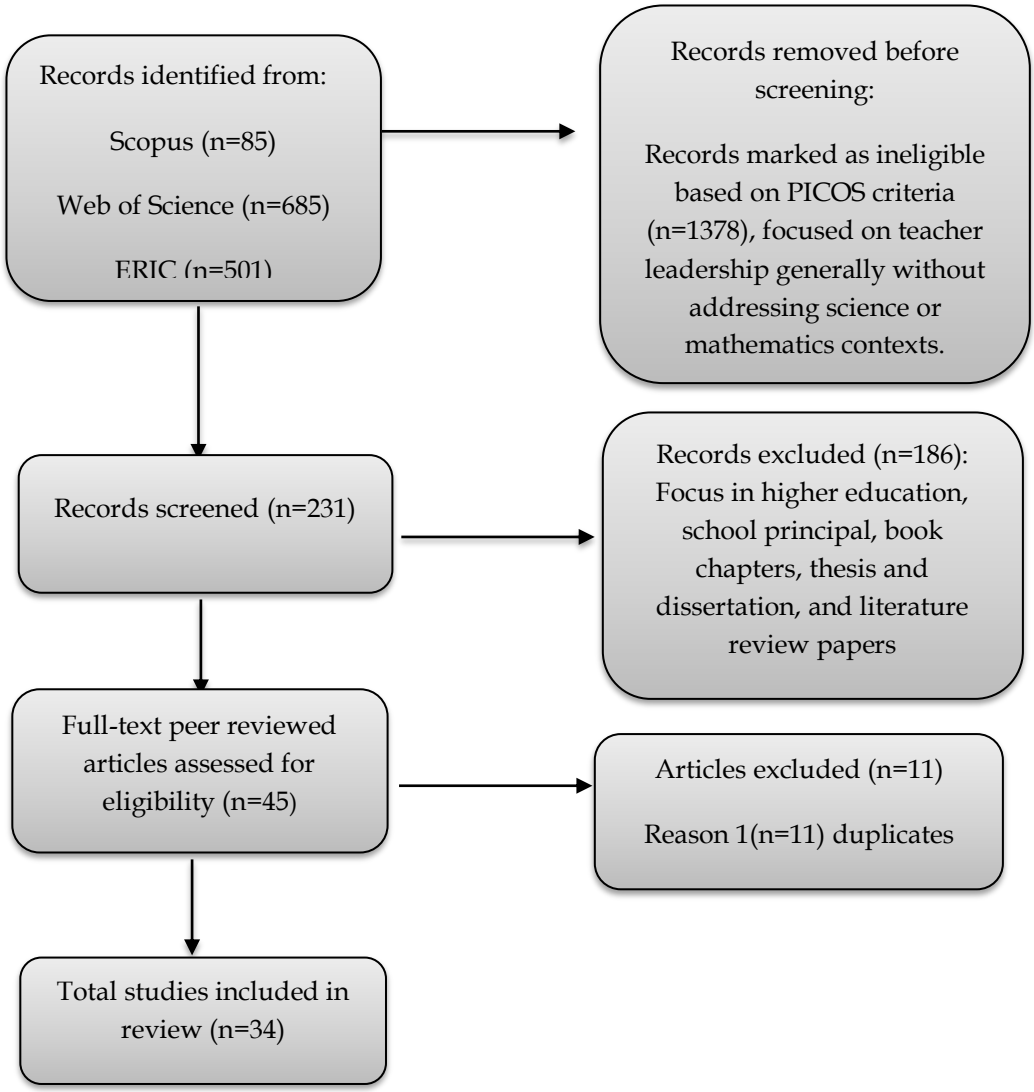

Figure 2: PRISMA Flow Diagram of the Study Selection Process (Page et al., 2021)

3.6 Data Extraction and Reliability

Data extraction tables were developed, presenting each study's authors, year, title, journal, location, theoretical/conceptual frameworks, methods, participants, purpose, themes, and key findings. Additionally, a table presenting a summary of studies by year, journal, and database was developed. Research questions were used in formulating these data extraction tables, ensuring that the information extracted is aligned with the research questions. Two reviewers independently verified 32% of the entries, achieving high inter-rater reliability (Cohen's $\kappa = 0.79$).

3.7 Quality Appraisal

Quality assessment was conducted using the Critical Appraisal Skills Programme (CASP) checklist for qualitative studies. We used the generic ten-question tool for appraising strengths and limitations of qualitative research methodology (Long et al., 2020). We also used the Mixed Methods Appraisal Tool **(**MMAT) (2018) for quantitative and mixed-methods studies (Hong et al., 2018). Studies scoring below

50% were excluded from thematic synthesis. Most studies (31 out of 34) achieved 70% or higher, indicating strong methodological rigor.

3.8 Data-synthesis

We employed Reflexive Thematic Analysis (RTA) as outlined by Braun and Clarke (2022) to synthesise and interpret the findings. Three authors independently conducted full-text reviews of the included studies, identifying key insights related to teaching, assessment, and teacher leadership practices beyond the classroom in science and mathematics education. Data extraction tables and summary notes were used to guide the development of initial codes and themes (Cooper et al., 2022). Code development involved deep immersion in the data, iterative discussions, and critical reflection to interpret meaning and ensure analytic depth (Braun & Clarke, 2022).

The authors held multiple meetings to refine codes, resolve interpretive differences, and explore relationships among codes. These collaborative engagements led to the generation, revision, and consolidation of themes aligned with the research questions. Ongoing reflexive meetings were conducted throughout the analysis to mitigate bias and enhance analytical transparency. Finally, the three authors engaged in further discussions with the wider research team to validate interpretations and ensure coherence, followed by the results presented below, using themes aligned with the research questions.

4. Results

4.1 Overview of Included Studies

The review synthesised 34 empirical studies that met the inclusion criteria, published between 2019 and June 2025, focusing on teacher leadership practices in science and mathematics education. The total number of studies per year is shown in the figure below.

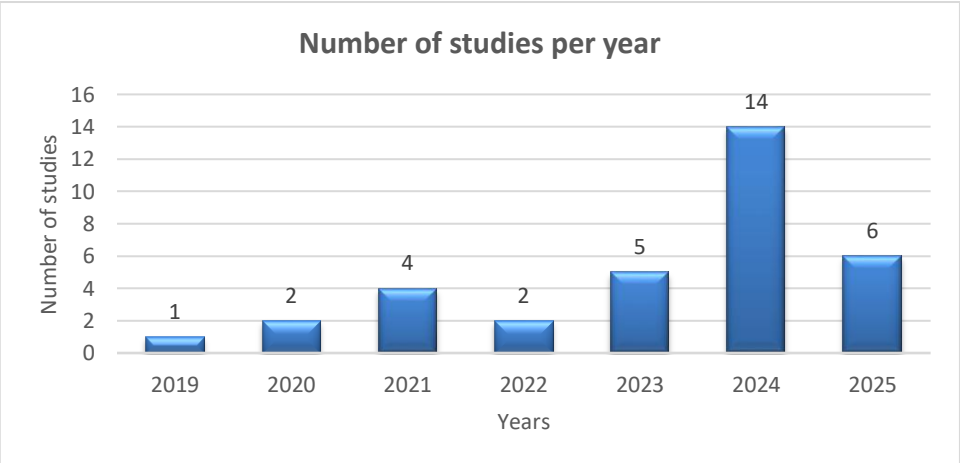

Figure 3: Number of studies per year

Most studies originated from North America, while a few came from Oceania, Europe, and Asia. All the articles were published in peer-reviewed journals. They were focused on teacher leadership practices in science and mathematics, whether

in the classroom or outside. This section presents the results from the 34 articles in line with the research questions.

4.2 Regional and Publication Source Distribution (RQ1)
A review of 34 peer-reviewed articles reveals a distinct concentration in the global production and dissemination of science and mathematics teacher leadership research. This section presents a geographic representation of the studies reviewed, the journals where the studies were published, and the databases.

4.2.1 Geographic Concentration
The analysis reveals a pronounced geographical imbalance, with North America contributing 27 out of 34 studies, overwhelmingly shaping the discourse on teacher leadership in science and mathematics education. Oceania accounts for three studies, while Europe and Asia contribute two each, representing countries such as Australia, New Zealand, Luxembourg, Portugal, Malaysia, and Turkey.

The lack of studies from Africa, South America, and broader regions of Asia and Eastern Europe highlights a significant gap in global representation. This concentration in Western contexts, especially the United States, suggests that the prevailing frameworks and narratives may be disproportionately influenced by U.S.-centric educational paradigms, raising concerns about the contextual relevance and inclusivity of existing research across diverse educational landscapes. Figure 5 shows the geographical representation of studies reviewed on teacher leadership practices in science and mathematics education.

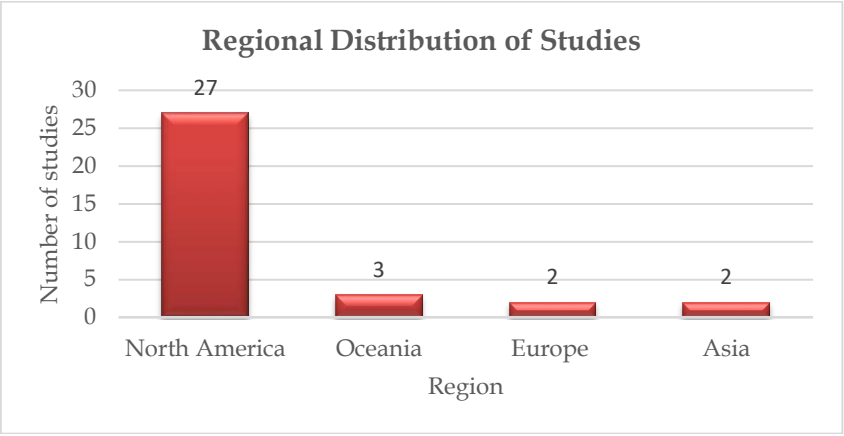

Figure 4: Regional distribution of studies

4.2.2 Key and Notable Journals
Reviewed empirical research studies were published across 22 distinct journals, with a few recurring sources. Most of the studies were published in the School Science and Mathematics Journal, which accounts for (n=9) publications (26.5%). Other notable journals include the Journal of Mathematics Teacher Education, which had (n=3) publications (8.8%); the Education Sciences with (n=2) publications (5.9%); the Science and Children Journal with (n=2) publications (5.9%). The rest of the journals (18) had 1 publication each (52.9%). While 22 journals are represented in the dataset, a small cluster, particularly School Science

and Mathematics, dominates publication output. Table 3 reflects the key and notable journals in which studies were published.

Table 1: Key and notable journals in which studies were published

Journal	No. of Articles	% of Total
School Science and Mathematics	9	26.5
Journal of Mathematics Teacher Education	3	8.8
Education Sciences	2	5.9
Science and Children	2	5.9
Other (18 journals)	18	52.9
Total	**34**	**100**

4.2.3 Database Indexing

The articles reviewed are indexed across four major academic databases, namely, Scopus (N=10); EBSCO Education Source (N=9); Web of Science (N=8); and ERIC (N=7), represented in Figure 6.

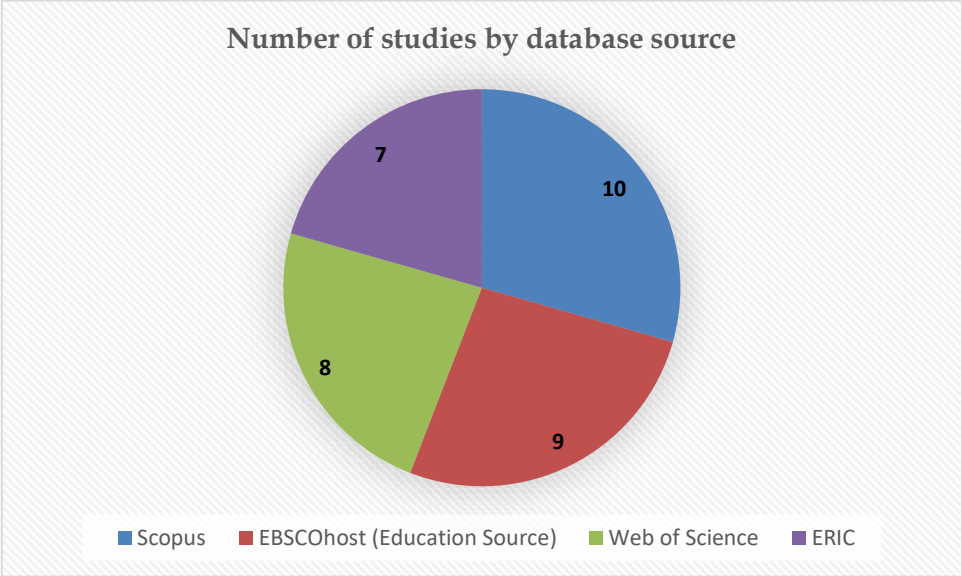

Figure 5: Number of articles per database source

The articles were indexed across major databases, with Scopus slightly ahead of others. This relatively even distribution suggests broad accessibility but highlights Scopus as a key gateway for scholarly engagement in this domain.

4.3 Theoretical/Conceptual Frameworks (RQ2)

There were several theoretical and conceptual frameworks underpinning research on teacher leadership in science and mathematics education in 27 of the 34 articles. Seven articles did not explicitly specify any conceptual or theoretical framework, indicating an area for future improvement. The analysis identifies the five most frequently used theoretical/conceptual frameworks across studies focused on teacher leadership in science and mathematics education. The table below summarises the five dominant theoretical/conceptual frameworks underpinning the reviewed studies on teacher leadership in science and mathematics education.

These include their descriptions, use frequency, and the scholars who used the theory.

Table 2: Dominant Theoretical/Conceptual Frameworks

Theory	Description	Frequency	Authors and Year
Communities of Practice (CoP)	Focuses on learning as social participation within a community, emphasising shared practices, mutual engagement, and joint enterprise.	7	Lotter et al. (2020) Superfine & Pitvorec (2021) Lisy et al. (2024) Park et al. (2024) McGraw et al. (2025) Quaisley et al. (2024) Ronan (2023)
Teacher Leadership Identity Models	Explores how teachers develop and enact leadership identities within educational contexts, often shaped by roles, relationships, and professional growth.	6	Velasco et al. (2024) Leonard et al. (2025) McGraw et al. (2025) Quaisley et al. (2024) Thomas et al. (2024) Ronan (2023)
Transformational Leadership Theory	Emphasises inspiring and motivating followers to achieve more than expected by fostering vision, intellectual stimulation, and individualised support.	5	Abbott et al. (2024) Toh & Yan-Li (2024) Sun (2023) Stevenson & Thompson (2025) Thomas et al. (2024)
Distributed Leadership Framework	Views leadership as a shared, collective activity distributed across multiple individuals and contexts within a school or educational system.	5	Weatherhead (2024) Ronan (2023) Abbott et al. (2024) Stevenson & Thompson (2025) Thomas et al. (2024)
Socio-transformative Constructivism (STC)	Integrates social justice and constructivist learning, promoting critical reflection, dialogue, and transformation in educational practices.	4	Kokka (2024) Thomas et al. (2024) McGraw et al. (2025) Lindstrom & Selmer (2022)

4.4 Research Methodologies (RQ3)

The analysis of commonly used methodologies in investigating teacher leadership in science and mathematics education revealed a distinct predominance of qualitative research methodologies, constituting 76.5% of the reviewed studies (n=26). This overwhelming presence strongly emphasises exploratory, interpretive, and context-rich inquiry, likely reflecting the nature of the research questions or phenomena under investigation. In contrast, quantitative approaches represent only 14.7% (n=5) of the total studies, indicating a comparatively limited

engagement with statistical measurement, hypothesis testing, or generalisable data analysis. This methodological underrepresentation could reflect a disciplinary preference for depth over breadth. The remaining 8.8% (n=3) studies employ mixed methods, highlighting a meaningful attempt to triangulate findings and balance the strengths of both qualitative and quantitative paradigms. The Figure represents the methodological distribution in the studies reviewed.

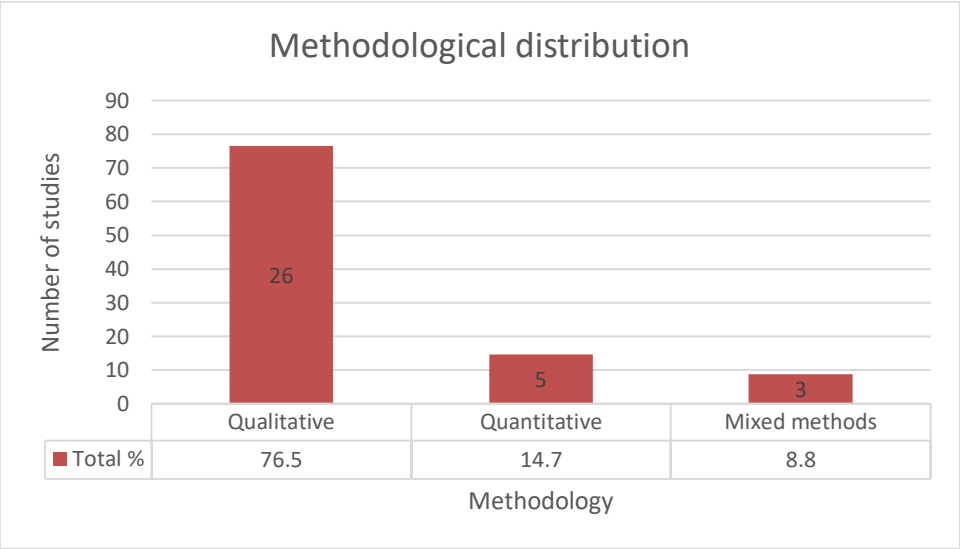

Figure 6: Methodological distribution

4.5 Dominant Research Themes (RQ4)

The analysis of 34 articles related to teacher leadership practices in science and mathematics education revealed eight dominant themes discussed below.

4.5.1 Professional Development [PD] (N= 23)

Teacher professional development was the most popular theme in the studies focusing on teacher leadership in science and mathematics. A total of 23 studies out of the 34 related to teacher professional development as one of the focuses of teacher leadership in science and mathematics education. In line with this theme, effective teacher leadership was closely tied to sustained and content-rich professional development. PD was linked to curriculum reform and instructional improvement (Abbott et al., 2024; Cassata & Allensworth, 2021).

4.5.2 Instructional Practices (N= 20)

Instructional practices were reported in 20 of the 34 articles. Leadership in instructional innovation, including inquiry-based teaching, responsive pedagogy, and learner-centred approaches, was noted in these articles. Articles such as that of Siry et al. (2025) and Weatherhead (2024) demonstrate shifts toward inquiry-driven science instruction, while Lindstrom and Selmer (2022) and Placa (2025) explore how leaders attend to student thinking and reasoning.

4.5.3 Leadership Identity (N= 19)

A substantial number of articles (n=19) presented how teachers perceive and enact leadership roles, including formal and informal capacities. These studies highlight diverse leadership identities such as activist, ambassador, and collaborator (Heredia et al., 2024). Advocacy and self-efficacy were also central to leadership identity development (Leonard et al., 2025; Velasco et al., 2024). The discussions under this theme showed that teachers transitioned from classroom teaching to leadership roles, which shaped their leadership identity (McGraw et al., 2025; Ronan, 2023).

4.5.4 Collaboration and Networking (N=18)

A total of (n=18) studies presented findings on the role of collaboration and networking in teacher leadership within science and mathematics education. Studies showed collaboration as a cornerstone of teacher leadership in these subjects. The studies show the value of peer mentoring, professional communities, and networked improvement communities (Heredia et al., 2024; Park et al., 2024; Ruggirello et al., 2025). Nguyen et al. (2024) highlight informal leaders' roles in advice networks in these subjects.

4.5.5 Equity and Inclusion (N= 16)

Equity and inclusion were also prominent, with a total of (n=16) studies presenting this theme. For example, Kokka (2024) and Magee et al. (2024) focus on culturally responsive pedagogy, while Frederic et al. (2024) and Velasco et al. (2024) address systemic barriers and advocate for marginalised communities, including Black queer students.

4.5.6 Systemic Change (N= 15)

Close to half of the studies (n=13) linked the role of teacher leaders in science and mathematics with systematic change. Teacher leaders influence broader educational systems through policy engagement and reform. For example, Abbott et al. (2024) and Cassata and Allensworth (2021) show how leadership can scale instructional change. Bundy et al. (2019) and Stults et al. (2023) illustrate advocacy for underrepresented subjects like physics and elementary science.

4.5.7 Student Outcomes (N= 13)

Student outcome emerged as one of the themes in (n=13) articles. Teacher leadership in science and mathematics was linked with improved student engagement and achievement. Leonard et al. (2025) report positive impacts on student problem-solving, while Cassata and Allensworth (2021) and Weatherhead (2024) connect leadership to curriculum alignment and performance gains.

4.5.8 Transformational Leadership (N=11)

A few studies (n=11) explored transformational leadership practices among science and mathematics teachers and how that influences learner achievement and behaviour. Toh and Yan-Li (2024) link leadership and teaching behaviour to increased student interest in science. As transformational leaders, teachers also took leadership in coaching and mentoring others (Baker, 2022; Superfine &

Pitvorec, 2021). Nguyen et al. (2024) highlight how informal math teacher leaders influence others through advice and information networks.

We have attached Appendix 1, which summarises the dominant themes, subthemes, and the number of studies.

4.6 Teacher Leadership Concerning instructional practices, assessment, and beyond-classroom roles in science and mathematics education (RQ5)

4.6.1 Teacher Leadership Concerning Instructional Practices, Including Curriculum Design, Classroom Pedagogy, and Content Delivery

This section synthesises findings from recent empirical studies on teacher leadership in science and mathematics education, focusing on instructional practices related to curriculum design, classroom pedagogy, and content delivery.

4.6.1 Curriculum Design

The reviewed articles revealed that teacher leaders play a pivotal role in the co-development and adaptation of curriculum materials, aligning instruction with reform-based goals. Research highlights how they engage in collaborative planning, often through professional networks and teacher-led PD, to design inquiry-based, equity-oriented curricula (Heredia et al., 2024; Siry et al., 2025). The studies showed that curriculum design is typically an iterative process, informed by student data and tailored to context-specific needs.

In New Zealand, for example, mathematics lead teachers employed student achievement data to co-design targeted instructional responses (Edwards & Ogle, 2021). Networked Improvement Communities (NICs) further enabled shared curriculum redesign strategies linked to improved student performance (Ruggirello et al., 2025). Across studies, a strong commitment to equity and cultural relevance was evident, positioning curriculum development as a tool for empowerment, especially for marginalised learners (Lisy et al., 2024; Magee et al., 2024).

4.6.2 Classroom Pedagogy

The analysis showed that pedagogical leadership is characterised by teacher leaders modelling and promoting student-centred, inquiry-based instruction. Teacher leaders equipped teachers with strategies such as classroom discourse, problem-solving, and clinical interviews to uncover students' thinking (Placa, 2025; Whitworth et al., 2021). A consistent theme was the shift from teacher-directed to student-driven instruction, emphasising conceptual understanding, reasoning, and critical reflection.

Teacher leaders supported the development of responsive teaching, often through tools like lesson study; however, challenges remained in sustaining deep student engagement. Several studies noted integration of social justice pedagogy, where teacher leaders fostered inclusive environments and addressed systemic inequities (Kokka, 2024; Lisy et al., 2024). Importantly, teacher leaders also guided colleagues in analysing student data to inform instruction, cultivating a culture of collective responsibility for learner success (Edwards & Ogle, 2021).

4.6.3 Content Delivery

The reviewed studies showed that teacher leaders enhance content delivery by mentoring peers, facilitating PD, and modelling effective strategies. Content delivery was strengthened through real-world applications and culturally relevant examples (Bundy et al., 2019; Stevenson & Thompson, 2025). Tools such as formative assessments, coaching models, and resources supported this effort (Cassata & Allensworth, 2021). Furthermore, teacher leaders serve as brokers of knowledge, translating policy and reform into practice, and guiding peers in content-specific pedagogy (Abbott et al., 2024; Park et al., 2024). Significantly, their influence is shaped by formal roles and informal leadership networks, where they often act as central instructional advisors, even without positional authority (Nguyen et al., 2024).

4.6.4 Teacher Leadership and Its Influence on Assessment Practices

The reviewed articles revealed that teacher leadership is pivotal in transforming science and mathematics education assessment practices. Beyond improving instruction, teacher leaders influence how assessment is designed, interpreted, and embedded into learning systems. Reviewed literature identifies three key areas of impact: advancing responsive and formative evaluation, fostering data literacy and collaborative assessment culture, and advancing equity in assessment.

4.6.5 Advancing Formative and Responsive Assessment

Teacher leaders actively promote formative assessment aligned with student-centred and inquiry-driven teaching. In the Master Teacher Leader cohort (Stults et al., 2023), teachers developed strategies like PDSA [Plan-Do-Study-Act] cycles to integrate assessment with instruction, particularly in response to pandemic disruptions. In addition, mathematics leaders (Placa, 2025) used clinical interviews to elicit students' conceptual thinking rather than surface-level answers, highlighting a shift toward deeper, responsive assessment.

4.6.6 Fostering Data Literacy and Collaborative Assessment Culture

Teacher leaders cultivated data-informed teaching cultures. Edwards and Ogle (2021) found that mathematics lead teachers in New Zealand guided colleagues in interpreting student data to inform both formative and summative assessments. These leaders fostered collaborative inquiry cycles and encouraged teachers to disaggregate data and take collective responsibility for outcomes. Siry et al. (2025) and Ruggirello et al. (2025) illustrate how teacher-led NICs applied improvement science methods such as PDSA cycles and structured data use to refine assessment practices and raise student achievement. In mathematics, leaders helped peers strengthen formative assessment skills (Placa, 2025), deepening understanding of student thinking.

4.6.7 Promoting Equity in Assessment

Equity is a growing focus in teacher-led assessment reform. Heredia et al. (2024) describe science teacher leaders who examined their grading for racial and linguistic bias, shifting toward more inclusive practices. Similarly, studies by Kokka (2024) and Magee et al. (2024) showcase how asset-based frameworks, centring on learner identities, languages, and lived experiences, help diversify

how learners demonstrate understanding. These approaches move beyond traditional tests, encouraging authentic, real-world assessments, recognising varied learner strengths.

4.6.8 Science and Mathematics Teacher Leadership Beyond the Classroom

Reviewed literature shows that teacher leadership in science and mathematics extends far beyond classroom instruction. Teacher leaders act as catalysts for change through professional development, mentoring, policy engagement, and broader school or district leadership. These roles contribute to both professional growth and systemic instructional reform.

4.6.9 Developing and Mentoring Colleagues

A recurring theme across studies is teacher leaders' central role in building their colleagues' instructional capacity. They often facilitate PD, model best practices, and mentor peers. For instance, leaders in districtwide STEM networks (Lisy et al., 2024; Park et al., 2024) supported co-planning and resource sharing. Similarly, Cassata and Allensworth (2021) highlighted how structured coaching tools enhanced mathematics PD. Leadership cohorts such as the Master Teacher Leaders (Stults et al., 2023) fostered collaborative reflection and shared instructional strategies, especially in hybrid learning contexts.

Studies from New Zealand (Edwards & Ogle, 2021) and the US (Heredia et al., 2024) also emphasise how leaders guide inquiry cycles, co-plan lessons, and model reform-oriented practices. Formal and informal mentoring emerged as a foundational element of leadership. Teacher leaders supported novice colleagues, modelled lessons, and built professional trust (Stevenson & Thompson, 2025; Weatherhead, 2024).

4.6.10 Policy Engagement and Advocacy

Teacher leaders also advocate for equity and reform at the policy level. Bundy et al. (2019) document how Master Teacher Fellows shaped science education policy and supported underrepresented groups, including through initiatives like U-ToP. Other leaders served as liaisons between policy and practice. For example, Heredia et al. (2024) describe teacher leaders translating policy into actionable classroom strategies, especially in implementing the Next Generation Science Standards [NGSS]. These leaders helped align administrative goals with instructional realities and built shared understanding across stakeholder groups.

4.6.11 Whole-School and System-Level Leadership

Beyond individual mentoring or PD, teacher leaders take on school-wide or system-level roles. They organise professional learning spaces, lead reform initiatives, and coordinate communication among staff (Heredia et al., 2024). Leaders facilitated data-driven instructional improvement across schools in networked improvement models (Park et al., 2024; Ruggirello et al., 2025). In some cases, teacher leaders stepped into formal leadership positions like science coordinators or district coaches (McGraw et al., 2025; Ronan, 2023). Others led without titles, shaping curriculum priorities, instructional norms, and school culture. Across contexts, their leadership helped embed shared responsibility and sustainable change.

By framing teacher leadership across instructional, assessment, and beyond-classroom domains, and examining how these dimensions intersect and influence one another, this study positions teacher leadership as a multidimensional and interconnected practice rather than a set of isolated roles. Such an approach acknowledges the complex realities of teachers' work in science and mathematics education, where leadership is simultaneously enacted in classrooms, assessment practices, and broader professional and policy spaces. Recognising these intersections not only deepens the understanding of teacher leadership but also highlights its potential to drive systemic change through integrated contributions to curriculum, pedagogy, equity, and professional learning.

4.7 Literature Gaps on Equity, Access, Inclusion, and Representation (RQ6)

While recent studies have expanded our understanding of teacher leadership in science and mathematics education, particularly in professional development and instructional capacity, a critical review of 34 articles reveals several persistent gaps. These gaps relate to equity, access, inclusion, and the representation of diverse learners and global contexts. Some are discussed below.

4.7.1 Equity as an Implicit, Not Central Concern

Equity and social justice are rarely positioned as foundational. While some studies foreground culturally relevant pedagogy or critical perspectives (Frederic et al., 2024; Kokka,2024; Magee et al., 2024), most treat equity as a secondary outcome rather than a driving purpose of teacher leadership. This marginalisation risks reducing equity to a byproduct of instructional improvement rather than a deliberate, measurable focus. As a result, the field lacks robust theorisation and critical engagement with systemic inequality.

4.7.2 Underrepresentation of Marginalised Learners

Only a few studies (Frederic et al., 2024; Kokka, 2024; Velasco et al., 2024) explicitly address marginalised groups such as Black queer students or urban learners. Most fail to centre the needs of learners with disabilities, multilingual backgrounds, or those from low-income communities. There is limited engagement with refugee, indigenous, or immigrant student populations.

4.7.3 Geographic and Contextual Narrowness

Geographically, research is heavily skewed toward the US, with minimal contributions from Asia (beyond Malaysia) or Latin America. Only a handful of studies (Siry et al., 2025; Toh & Yan-Li, 2024) go beyond Western settings, reflecting a dominant Anglo-American perspective in the literature. The overwhelming concentration of studies in North America, Europe, and Australia limits the transferability of findings to other educational systems. Rural settings though occasionally mentioned (Lotter et al., 2020; Murphy, 2022), remain underexplored.

4.7.4 Limited Intersectional Analysis

Few studies consider how identities such as race, gender, class, and sexuality intersect to shape both teaching and leadership. Frederic et al. (2024) stand out in

applying a critical lens to examine STEM spaces as shaped by white, cis-heteropatriarchal norms. Broader uptake of intersectionality remains lacking.

4.7.5 Informal and Unsupported Equity Roles
Equity-oriented leadership often exists informally, with little institutional support. Teachers who take on advocacy roles (Heredia et al., 2023; Lisy et al., 2024) frequently report a lack of structural scaffolding to enact change at scale. This limits the potential of equity-focused teacher leadership to become sustainable or systemic.

4.7.6 Limited Institutional Power of Teacher Leaders
Many teacher leaders operate in informal roles without decision-making authority. Even when equity is prioritised, their efforts are often constrained by leadership hierarchies, policy restrictions, and a lack of administrative support. This structural imbalance undermines their capacity to drive lasting change.

4.7.7 Gaps in Longitudinal and Impact-Focused Research
Most studies are short-term and qualitative. There is little data on the long-term impact of equity-focused leadership on student outcomes or system change. The scalability and sustainability of such practices remain unclear.

5. Discussion

This systematic review of 34 peer-reviewed studies published between 2019, and June 2025 reveals a dynamic and evolving understanding of teacher leadership in science and mathematics education. The review findings expose a pronounced geographical imbalance in line with global representation and knowledge production, with North America accounting for 27 of the 34 studies (79.4%). Oceania contributed three studies, while Europe and Asia offered two each.

Notably, Africa, South America, and parts of Eastern Europe and Central Asia remain absent, underscoring a narrow lens through which teacher leadership is conceptualised and practised. This concentration suggests the predominance of U.S.-centric paradigms and raises concerns about the contextual relevance of existing findings to diverse global educational systems. While several US studies offer rich insights into urban and equity-driven leadership, the lack of Global South representation limits the field's inclusivity and cross-cultural resonance. It is worth noting that there may be studies in other contexts listed on other databases or published in other languages, which were excluded from this review.

Though several theories may be relevant for studying teacher leadership practices in science and mathematics education, integrating CoP Theory, Teacher Leadership Identity Theory, and Transformational Leadership Theory provides a robust lens for understanding teacher leadership as a relational, identity-driven, and context-responsive practice. These frameworks collectively illuminate how leadership is enacted through collaboration, recognition, and vision-driven influence within and beyond the classroom.

The review of methodological trends and gaps reveals a strong preference for qualitative methodologies (76.5%), reflecting the interpretive nature of identity, pedagogy, and leadership. While rich in contextual insights, this methodological leaning may limit generalisability and impact measurement. Only 14.7% of studies employed quantitative methods, and 8.8% used mixed methods. Future research should consider methodological diversification to enhance validity and cross-contextual applicability.

The findings underscore the multifaceted nature of teacher leadership, which spans instructional innovation, professional development, identity formation, equity advocacy, and systemic reform. Teacher leaders play a pivotal role in shaping instructional practices by actively engaging in curriculum design, modelling innovative pedagogy, and enhancing content delivery (Bundy et al., 2019; Stevenson & Thompson, 2025). Teacher leaders foster instructional growth through mentoring, coaching, and reflective practice (Abbott et al., 2024; Cassata & Allensworth, 2021). This aligns with the CoP (Wenger, 1998) framework, which positions learning as a socially situated process.

Teacher leaders act as facilitators of collective learning, often within professional networks and improvement communities. Concerning instructional practices, teacher leaders model inquiry-based and student-centred pedagogy (Siry et al., 2025; Weatherhead, 2024). These practices reflect the Transformational Leadership (Bass, 1985), where leaders inspire pedagogical shifts and foster intellectual stimulation among peers and students. The review shows that leadership is not merely a role, but a dynamic identity shaped by recognition, agency, and context, aligning with Teacher Leadership Identity Theory (Akkerman & Meijer, 2011; Beauchamp & Thomas, 2009).

A notable finding is the growing attention to equity and inclusion, promoting culturally responsive pedagogy and advocacy for marginalised learners (Kokka, 2024; Magee et al., 2024). However, equity often remains a secondary concern rather than a central focus. This suggests a need for more critical and transformative approaches to teacher leadership that foreground social justice as a core objective. The review revealed that teacher leaders influence policy, curriculum reform, and school-wide practices (Abbott et al., 2024; Cassata & Allensworth, 2021). However, they operate in informal roles without institutional support, limiting their capacity to enact sustainable change, pointing to a structural imbalance that must be addressed through policy and leadership development initiatives. The review also highlights teacher leaders' contributions to transforming assessment practices by promoting formative and responsive assessment strategies.

As a result, teacher leadership in science and mathematics improved student engagement and achievement (Leonard et al., 2025; Sun, 2023), while also showing behaviour that increases student interest in science (Toh & Yan-Li, 2024). As transformational leaders, teacher leaders in science and mathematics coach and mentor their peers (Baker, 2022; Nguyen et al., 2024; Superfine & Pitvorec, 2021). This shows leadership beyond the confines of the classroom as they support

colleagues in instructional improvement, lead school-wide initiatives, and contribute to district-level reform efforts. Despite operating without formal authority, these leaders shape institutional culture and instructional norms, demonstrating the systemic impact of teacher leadership.

6. Limitations of the Review

Several limitations were noted in conducting the review. Articles published in non-English languages were removed, meaning the study may have missed valuable insights from those excluded articles based on language. This may have contributed to the geographical representation of the included studies. Only peer-reviewed articles were included. There may be informative studies that were excluded based on that criterion. We used four databases to search for the literature. Other databases may have peer-reviewed empirical studies on teacher leadership practices in science and mathematics that were not included in this review, which may come from the missing geographical areas.

7. Conclusion

This review offers a transformative contribution to the field of teacher leadership in science and mathematics education by reframing leadership as a relational, equity-oriented, and contextually embedded practice. Unlike previous reviews that focused narrowly on formal roles or isolated interventions, this synthesis integrates 34 studies through robust theoretical lenses: CoP, Teacher Leadership Identity Theory, and Transformational Leadership to illuminate how leadership is enacted, recognised, and sustained across diverse educational settings. Teacher leaders emerge not simply as instructional experts but as agents of systemic change, curriculum design, mentorship of peers, advocating for equity, and influencing institutional culture.

The review highlights the strategic significance of informal leadership, especially in equity-driven initiatives, and calls for broader recognition of these contributions in policy and practice. It also identifies critical gaps: a dominance of U.S.-based studies, limited longitudinal research, and underrepresentation of marginalised learners and global perspectives. Practically, the findings offer actionable insights for educators, school leaders, and policymakers. These include embedding leadership development in science and mathematics teacher preparation, fostering collaborative school cultures, and designing professional learning that builds agency and advocacy skills. The review urges stakeholders to move beyond role-based definitions and invest in the conditions of trust, collaboration, and recognition that allow teacher leaders to thrive.

Ultimately, this review advances the field by offering a conceptual and methodological expansion: it positions teacher leadership not as a static role but as a dynamic, identity-driven process capable of reshaping science and mathematics education. It provides a roadmap for cultivating inclusive, distributed leadership and invites researchers to pursue more diverse, impact-oriented studies. In doing so, it reimagines teacher leadership as a transformative force that bridges theory and practice to drive meaningful change in classrooms, schools, and systems.

8. Recommendations

Targeted recommendations are made based on the synthesis of empirical studies reviewed. The recommendations may guide future researchers, curriculum and policy makers, and Journal Editors and Academic Publishers.

Researchers should diversify methodologies by incorporating more mixed-methods and longitudinal studies to capture both sustainability and measurable impact of teacher leadership practices on learner outcomes and systemic reform. Centre equity and inclusion by designing studies that foreground equity as a central concern, using intersectional frameworks to explore how race, gender, class, and language shape leadership. Expand global representation by conducting and publishing research from underrepresented regions, especially the Global South, to enrich the global discourse and contextual relevance. Investigate informal leadership to see how informal teacher leaders operate, influence peers, and navigate institutional constraints.

Policy makers and curriculum developers should recognise and support informal leaders, develop policies that formally acknowledge and support teachers who lead without titles, especially in equity-focused roles. Invest in leadership development by providing sustained, content-specific professional development that builds leadership capacity in science and mathematics. Facilitate collaborative structures that promote professional learning communities, networked improvement communities, and cross-school collaborations to scale leadership impact.

Journal Editors and Academic Publishers should actively solicit and prioritise submissions from underrepresented regions, especially in the Global South, where teacher leadership may manifest differently due to contextual, cultural, and systemic factors. Broaden editorial criteria to value informal and equity-oriented leadership narratives, which are often excluded due to their non-traditional methodologies or lack of formal leadership framing. Diversify editorial boards and peer reviewers, ensuring representation from scholars with expertise in equity, relational leadership, and global education systems. Create thematic calls for papers that centre teacher agency, identity, and advocacy in STEM education, especially in contexts of marginalisation or reform.

9. Acknowledgements

This study was supported by the South African National Roads Agency SOC Ltd (SANRAL) through the Science and Mathematics Education Research Chair at the University of the Free State.

10. References

Abbott, R., Moran, M., & Wideman, A. B. (2024). Three Transformative Leadership Practices: Building capacity and fostering a culture of commitment to science teaching and learning in an elementary school district. *Science and Children*, *61*(1), 11-14. https://doi.org/10.1080/00368148.2024.2293467

Adams, D. (2022). Leadership in science instruction: A systematic review of research. *Asia Pacific Journal of Educators and Education, 37*(2), 247-261. https://doi.org/10.21315/apjee2022.37.2.12.

Akiba, M., & Liang, G. (2016). Effects of teacher professional learning activities on student achievement growth. *The Journal of Educational Research*, *109*(1), 99-110. https://doi.org/10.1080/00220671.2014.924470

Akkerman, S. F., & Meijer, P. C. (2011). A dialogical approach to conceptualising teacher identity. *Teaching and Teacher Education, 27*(2), 308–319. https://doi.org/10.1016/j.tate.2010.08.013

Amador, J. M. (2019). Mathematical noticing: Eliciting and analysing teacher leaders' noticing of student thinking. *Journal of Mathematics Teacher Education*, 22, 305–328. https://doi.org/10.1007/s10763-019-09956-5

Amir-Behghadami, M., & Janati, A. (2020). Population, Intervention, Comparison, Outcomes and Study design (PICOS) criteria to formulate research questions in evidence-based practice. *Journal of Evidence-Based Medicine and Healthcare, 7*(17), 750–752. https://doi.org/10.18410/jebmh/2020/154

Baker-Doyle, K. J. (2017). Book Review: Transformative Teachers: Teacher Leadership and Learning in a Connected World. *Journal of Education, 197(*2), 49–51. https://doi.org/10.1177/002205741719700206

Bass, B. M. (1985). Leadership: Good, better, best. *Organisational Dynamics, 13*(3), 26–40. https://doi.org/10.1016/0090-2616(85)90028-2

Beauchamp, C., & Thomas, L. (2009). Understanding teacher identity: An overview of issues in the literature and implications for teacher education. *Cambridge Journal of Education, 39*(2), 175–189. https://doi.org/10.1080/03057640902902252

Blose, S., & Khuzwayo, N. Q. (2023). Teacher leadership in action: An inquiry into the lived experiences of subject heads in secondary schools. *International Journal of Leadership in Education, 26*(2), 244-259. https://doi.org/10.1080/13603124.2020.1808710

Braun, V., & Clarke, V. (2022). *Thematic Analysis, A practical guide*. SAGE.

Bundy, B., Dahl, J., Guiñals-Kupperman, S., Martino, K., Hengesbach, J., Metzler, J., Smith, T., Spencer, N., Whitehurst, A., Vargas, M., & Vieyra, R. (2019). Aspiring to Lead: Physics Teacher leaders influencing science Education Policy. *The Physics Teacher*, *57*(3), 186–189. https://doi.org/10.1119/1.5092483

Cassata, A., & Allensworth, E. (2021). Scaling standards-aligned instruction through teacher leadership: methods, supports, and challenges. *IJ STEM Ed* 8, 39. https://doi.org/10.1186/s40594-021-00297-w

Cooper, N., Horne, T., Hayes, G. R., Heldreth, C., Lahav, M., Holbrook, J., & Wilcox, L. (2022, April). A systematic review and thematic analysis of community-collaborative approaches to computing research. In *Proceedings of the 2022 CHI conference on human factors in computing systems* (pp. 1-18). https://doi.org/10.1145/3491102.3517716

Cunningham, K. M., Snodgrass Rangel, V., Lochmiller, C. R., & Farmer, M. (2024). Developing educational leadership in mathematics and science: Insights from teaching and learning faculty. *Journal of Research on Leadership Education, 19*(2), 241-265. https://doi.org/10.1177/19427751231170243

Darling-Hammond, L. (1998). Teacher learning that supports student learning. *Educational Leadership*, *55*(5), 6–11. https://eric.ed.gov/?id=EJ560879

Edwards, F., & Ogle, D. (2020). Data informed leadership: the work of primary mathematics lead teachers in New Zealand. *Teacher Development*, *25*(1), 18–36. https://doi.org/10.1080/13664530.2020.1837217

Fairman, J. C., & Mackenzie, S. V. (2015). How teacher leaders influence others and understand their leadership. *International Journal of Leadership in Education*, *18*(1), 61-87. https://doi.org/10.1080/13603124.2014.904002

Frederic, A., Fitzgerald-Russell, M., Shelton, W., Suárez, M. I., & Garvey, J. C. (2024). Unlocking STEM pathways: revealing STEM choices and science teachers

empowering Black queer students. *Education Sciences*, *14*(11), 1254. https://doi.org/10.3390/educsci14111254

Grant, C. (2019). Excavating the South African teacher leadership archive: Surfacing the absences and re-imagining the future. *Educational Management Administration & Leadership*, *47*(1), 37-55. https://doi.org/10.1177/1741143217717274

Heredia, S. C., Phillips, M., Stallings, S., Worsley, T., Yu, J. H., & Allen, C. D. (2023). Identifying the Roles of Science Teacher Leaders in Practice. *Journal of Science Teacher Education*, *35*(2), 109–126. https://doi.org/10.1080/1046560x.2023.2182017

Hong, Q.N., Pluye, P., Fàbregues, S., Bartlett, G., Boardman, F., Cargo, M., Dagenais, P., Gagnon, M.P., Griffiths, F., Nicolau, B., O'Cathai, A., Rousseau, M.C., Vedel, I. (2018). Mixed Methods Appraisal Tool (MMAT), version 2018. Registration of Copyright (#1148552), Canadian Intellectual Property Office, Industry Canada. http://mixedmethodsappraisaltoolpublic.pbworks.com/w/page/127425845/Download%20the%20MMAT

Johnson, N., & Phillips, M. (2017). "Rayyan for systematic reviews". *Libraries Faculty and Staff Scholarship and Research.* Paper 197. http://dx.doi.org/10.1080/1941126X.2018.1444339

Kokka, K. (2024). "I really got to think about my background, their background, and how do we come together on something?": One emergent mathematics teacher leader's reflexive journey with Social Justice Mathematics. *School Science and Mathematics,* 1-16. https://doi.org/10.1111/ssm.12688

Leonard, J., Blondonville-Ford, D., Grubb, D., Cheng, D., & Wang, X. (2025). Self-efficacy, agency, and values as predictors of STEM teacher leader identity in urban-like learning environments. *School Science and Mathematics*, 1-25. https://doi.org/10.1111/ssm.18347

Lindstrom, D., & Selmer, S. (2022). Responsive teaching and the instructional reasoning of expert elementary mathematics teachers. *Education Sciences*, *12*(5), 350. https://doi.org/10.3390/educsci12050350

Lisy, E., Campbell, T., & Park, B. (2024). The emergence of science teacher leadership in the context of the pursuit of teaching science for social justice. *School Science and Mathematics*, 1-14. https://doi.org/10.1111/ssm.12662

Lochmiller, C. R., & Cunningham, K. M. (2019). Leading learning in content areas: A systematic review of leadership practices used in mathematics and science instruction. *International Journal of Educational Management, 33*(6), 1219-1234. https://doi.org/10.1108/IJEM-03-2018-0094

Long, H. A., French, D. P., & Brooks, J. M. (2020). Optimising the value of the critical appraisal skills programme (CASP) tool for quality appraisal in qualitative evidence synthesis. Research Methods in Medicine & Health Sciences, 1 (1), 31–42. *SAGE Journals. https://doi. org/10.1177/2632084320947559*

Lotter, C., Yow, J. A., Lee, M., Zeis, J. G., & Irvin, M. J. (2020). Rural teacher leadership in science and mathematics. *School Science and Mathematics*, *120*(1), 29–44. https://doi.org/10.1111/ssm.12383

Loucks-Horsley, S., Stiles, K. E., Mundry, S., Love, N., & Hewson, P. W. (2010). *Designing professional development for teachers of science and mathematics.* London: Corwin Press.

Magee, P. A., Scribner, S. M. P., & Willey, C. (2024). Culturally Relevant Science Pedagogy as an Impetus for Teacher Leadership. *International Journal of Teacher Leadership*, *13*(1), 53-75. https://eric.ed.gov/?id=EJ1462789

Margolis, J., & Doring, A. (2013). What Do Today's Teachers Want (And Not Want) From Teacher Leaders? *The New Educator*, *9*(3), 192-209. https://doi.org/10.1080/1547688X.2013.806724

McGraw, R., Renzaglia, K. S., & Sheppard, P. (2025). Professional development and instructional leadership: views and experiences of US mathematics and science teachers who leave the classroom to lead. *Journal of Education for Teaching International Research and Pedagogy*, 1–15. https://doi.org/10.1080/02607476.2025.2502837

Munje, P.N., Tsakeni., M & Jita, LC. (2020). School heads of departments' roles in advancing science and mathematics through the distributed leadership framework. *International Journal of Learning, Teaching and Educational Research, 19*(9), 39-57. https://doi.org/10.26803/ijlter.19.9.3

Murphy, S. (2022). Leadership practices contributing to STEM education success at three rural Australian schools. *The Australian Educational Researcher*, 50, 1049–1067. https://doi.org/10.1007/s13384-022-00541-4

National Council of Teachers of Mathematics. Commission on Standards for School Mathematics. (1989). *Curriculum and evaluation standards for school mathematics.* National Council of Teachers of Mathematics. Reston, Va.: The Council. https://archive.org/details/curriculumevalua00nati

Nguyen, P., Webel, C., & Dames, B. (2024). How informal elementary teacher leaders in mathematics are positioned in advice and information networks. *School Science and Mathematics, 125*(4), 357-370. https://doi.org/10.1111/ssm.12687

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*. https://doi.org/10.1136/bmj.n71

Park, B., Campbell, T., Hanrahan, J., Dolma, T., Murray, E., Russell, J., Lisy, E., & Bai, Y. (2024). Teacher leadership within a districtwide STEM teacher professional network. *International Journal of Leadership in Education*, 1–31. https://doi.org/10.1080/13603124.2024.2330553

Placa, N. (2023). Listening to learn investigating how teacher leaders elicit and attend to students' mathematical thinking in clinical interviews. *Journal of Mathematics Teacher Education, 28*(1), 51-71. https://doi.org/10.1007/s10857-023-09614-2

Poekert, P., Alexandrou, A., & Shannon, D. (2016). How teachers become leaders: An internationally validated theoretical model of teacher leadership development. *Research in Post-compulsory Education*, *21*(4), 307-329. https://doi.org/10.1080/13596748.2016.1226559

Ronan, D. M. (2023). Science as a "Special": Navigating the role of science specialist in urban elementary schools. *School Science and Mathematics*, *123*(6), 220–233. https://doi.org/10.1111/ssm.12597

Ruggirello, R. M., Loehr, A. M., Terada, T., Jabbari, J., Chun, Y., Elkana, M., & Brockhouse, A. (2025). Early impact of teacher leaders in a networked Improvement community on middle school mathematics performance. *The Educational Forum*, 1–15. https://doi.org/10.1080/00131725.2025.2488506

Shen, J., Wu, H., Reeves, P., Zheng, Y., Ryan, L., & Anderson, D. (2020). The association between teacher leadership and student achievement: A meta-analysis. *Educational research review, 31*, 100357. https://doi.org/10.1016/j.edurev.2020.100357

Siry, C., Wilmes, S. E. D., & Heesen, K. T. (2025). Co-Development and Collaboration for Responsive Teacher Education: a teacher Leader network to support Reform-Based Science instruction. *Journal of Science Teacher Education*, 1–19. https://doi.org/10.1080/1046560x.2024.2446100

Spillane, J. P. (2005). Distributed leadership. *The Educational Forum*, *69*(2), 143–150. https://www.researchgate.net/publication/233061505_Distributed_Leadership

Stevenson, E., & Thompson, P. (2025). Teacher leadership for integrated STEM education: Identifying what effective leaders need to know and do. *School Science and Mathematics, 125*(4), 318-329. https://doi.org/10.1111/ssm.18322

Stults, S. E., Cherry, K., Jacobi, J. A., & Shefner, R. (2023). Science curriculum gets a boost from teacher leaders. *The Learning Professional*, *44*(6), 32-36. https://www.proquest.com/docview/2925616227?pq-origsite=gscholar&fromopenview=true&sourcetype=Scholarly%20Journals

Sun, J., Zhang, R., & Forsyth, P. B. (2023). The effects of teacher trust on student learning and the malleability of teacher trust to school leadership: A 35-year meta-analysis. *Educational Administration Quarterly*, *59*(4), 744-810. https://doi.org/10.1177/0013161X231183662

Superfine, A. C., & Pitvorec, K. (2021). Using community artifacts to support novice math teacher educators in teaching prospective teachers. *International Journal of Science and Mathematics Education*, *19*(S1), 59–75. https://doi.org/10.1007/s10763-021-10152-7

Swartz, M. K. (2021). PRISMA 2020: an update. *Journal of Pediatric Health Care, 35*(4), 351. https://doi.org/10.1016/j.pedhc.2021.04.011

Tan, C. Y. (2024). Influence of principal leadership across contexts on the science learning of students. *Asia Pacific Education Review*, *25*(1), 31-44. https://doi.org/10.1007/s12564-023-09828-2

Toh, C., & Yan-Li, S. (2024). Teachers' transformational leadership and teaching behaviour in enhancing secondary private school students' interest in science: a mediation analysis. *Malaysian Online Journal of Educational Sciences*, *12*(1), 14–28. https://doi.org/10.22452/mojes.vol12no1.2

United Nations (UN). (2023). *Sustainable Development Goals.* United Nations. https://unstats.un.org/sdgs/report/2023/The-Sustainable-Development-Goals-Report-2023.pdf

Velasco, R. C. L., Pullen, K. R., & Remington, J. D. (2024). Advocates for STEM education: Developing advocacy identity in STEM teacher leadership. *School Science and Mathematics*, 1-18. https://doi.org/10.1111/ssm.18314

Weatherhead, A. (2024). The Power of Teacher Leadership: Unlocking the potential of science educators. *Science and Children*, *61*(3), 7–10. https://doi.org/10.1080/00368148.2024.2340802

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity.* London: Cambridge University Press.

Whitworth, B. A., Wilson, S., & Watson, S. (2021). Examining Teacher Leadership as a Model for Improvement in Science Education. *Science Educator*, *28*(1), 21-29. https://eric.ed.gov/?id=EJ1303119

Windschitl, M., Thompson, J., Braaten, M., & Stroupe, D. (2012). Proposing a core set of instructional practices and tools for teachers of science. *Science Education*, *96*(5), 878-903. https://doi.org/10.1002/sce.21027

York-Barr, J., & Duke, K. (2004). What do we know about teacher leadership? Findings from two decades of scholarship. *Review of Educational Research*, *74*(3), 255–316. https://doi.org/10.3102/00346543074003255

Yow, J. A., Lotter, C., & Criswell, B. (2021). *The need for STEM teacher leadership. School Science and Mathematics, 121*(3). https://doi.org/10.1111/ssm.12461

Appendix 1: Dominant and sub-themes

Dominant Themes	Subthemes	Number of studies
Professional Development	Coaching and mentoring (Baker,2022); McGraw et al. (2025)	23
	Practice-based and reflective learning (Selmer, 2022; Superfine & Pitvorec, 2021)	
	Curriculum-focused PD (Abbott et al., 2024); PD embedded in instructional reform (Cassata & Allensworth, 2021)	
Instructional Practices	Inquiry-based and student-centered teaching (Siry et al., 2025; Weatherhead, 2024)	20
	Whole-class discussion orchestration (Faria et al., 2024)	
	Responsive teaching and instructional reasoning (Lindstrom & Selmer, 2022)	
	Eliciting and attending to student thinking (Placa, 2025)	
Leadership Identity	Role conceptualization (activist, ambassador, collaborator, etc.) (Heredia et al., 2024); Advocacy and self-efficacy (Leonard et al., 2025; Velasco et al., 2024)	19
	Transition from classroom teacher to leader (McGraw et al., 2025; Ronan, 2023)	
	Leadership recognition (formal vs. informal) (Nguyen et al., 2024)	
Collaboration and Networking	Peer mentoring and coaching (Heredia et al., 2024; Park et al., 2024)	18
	Networked Improvement Communities (NICs) (Ruggirello et al., 2025)	
	Advice and information networks (Nguyen et al., 2024)	
	Community building and shared learning (Abbott et al., 2024; Quaisley et al., 2024)	
Equity and Inclusion	Social justice-oriented leadership (Kokka, 2024)	16
	Culturally responsive pedagogy (Frederic et al., 2024; Magee et al., 2024)	
	Addressing systemic barriers for marginalized groups (Ronan, 2023; Velasco et al., 2024), Empowering underrepresented students (Frederic et al., 2024; Bundy et al., 2019)	
Systemic Change	Scaling standards-aligned instruction (Cassata & Allensworth, 2021)	15
	Structural challenges in science education prioritization (Abbott et al., 2024; Ronan, 2023)	
	Sustainability and scalability of leadership programs (Stults et al., 2023)	

Student Outcomes	Advocacy for underrepresented subjects (Bundy et al., 2019; Stults et al., 2023) Enhancing student engagement and problem-solving (Sun, 2023) Promoting equity in student achievement (Leonard et al., 2025) Building scientific identity and curiosity (Weatherhead, 2024) Linking leadership practices to student performance (Cassata & Allensworth, 2021)	13
Transformational Leadership	Leadership and teaching behavior linked to student science interest (Toh & Yan-Li, 2024). Instructional coaching and mentoring (Nguyen et al., 2024)	11