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REVIEW ARTICLE

From teacher methods to school sustainability: A systematic literature review

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ABSTRACT

The effects of teaching strategies on school sustainability over a ten-year period are examined in this systematic literature review (SLR). Using the PRISMA technique, the study thoroughly analysed six databases and identified 80 papers that need further investigation. Content analysis was refined iteratively, starting with automatic analysis using Leximancer. The researcher's point of view influenced the analysis's final development. The study underlined the wide range of applications and enduring effects of teaching practices on school sustainability, underscoring their vital role in improving academic standards and ensuring the adaptability and durability of educational institutions. In order to shape successful educational practices, direct professional development, and inform policy frameworks that promote long-term institutional resilience, this SLR tackles significant gaps in the literature and presents numerous important improvements. Adopting multidisciplinary, emotionally intelligent, culturally sensitive, and technologically advanced techniques is also essential to the future of sustainability in teaching ethics. Future studies can support more inclusive, transformative, and successful sustainability teaching methods in a variety of educational contexts by tackling these new areas.

Keywords: school sustainability; teacher methods; pedagogical impact; systematic literature review; PRISMA

1. Introduction

Recent studies have increasingly examined the relationship between teaching practices and school sustainability in order to gain a better understanding of how educators are changing their role in creating sustainable learning environments. In the last ten years, researchers have investigated the ways in which instructional strategies, professional development, and pedagogical philosophies support schools' long-term viability—not just in terms of academic performance but also in terms of promoting social justice, environmental responsibility, and institutional resilience[1,2]. According to this research, teachers have a crucial role in encouraging sustainability-oriented thinking and practice in educational systems, not just as curriculum implementers[3,4].

In discussions about education, the broad reach and revolutionary potential of teacher-led sustainability initiatives are becoming more widely acknowledged. The achievement of these objectives frequently depends on the daily choices and values made by educators, even in the presence of infrastructure and

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policies that encourage sustainable behaviours[5,6]. Thus, it is essential to comprehend how teaching practices and school sustainability interact in order to identify best practices, guide institutional reforms that support global sustainability objectives, and inform teacher education.

Research on the precise ways that teaching practices influence sustainable schooling is still dispersed, despite increased awareness of this relationship. While some studies have focused on the effects of inclusive teaching methods, values education, and pedagogical innovations, other studies have highlighted the importance of teacher collaboration, leadership, and capacity building as sustainability drivers[7-9]. A cohesive, methodical investigation of these elements is still lacking, though. This gap offers a chance to synthesise current understanding, identify new themes, and suggest lines of investigation.

The goal of this SLR is to critically analyse how teacher practices affect school sustainability over a ten-year period, taking into account everything that has been discussed thus far. Additionally, this essay aims to elucidate the various ways in which teacher techniques impact and progress teacher methods. The following research questions have been created in order to achieve the goal.

1) What new information has emerged regarding how methods affect the sustainability of schools?

2) What avenues will the study of teacher strategies for school sustainability pursue in the future?

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) technique was used to accomplish this goal[10], which directed the meticulous selection, examination, and synthesis of pertinent studies from a variety of scholarly databases. In addition to offering an evidence-based summary of significant advancements, this review advances our knowledge of how instructional strategies can serve as the cornerstone for creating inclusive, resilient, and future-ready educational institutions.

2. Materials and methods

2.1. Selection of papers

We started by performing a thorough literature search in order to present an overview of current studies. The literature search has mostly focused on publications that discuss how teacher practices affect school sustainability.

To locate the most pertinent articles, the author employed the following search parameters:

Databases searched: Web of Science, Scopus, ScienceDirect, Taylor & Francis, Wiley and Google Scholar.

In addition, Google Scholar was used solely as a supplementary source for gray literature validation rather than as a formal inclusion database.

To facilitate the gathering of publications that highlight the influence of teaching methods on school sustainability over the past decade, the data inclusion time frame was set from 2014 to 2024.

Inclusion criteria were as follows:

Topic, Abstract, and Keywords: “sustainable school” AND “teacher method”

Population: Education-related contexts

Publication date: =2014 – 2024

Data collection source: Both original and secondary research considered

Language: English

Publication type: Peer-reviewed journal articles only (book chapters, conference papers, and dissertations were excluded to maintain quality consistency)

Access status: Open access preferred, where applicable

Following the PRISMA 2020 standards[11], a transparent and reproducible search protocol was employed. The complete PRISMA 2020 Checklist is completed. To ensure search transparency, we have described the Boolean logic, keyword combinations, and search strings used in each database. Database-specific filters (title, abstract, and keywords) and boolean operators (AND, OR) were systematically employed to maximize coverage[12]. The initial search results retrieved from the databases are shown in **Table 1**.

Table 1. Search results based on different databases and keywords.

	Search keywords	Amount
Scopus	TITLE-ABS-KEY（“sustainable school” AND “teacher method”）	397
ScienceDirect	TITLE-ABS-KEY（“sustainable school” AND “teacher method”)	44
Web of Science		221
Taylor&Francis	TS =（“sustainable school” AND “teacher method”)	48
Wiley		35
Google Scholar	Supplementary literature validation	11
Total		756

The quality of the selected studies was evaluated using the 2018 edition of the Mixed Methods Appraisal Tool (MMAT)[13]. Two reviewers separately assessed each article, concentrating on aspects such as the appropriateness of the statistical methods used, the accuracy and relevance of the research questions, and the overall confidence with which the research problems were resolved. The review considered the interpretation of the data in addition to the coherence and comprehensiveness of the findings, arguments, and conclusions.

After duplicate removal and title–abstract screening, 143 records remained. Following a full-text review against inclusion criteria, 80 peer-reviewed publications were retained for final analysis. The selection process and exclusion rationale are presented in the PRISMA 2020 flow diagram (**Figure 1**).

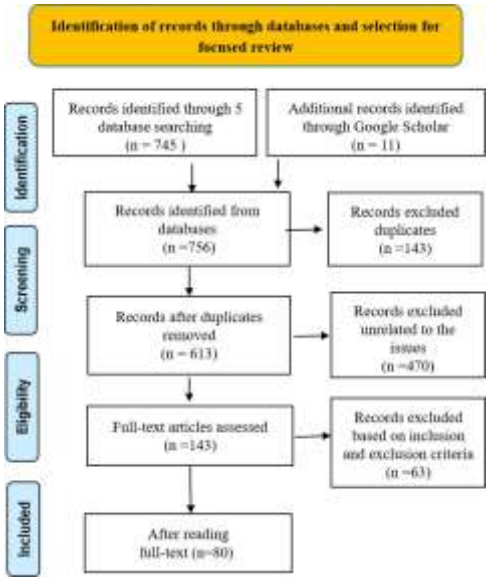

Figure 1. PRISMA 2020 flow diagram illustrating the selection of papers.

2.2. Analysis

First, we examined the annual publication trends to understand research evolution over time. We then conducted a two-stage content analysis, combining automated computational analysis and researcher-led interpretive coding to ensure both analytical breadth and contextual depth.

Automated content analysis was performed using Leximancer v5.0 (Leximancer, 2024), which applies a Bayesian learning algorithm for text mining and concept mapping[14]. This method identifies co-occurring concepts and visualizes them through concept maps that represent thematic clusters[15].

Text preprocessing procedures included:

Converting all Word and PDF documents to plain text.

Removing extraneous metadata such as titles, figure captions, tables, and author affiliations.

Excluding frequent non-thematic terms (e.g., “data,” “table,” “figure,” “analyze”).

Applying customized stop-word and merge lists to ensure thematic precision.

The Leximancer configurations were as follows: Theme Size = 30%, Rotation = 0°, and Concepts = 100%.

Thirteen recurring themes emerged from the 80 included publications.

This integrative approach—combining computational mapping and theoretical interpretation—ensured both methodological rigor and replicability, aligning with the reproducibility standards of PRISMA 2020.

3. Results

3.1. Field evolution by numbers

The results of the literature search led to the classification of 80 works (**Table 2**).

Table 2. Number of papers per year.

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
Amount	0	2	3	3	5	11	12	9	14	18	3	80

The papers were examined further to determine the journals in which they had appeared over time. 80 Articles were published in 32 journals, with 35 of them were published in Sustainability, 6 in Journal of Teacher Education for Sustainability, and 4 in Environmental Education Research, as **Table 3** shows.

Table 3. Number of publications per journal and year.

Journal	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Sustainable Development		1									
Sustainability		1	1	1	3	5	4	4	9	4	3
Environmental Education Research			1			1		1		1	
Journal of Teacher Education for Sustainability			1	1		1	3				
Educational Research				1							
Medical Teacher					1					1	
International Research in Geographical and Environmental Education					1						
Discrete Dynamics in Nature and Society						1					
Ain Shams Engineering Journal						1					
Teaching and Teacher Education						1				1	
Frontiers in Education						1					

Journal	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Turkish Online Journal of Distance Education,							1				
Education Inquiry							1				
Journal of Physics: Conference Series							1				
Education Sciences							2			1	
Chemistry Teacher International							1				
Journal of Cleaner Production								2			
Frontiers in Psychology								1			
Eurasia Journal of Mathematics, Science and Technology Education								1			
E3S Web of Conferences									1		
Revista Romaneasca Pentru Educatie Multidimensionala									1		
Jurnal Pendidikan IPA Indonesia									1		
Jurnal Pendidikan Agama Islam									1		
International Journal of Environmental Research and Public Health									1		
European Journal of Investigation in Health, Psychology and Education										1	
International Journal of Evaluation and Research in Education (IJERE)										2	
Procedia - Social and Behavioral Sciences										1	
Journal of Leadership Education										1	
Cogent Social Sciences										1	
Episodes										1	
Sustainability Science										1	
IOP Conference Series										1	
	0	2	3	3	5	11	12	9	14	18	3
						80					

Table 3. (*Continued*)

Figure 2 shows that 13 studies were categorised as theoretical, 28 as qualitative, 26 as quantitative, and 13 as hybrid approaches. All considered studies, the authors' claimed methods, and the methodological categories assigned to them are listed in **Table A1** of Appendix A.

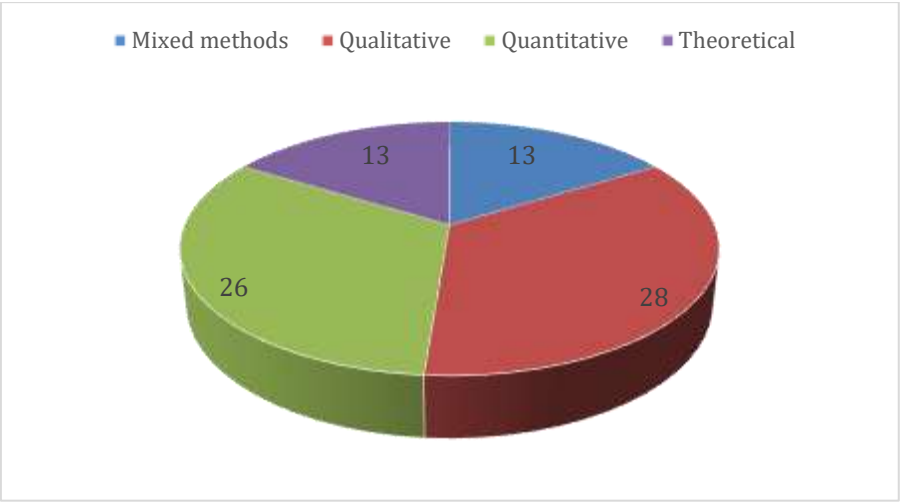

Figure 2. Article distribution by approach.

Subsequent investigation revealed that 10 publications—the majority of which were theoretical studies—lacked the study's nation and location. The majority of the research for the remaining 70 papers was conducted in Asian countries (33), with Europe coming in second with 24 papers. Additionally, studies were carried out in America (2), Africa (5), and Mixed (6) (**Figure 3**).

Figure 3. Number of the country of studies.

3.2. Results of thematic analysis

After using Leximancer to assess 80 papers, we discovered 13 themes with the following configuration (**Figure 4**). "Teachers," "education," "teaching," "students," "sustainability," "future," "need," "SDGs," "model," "used," "level," "time," and "parents" are among the themes that emerged from the investigation. According to the number of matches discovered in the examined text, the themes are arranged in descending order. And according to **Table 4**, the top three theme lines were "teachers," "education," and "teaching."

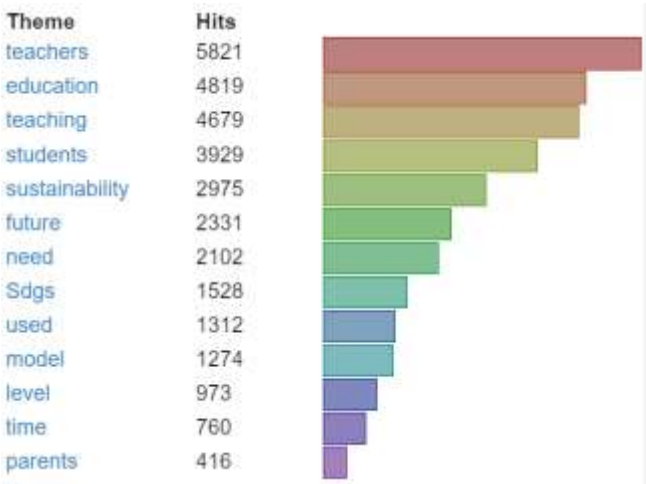

Figure 4. Identified themes.

Table 4. Concepts included in the themes.

Theme	Hits	Connectivity	Concepts
teachers	5821	68861	teachers, teacher, study, school, research, professional, training, schools, quality, practice, results, community, course, university, secondary, theory, con
education	4819	56300	education, development, sustainable, curriculum, important, related, role, studies, context, subject, science, higher, areas, academic, individual, key, positive
teaching	4679	51150	teaching, learning, educational, activities, methods, different, process, classroom, based, student, system, experience, digital, developed
students	3929	35476	students, knowledge, skills, approach, use, work, content, focus, re, resources, information, project
sustainability	2975	29032	sustainability, social, ESD, environmental, issues, change, concept, global, impact, climate, society, risk, de, tion
future	2331	19609	future, environment, understanding, critical, thinking, awareness, example, ability, making, others
need	2102	16842	need, support, develop, challenges, including, approaches, order, perspective, courses, countries
SDGs	1528	10330	SDGs, world, people, human, values, life, nature, health, PG
model	1274	9306	model, evaluation, during, method, design, assessment, attention
used	1312	8109	used, using, participants, materials
level	973	6334	level, leadership, signi, following
time	760	4175	time, group, online
parents	416	2258	parents, conducted

With the help of Leximancer, we were also able to produce a "concept map"; **Figure 5** shows this. Concepts and topics comprise the concept map. Size (as a "heat map": the brighter the theme, the more frequently it appears in the text under examination) and colour (as a "heat map") illustrate the importance of themes[14,15].

The concept map also shows the themes that overlap, like "teaching" with the other five themes ("students," "used," "model," "teachers," and "need" in our case); the concepts that are shared by two themes, like "challenges" and "role," which are shared by "education" and "need" in our case; and the relationships that maintain the relationships between the themes, like "development"–"studies"–"curriculum" (also known as "education").

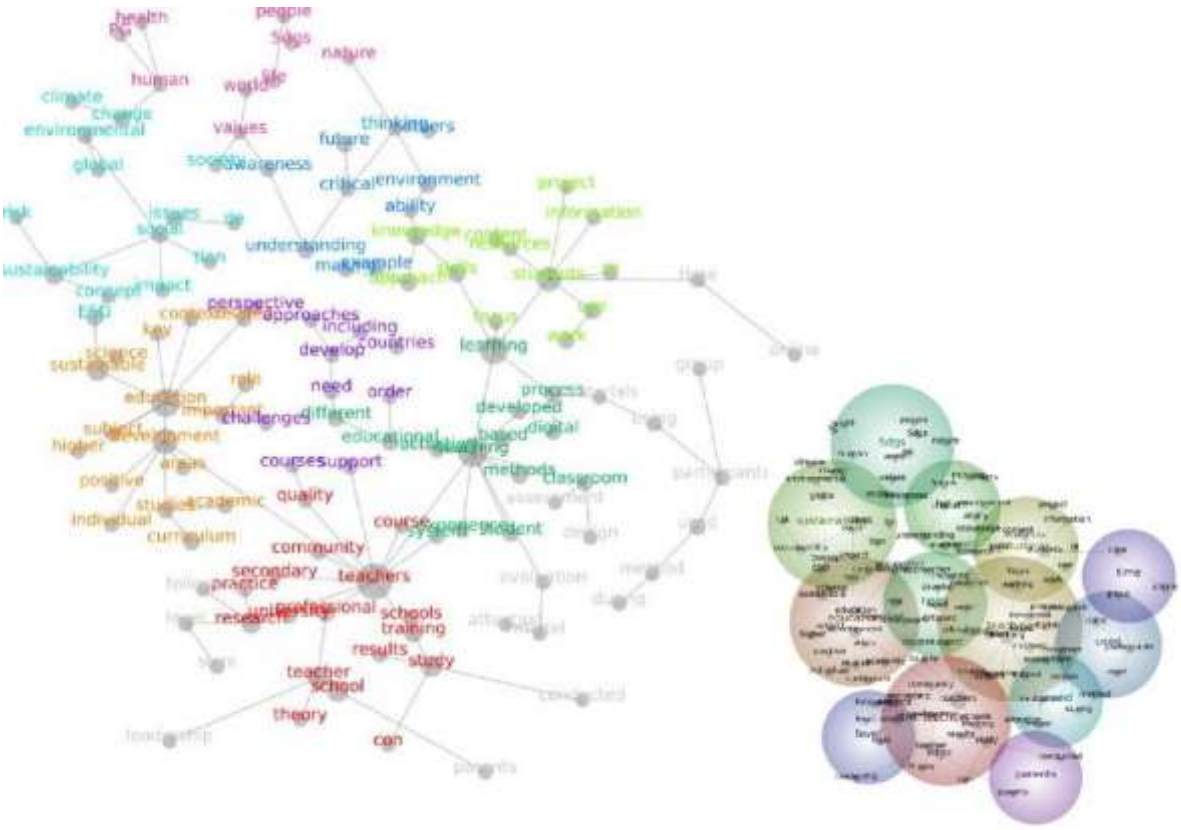

Figure 5. Leximancer concept map.

Through the concept map, which uses various colours for themes and concepts, we can see the various groupings. For instance, "teacher" provides the basis for the red cluster theme, "education" for the orange cluster theme, and "need" for the purple cluster theme. They both emphasise "challenges" in their overlaps. The overlap of some of the concepts and their centrality in the concept map allow us to perceive some of these interactions in a corresponding manner.

3.3. Results of content analysis

The map's concept provided useful information on the connections between teacher practices and school sustainability. These papers from a variety of scholarly publications tried to extract the complicated following a thorough analysis and evaluation of the most recent and pertinent advances, as indicated in **Table 5**. They paid special attention to the following areas.

Table 5. Key development of the studies.

Key development	Categories	References
Pedagogical Practice and Curriculum	Curriculum design and pedagogy for sustainability	Hımmetoglu et al.(2020)[16];Sá & Serpa (2020)[2]; Alkhawaldeh (2017)[17]; Aslam et al.(2023)[18]; Bevan et al.(2023)[7]; Biasutti et al.(2019)[4]; Ichinose (2019)[3]; Jekabsone & Ratniece (2023)[19]; Şemin (2019)[20].
	Assessment and evaluation practices	Moreno-Guerrero et al.(2020)[21]; Sánchez-Prieto et al.(2021)[22]; Spahiu & Lindemann-Matthies (2015)[23]; Xu & Yue (2019)[24].
	Inclusive and equitable teaching approaches	Ma et al.(2023)[25]; Maashi et al.(2022)[26]; Sebastián-López & González (2020)[27];Tun (2019)[28]; Vasconcelos et al.(2016)[29].
	Environmental and ecological education	Yli-Panulaet al.(2019)[30]; Zhang et al.(2021)[31]; Zhang et al.(2023)[32].
	Values education and citizenship	Stevenson et al.(2017)[33]; Thompson (2018)[34]; Ovcharuk et al.(2020)[35]; Al-Hail et al.(2021)[36]; Bendtsen et al.(2022)[37]; Ferreira et al.(2020)[38]; Hsieh et al.(2020)[39]; Liu et al.(2021)[40].
	Teacher professional development and capacity building	Leal Filho et al.(2019)[1]; Leal Filho et al.(2018)[41]; Garzón Artacho et al.(2020)[42]; Alkaher & Carmi (2024)[43]; Al-Thani et al.(2021)[44]; El-Aasar et al.(2024)[45]; Huang et al.(2023)[46]; Jeronen et al.(2016)[47], Nguyen et al.(2020)[48].
Teacher Capacity and Development	Teachers' attitudes and beliefs toward sustainability	Opuni-Frimpong et al.(2022)[8]; Peedikayil et al.(2023)[49]; Tascı (2015)[50]; Wu et al. (2022)[6]; Yeh & Barrington (2023)[51]; Zhao et al.(2022)[52].
	Barriers and challenges faced by teachers	Clarke & Mcphie (2016)[5]; Betancourt-Odio et al.(2021)[53]; Chen et al.(2021)[54]; Fröberg et al.(2023)[55]; Lin et al.(2022)[56]; Mróz & Ocetkiewicz (2021)[57]; Thor & Karlsudd (2020)[58].
Leadership and School Systems	Teacher agency and leadership	Wamsler et al.(2018)[59]; Id Babou et al.(2023)[60]; Colás-Bravo et al.(2018)[61]; Ichinose (2017)[62]; Thi Ngoc Lien et al.(2021)[63]; Lin et al.(2022)[64]; Pehoiu (2019)[65].
	Policy alignment and school governance	Bernsteiner et al.(2023)[66]; Fiel'ardh et al.(2023)[67]; Ghorbani et al.(2018)[68]; Imai et al.(2022)[69]; Letouzey-Pasquier et al.(2023)[70]; Nguyen et al.(2022)[71]; Purwianingsih et al.(2022)[72]; Uleanya et al.(2019)[73].
Community and Collaboration	Collaboration and community engagement	Agbedahin (2019)[74]; Anđić & Mažar(2023)[75]; Brown et al.(2024)[76]; Colmenares-Quintero(2022)[77]; Holo et al.(2023)[78]; Jiang et al.(2023)[9]; Koç & Bastas (2019)[79]; Sadłowska-Wrzesińska et al.(2022)[80].
Innovation and Digital Integration	Technology integration and digital literacy	Chen et al.(2022)[81]; Kwon & Choi (2022)[82]; Mubin et al.(2023)[83]; Naidoo & Reddy (2023)[84]; Ozeren et al.(2020)[85]; Sund & Gericke (2020)[86].

The research review also emphasises the diverse role that educators play in promoting school sustainability, highlighting the ways in which curriculum design, teacher development, leadership, and pedagogical practices all support sustainable education. The review demonstrates how educators are leading the way in implementing inclusive, ecologically sensitive, and value-driven teaching approaches by drawing on a wide range of recent studies. In addition to promoting the inclusion of sustainability principles in the curriculum, these initiatives give students the tools they need to critically analyse global issues and take an active role in civic life.

Furthermore, it became clear that professional development and teacher capacity were essential to advancing sustainable education. In order to give teachers the abilities and self-assurance they need to spearhead sustainability projects, the literature highlights the importance of ongoing training, reflective

practice, and institutional support. The acceptance and implementation of sustainability-focused practices are also greatly influenced by the attitudes and beliefs of teachers, while institutional inertia, a lack of legislative support, and resource constraints continue to be major obstacles.

The literature shows that teacher agency, policy alignment, and school governance structures that promote sustainability are becoming increasingly important in terms of leadership and school systems. It is believed that integrating sustainability into the operations and culture of educational institutions requires leadership that promotes creativity, teamwork, and shared responsibility. In order for schools to serve as focal points for more extensive social transformation and environmental awareness, cooperation with communities and stakeholders is crucial.

In conclusion, there is strong evidence from the examined literature that the goal of school sustainability is closely related to leadership and teaching strategies. Teachers can create schools that are resilient and prepared for the future by implementing collaborative leadership, inclusive pedagogy, strategic curriculum design, and teacher empowerment. It will be essential to invest in teacher development and create a supportive policy environment as sustainability becomes a pressing educational necessity. In addition to improving educational quality, these all-encompassing strategies will forward the global sustainability agenda and produce generations that are prepared to create a world that is just, equitable, and sustainable[1].

4. Discussion

A rising amount of data shows that improving educational quality and promoting school sustainability depend heavily on teacher practices and professional development. Although incorporating sustainability into everyday instruction, administration, and community involvement remains difficult for educators and school administrators, a wealth of research from a variety of educational contexts provides insightful information about the advantages and disadvantages of existing strategies. These studies, which draw from a variety of academic viewpoints, jointly demonstrate the crucial role that educators play in promoting sustainable development, both as change agents and as implementers of curricula. The results highlight how difficult it is to promote sustainability in schools and suggest key directions for further research, especially in building teacher capacity, encouraging inclusive pedagogy, and coordinating institutional procedures with sustainability objectives.

4.1. Discussion of findings

This study carried out a thorough content analysis of academic literature released in recent years in order to gain a better understanding of the state of teacher practices in relation to school sustainability. The objective was to investigate the importance, changing patterns, and complex effects of teaching strategies on advancing sustainability in learning environments. In order to understand how scholars have handled the study of pedagogical practices, teacher capacity, institutional leadership, community engagement, and digital integration as they pertain to sustainable education, this analysis categorised and synthesised current advancements. In order to identify important areas of attention that influence sustainable practices in schools, the evaluation also assessed the depth and relevance of these research issues.

Specifically, the results of the content analysis showed that in five main subject areas, teaching practices had a substantial impact on sustainability: 1) Curriculum and Pedagogical Practice; 2) Teacher Development and Capacity; 3) School Systems and Leadership; 4) Community and Cooperation; and 5) Innovation and Digital Integration. Values-based learning, environmental education, and inclusive teaching strategies were prioritised in pedagogical practice. Professional growth and sustainability attitudes were found to be important factors in teacher development. While community collaboration emphasised the importance of

stakeholder participation, leadership and school governance were intimately associated with teacher agency and policy alignment. Lastly, the incorporation of technology demonstrated how important digital literacy is becoming for promoting sustainability.

All things considered, the analysis indicates that encouraging sustainability in education necessitates a comprehensive strategy that supports educators as proactive leaders and collaborators within their institutions in addition to serving as content providers. The varied literature emphasises how curriculum, teacher preparation, community engagement, and leadership are all intertwined in achieving sustainable education. These results open the door for more investigation into the innovations and contextual obstacles that influence sustainable educational systems, in addition to reaffirming the importance of teaching practices in sustainability discourse.

4.2. Future research directions

Future studies on sustainability in teacher education should focus on a number of important topics, according to the evaluated literature. Much more research is needed, particularly in the areas of long-term effects, emotional and ethical aspects, technology integration, cultural contexts, teacher leadership, content innovation, and post-pandemic changes, even though there has been progress in incorporating sustainability into teacher training programs.

First, studies in the future might evaluate how incorporating sustainability into teacher education affects things in the long run. Although recent studies have focused on short-term results, longitudinal studies that monitor pre-service and in-service instructors over time are obviously needed. Research of this kind may shed light on whether sustainability education results in enduring pedagogical change and quantifiable increases in environmental awareness and student participation.

Second, the increasing significance of digital technologies in education necessitates a targeted investigation into the ways in which these instruments might either facilitate or impede sustainability teaching. More research should look at how well digital platforms, gamification, and virtual learning environments work in different educational contexts, even though some studies highlight their advantages. In order to guarantee that all students, regardless of background, benefit from these advancements, concerns about digital fairness and accessibility must also be addressed.

Third, it is important to highlight how cultural and contextual elements influence sustainability education. Localised approaches to sustainability are more successful than one-size-fits-all ones, according to comparative research from nations including Qatar, Jordan, China, and Croatia. Therefore, future studies should investigate the ways in which social expectations, institutional policies, and cultural norms affect the incorporation of sustainability in teacher education. This could result in the creation of context-sensitive models that uphold and represent regional realities while advancing international sustainability objectives.

Fourth, curriculum leadership and teacher autonomy need to be given more consideration in sustainability projects. Growing knowledge of how curriculum implementation affects school sustainability in recent years has brought attention to the crucial role that skilled leadership plays in this regard[87]. Teachers can encourage and spearhead sustainability initiatives at the school and community levels in addition to carrying out courses. Future research should look into how teacher education programs may help teachers become more capable of advocating for systemic change, taking on leadership roles, and co-creating sustainability curricula.

Finally, a promising avenue for sustainability research is transdisciplinary and creative content domains. Topics including biodiversity, outdoor learning, and physical education have all been investigated recently as

means of promoting sustainable education. How including these and other unconventional subjects improves students' ecological literacy, develops critical thinking skills, and strengthens their bond with nature could be the subject of future studies.

In conclusion, embracing multidisciplinary, emotionally intelligent, culturally sensitive, and technologically advanced techniques is key to the future of sustainability in teacher ethics. Future studies can support more inclusive, transformative, and successful sustainability teaching methods in a variety of educational contexts by tackling these new areas.

4.3. Limitations of the research

Although the thorough literature assessment revealed a number of limitations that should be carefully considered and suggest productive avenues for future research, this study has advanced our understanding of how teacher behaviours improve school sustainability. Although methodological benefits are provided by the use of large datasets and methodical methodologies, the analysis also identified significant gaps that restrict the depth and generalisability of current findings.

First, a significant drawback is the excessive dependence on cross-sectional study methods, which are unable to adequately represent how sustainability practices in education are changing over time. These studies frequently offer a moment in time without taking institutional reactions, systemic reforms, or long-term shifts in teacher behaviour into consideration. Furthermore, there is little research done in places like China, and the majority of the material that is now available is geographically centred in Eastern environments, especially in Asia. This disparity limits our comprehension of how political, economic, and cultural elements influence sustainable practices in various educational contexts.

Furthermore, few studies critically examine the transformative effects of digital tools, remote learning, and AI integration on teacher engagement and sustainable pedagogy, despite the fact that talks about sustainability increasingly incorporate digitalisation and innovation. The scope of current study is further limited by the exclusion of multidisciplinary approaches, especially those that combine social policy, educational technology, and environmental science.

The comparability and synthesis of results are further challenged by methodological variations among chosen studies. Numerous studies used cross-sectional designs, which make it difficult to monitor how teaching behaviours change in response to institutional or policy changes. Furthermore, interdisciplinary research that incorporates viewpoints from disciplines like political science, economics, environmental studies, and technology is conspicuously lacking. Such study could provide deeper understanding of the intricate dynamics of school sustainability.

Future studies should prioritise reducing geographic bias while expanding the scope of literature search algorithms to include non-English sources and gray literature in order to overcome these constraints. Finding the long-term effects of teacher-driven sustainability initiatives will be made easier by embracing mixed-methods and longitudinal study approaches. Furthermore, multidisciplinary cooperation ought to be promoted in order to investigate the ways in which educational sustainability interacts with more general socio-political, economic, and technological elements. It will also be crucial to conduct further research on stakeholder participation, including how communities, educators, leaders, and students collaborate to create sustainable practices.

Longitudinal research should be given top priority in future studies to track how teacher practices change in response to shifting sustainability objectives and educational needs. A more thorough and inclusive understanding of sustainability in global education will be captured with the support of a greater

emphasis on cross-cultural study. Furthermore, a more nuanced investigation of intricate educational ecosystems will be possible through the integration of mixed-methods designs and multidisciplinary frameworks.

5. Conclusion

In summary, this review highlights the need for ongoing, comparative, and cooperative research into how teachers implement and maintain educational transformation in increasingly complex learning environments. Using the PRISMA framework to integrate findings from the previous ten years, this systematic literature review investigated the ways in which teaching behaviours support school sustainability. The review offers a strong overview of the changing relationship between teaching and sustainability by combining findings from five thematic domains: curriculum and pedagogical practice, teacher capacity and development, leadership and school systems, community and collaboration, and innovation and digital integration. Educators are essential but frequently overlooked sustainability agents who impact not only environmental consciousness but also inclusivity, values education, and institutional resilience. The generalisability of current findings is constrained by enduring restrictions, including the predominance of cross-sectional designs, the geographic concentration of research in Eastern and Asian contexts, and the lack of methodological triangulation. Longitudinal and mixed-methods techniques, wider involvement of non-English and under-represented regions, and interdisciplinary partnerships bridging educational, social, and environmental sciences will all be necessary to overcome these limitations. Therefore, future studies should concentrate on developing context-sensitive, empirically supported frameworks that capture the evolution of teaching techniques across various educational systems. In the end, such study might shape more inclusive and flexible models of sustainable education by strengthening methodological rigour and expanding theoretical knowledge.

Author contributions

Conceptualization, Yihong Peng, Bity Salwana Alias, and Azlin Norhaini Mansor; Methodology, Yihong Peng; Software, Yihong Peng; Validation, Yihong Peng, Bity Salwana Alias, and Azlin Norhaini Mansor; Formal Analysis, Yihong Peng; Investigation, Yihong Peng; Resources, Yihong Peng; Data Curation, Yihong Peng; Writing—Original Draft Preparation, Yihong Peng; Writing—Review & Editing, Yihong Peng; Visualization, Yihong Peng; Supervision, Bity Salwana Alias and Azlin Norhaini Mansor; Project Administration, Bity Salwana Alias and Azlin Norhaini Mansor.

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Conflict of interest

The authors declare no conflicts of interest.

References

1. Leal Filho, W., Shiel, C., Paço, A., Mifsud, M., Ávila, L. V., Brandli, L. L., Molthan-Hill, P., Pace, P., Azeiteiro, U. M., Vargas, V. R., & Caeiro, S. (2019). Sustainable Development Goals and sustainability teaching at universities:

Falling behind or getting ahead of the pack? Journal of Cleaner Production, 232, 285–294. https://doi.org/10.1016/j.jclepro.2019.05.309
2. Sá, M. J., & Serpa, S. (2020). The COVID-19 Pandemic as an Opportunity to Foster the Sustainable Development of Teaching in Higher Education. Sustainability, 12(20), 8525. https://doi.org/10.3390/su12208525
3. Icihnose, T. (2019). The Effectiveness of the Methods and Approaches of ESD for 2030 Sustainable Development Goals; From Analysis of the Questionnaire Survey to the School Teachers. Journal of Physics: Conference Series, 1417(1), 012072. https://doi.org/10.1088/1742-6596/1417/1/012072
4. Biasutti, M., Concina, E., & Frate, S. (2019). Social Sustainability and Professional Development: Assessing a Training Course on Intercultural Education for In-Service Teachers. Sustainability, 11(5), 1238. https://doi.org/10.3390/su11051238
5. Clarke, D. A. G., & Mcphie, J. (2016). From places to paths: Learning for Sustainability , teacher education and a philosophy of becoming. Environmental Education Research, 22(7), 1002–1024. https://doi.org/10.1080/13504622.2015.1057554
6. Wu, W., Hu, R., Tan, R., & Liu, H. (2022). Exploring Factors of Middle School Teachers' Satisfaction with Online Training for Sustainable Professional Development under the Impact of COVID-19. Sustainability, 14(20), 13244. https://doi.org/10.3390/su142013244
7. Bevan, J., Blyth, R., Russell, B., Holtgrewe, L., Cheung, A. H. C., Austin, I., Shah, V., Butler, M., Fraser, S., Pabellan, V., Shoker, S., Corriero, A., Lok, P., Wieczorek, K., Przypasniak, Z., Boydell, J., Farrow, A., Gibson, P., Miller, E., … O'Hara, S. (2023). Planetary health and sustainability teaching in UK medical education: A review of medical school curricula. Medical Teacher, 45(6), 623–632. https://doi.org/10.1080/0142159X.2022.2152190
8. Opuni-Frimpong, N. Y., Essel, H. B., Opuni-Frimpong, E., & Obeng, E. A. (2022). Sustainable Development Goal for Education: Teachers' Perspectives on Climate Change Education in Senior High Schools (SHS). Sustainability, 14(13), 8086. https://doi.org/10.3390/su14138086
9. Jiang, M., Yu, H., He, J., Qian, G., & Bialas, M. (2023). Effectiveness of Cooperative Learning Instructional Models in Training In-Service Physical Education Teachers in Southwest China. Sustainability, 15(13), 9993. https://doi.org/10.3390/su15139993
10. Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & for the PRISMA Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. BMJ, 339(jul21 1), b2535–b2535. https://doi.org/10.1136/bmj.b2535
11. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, Shamseer L, Tetzlaff JM, Akl EA, Brennan SE, Chou R. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. bmj. 2021 Mar 29;372. Available from: https://doi.org/10.1136/bmj.n71
12. Bramer, W. M., De Jonge, G. B., Rethlefsen, M. L., Mast, F., & Kleijnen, J. (2018). A systematic approach to searching: An efficient and complete method to develop literature searches. Journal of the Medical Library Association, 106(4). https://doi.org/10.5195/jmla.2018.283
13. Hong, Q. N., Fàbregues, S., Bartlett, G., Boardman, F., Cargo, M., Dagenais, P., ... & Pluye, P. (2018). The Mixed Methods Appraisal Tool (MMAT) version 2018 for information professionals and researchers. Education for information, 34(4), 285-291. https://doi.org/10.3233/EFI-180221
14. Randhawa, K., Wilden, R., & Hohberger, J. (2016). A Bibliometric Review of Open Innovation: Setting a Research Agenda. Journal of Product Innovation Management, 33(6), 750–772. https://doi.org/10.1111/jpim.12312
15. Pucihar, A. (2020). The digital transformation journey: Content analysis of Electronic Markets articles and Bled eConference proceedings from 2012 to 2019. Electronic Markets, 30(1), 29–37. https://doi.org/10.1007/s12525-020-00406-7
16. Himmetoglu, B., Aydug, D., & Bayrak, C. (2020). EDUCATION 4.0: DEFINING THE TEACHER, THE STUDENT, AND THE SCHOOL MANAGER ASPECTS OF THE REVOLUTION. Turkish Online Journal of Distance Education, 21(Special Issue-IODL), 12–28. https://doi.org/10.17718/tojde.770896
17. Alkhawaldeh, A. (2017). School-based Teacher Training in Jordan: Towards On-school Sustainable Professional Development. Journal of Teacher Education for Sustainability, 19(2), 51–68. https://doi.org/10.1515/jtes-2017-0014
18. Aslam, S., Alghamdi, A. A., Abid, N., & Kumar, T. (2023). Challenges in Implementing STEM Education: Insights from Novice STEM Teachers in Developing Countries. Sustainability, 15(19), 14455. https://doi.org/10.3390/su151914455
19. Jekabsone, I., & Ratniece, L. (2023). Integrating Sustainability Into Curriculum of Legal Education in Latvia: An Insight Into the Main Issues. Journal of Teacher Education for Sustainability, 25(2), 60–75. https://doi.org/10.2478/jtes-2023-0016
20. Şemin, F. K. (2019). The competencies of principals in ensuring sustainable education: Teachers' views. International Journal of Evaluation and Research in Education (IJERE), 8(2), 201. https://doi.org/10.11591/ijere.v8i2.18273

21. Moreno-Guerrero, A.-J., Rodríguez-Jiménez, C., Gómez-García, G., & Ramos Navas-Parejo, M. (2020). Educational Innovation in Higher Education: Use of Role Playing and Educational Video in Future Teachers' Training. Sustainability, 12(6), 2558. https://doi.org/10.3390/su12062558
22. Sánchez-Prieto, J., Trujillo-Torres, J. M., Gómez-García, M., & Gómez-García, G. (2021). Incident Factors in the Sustainable Development of Digital Teaching Competence in Dual Vocational Education and Training Teachers. European Journal of Investigation in Health, Psychology and Education, 11(3), 758–769. https://doi.org/10.3390/ejihpe11030054
23. Spahiu, M., & Lindemann-Matthies, P. (2015). Effect of a Toolkit and a One-Day Teacher Education Workshop on ESD Teaching Content and Methods—A Study from Kosovo. Sustainability, 7(7), 8051–8066. https://doi.org/10.3390/su7078051
24. Xu, P., & Yue, X. (2019). Talent leadership strategies enhance teacher's professional competencies in 21st century education for sustainable development. IOP Conference Series: Earth and Environmental Science, 373(1), 012003. https://doi.org/10.1088/1755-1315/373/1/012003
25. Ma, X., Jiang, M., & Nong, L. (2023). The effect of teacher support on Chinese university students' sustainable online learning engagement and online academic persistence in the post-epidemic era. Frontiers in Psychology, 14, 1076552. https://doi.org/10.3389/fpsyg.2023.1076552
26. Maashi, K. M., Kewalramani, S., & Alabdulkareem, S. A. (2022). Sustainable professional development for STEM teachers in Saudi Arabia. Eurasia Journal of Mathematics, Science and Technology Education, 18(12), em2189. https://doi.org/10.29333/ejmste/12597
27. Sebastián-López, M., & De Miguel González, R. (2020). Mobile Learning for Sustainable Development and Environmental Teacher Education. Sustainability, 12(22), 9757. https://doi.org/10.3390/su12229757
28. Tun, M. S. (2019). Fulfilling a new obligation: Teaching and learning of sustainable healthcare in the medical education curriculum. Medical Teacher, 41(10), 1168–1177. https://doi.org/10.1080/0142159X.2019.1623870
29. Vasconcelos, C., Torres, J., Vasconcelos, L., & Moutinho, S. (2016). Sustainable development and its connection to teaching geoethics. Episodes, 39(3), 509–517. https://doi.org/10.18814/epiiugs/2016/v39i3/99771
30. Yli-Panula, E., Jeronen, E., & Lemmetty, P. (2019). Teaching and Learning Methods in Geography Promoting Sustainability. Education Sciences, 10(1), 5. https://doi.org/10.3390/educsci10010005
31. Zhang, J., Chen, Z., Ma, J., & Liu, Z. (2021). Investigating the Influencing Factors of Teachers' Information and Communications Technology-Integrated Teaching Behaviors toward "Learner-Centered" Reform Using Structural Equation Modeling. Sustainability, 13(22), 12614. https://doi.org/10.3390/su132212614
32. Zhang, Y., Sun, S., Ji, Y., & Li, Y. (2023). The Consensus of Global Teaching Evaluation Systems under a Sustainable Development Perspective. Sustainability, 15(1), 818. https://doi.org/10.3390/su15010818
33. Stevenson, R. B., Lasen, M., Ferreira, J. A., & Davis, J. (2017). Approaches to embedding sustainability in teacher education: A synthesis of the literature. Teaching and Teacher Education, 63, 405–417. https://doi.org/10.1016/j.tate.2017.01.013
34. Thompson, C. S. (2018). The Construct of 'Respect' in Teacher-Student Relationships: Exploring Dimensions of Ethics of Care and Sustainable Development. Journal of Leadership Education, 17(3), 42–60. https://doi.org/10.12806/V17/I3/R3
35. Ovcharuk, O., Ivaniuk, I., Soroko, N., Gritsenchuk, O., & Kravchyna, O. (2020). The use of digital learning tools in the teachers' professional activities to ensure sustainable development and democratization of education in European countries. E3S Web of Conferences, 166, 10019. https://doi.org/10.1051/e3sconf/202016610019
36. Al-Hail, M. A., Al-Fagih, L., & Koç, M. (2021). Partnering for Sustainability: Parent-Teacher-School (PTS) Interactions in the Qatar Education System. Sustainability, 13(12), 6639. https://doi.org/10.3390/su13126639
37. Bendtsen, M., Forsman, L., & Björklund, M. (2022). Exploring empowering practices for teachers' sustainable continuing professional development. Educational Research, 64(1), 60–76. https://doi.org/10.1080/00131881.2021.2000338
38. Ferreira, M., Martinsone, B., & Talić, S. (2020). Promoting Sustainable Social Emotional Learning at School through Relationship-Centered Learning Environment, Teaching Methods and Formative Assessment. Journal of Teacher Education for Sustainability, 22(1), 21–36. https://doi.org/10.2478/jtes-2020-0003
39. Hsieh, Y.-Z., Lin, S.-S., Luo, Y.-C., Jeng, Y.-L., Tan, S.-W., Chen, C.-R., & Chiang, P.-Y. (2020). ARCS-Assisted Teaching Robots Based on Anticipatory Computing and Emotional Big Data for Improving Sustainable Learning Efficiency and Motivation. Sustainability, 12(14), 5605. https://doi.org/10.3390/su12145605
40. Liu, H., Chu, W., Fang, F., & Elyas, T. (2021). Examining the Professional Quality of Experienced EFL Teachers for Their Sustainable Career Trajectories in Rural Areas in China. Sustainability, 13(18), 10054. https://doi.org/10.3390/su131810054
41. Leal Filho, W., Raath, S., Lazzarini, B., Vargas, V. R., De Souza, L., Anholon, R., Quelhas, O. L. G., Haddad, R., Klavins, M., & Orlovic, V. L. (2018). The role of transformation in learning and education for sustainability. Journal of Cleaner Production, 199, 286–295. https://doi.org/10.1016/j.jclepro.2018.07.017

42. Garzón Artacho, E., Martínez, T. S., Ortega Martín, J. L., Marín Marín, J. A., & Gómez García, G. (2020). Teacher Training in Lifelong Learning—The Importance of Digital Competence in the Encouragement of Teaching Innovation. Sustainability, 12(7), 2852. https://doi.org/10.3390/su12072852
43. Alkaher, I., & Carmi, N. (2024). Population growth as the elephant in the room: Teachers' perspectives and willingness to incorporate a controversial environmental sustainability issue in their teaching. Environmental Education Research, 1–28. https://doi.org/10.1080/13504622.2023.2296358
44. Al-Thani, W. A., Ari, I., & Koç, M. (2021). Education as a Critical Factor of Sustainability: Case Study in Qatar from the Teachers' Development Perspective. Sustainability, 13(20), 11525. https://doi.org/10.3390/su132011525
45. El-Aasar, M., Shafik, Z., & Abou-Bakr, D. (2024). Outdoor learning environment as a teaching tool for integrating education for sustainable development in kindergarten, Egypt. Ain Shams Engineering Journal, 15(4), 102629. https://doi.org/10.1016/j.asej.2024.102629
46. Huang, L., Zhang, W., Jiang, H., & Wang, J.-L. (2023). The Teaching Quality Evaluation of Chinese-Foreign Cooperation in Running Schools from the Perspective of Education for Sustainable Development. Sustainability, 15(3), 1975. https://doi.org/10.3390/su15031975
47. Jeronen, E., Palmberg, I., & Yli-Panula, E. (2016). Teaching Methods in Biology Education and Sustainability Education Including Outdoor Education for Promoting Sustainability—A Literature Review. Education Sciences, 7(1), 1. https://doi.org/10.3390/educsci7010001
48. Nguyen, T. P. L., Nguyen, T. H., & Tran, T. K. (2020). STEM Education in Secondary Schools: Teachers' Perspective towards Sustainable Development. Sustainability, 12(21), 8865. https://doi.org/10.3390/su12218865
49. Peedikayil, J. V., Vijayan, V., & Kaliappan, T. (2023). Teachers' attitude towards education for sustainable development: A descriptive research. Int J Eval & Res Educ ISSN, 2252(8822), 8822. https://doi.org/10.11591/ijere.v12i1.23019
50. Tascı, B. G. (2015). "Sustainability" Education by Sustainable School Design. Procedia - Social and Behavioral Sciences, 186, 868–873. https://doi.org/10.1016/j.sbspro.2015.04.199
51. Yeh, C. S.-H., & Barrington, R. (2023). Sustainable positive psychology interventions enhance primary teachers' wellbeing and beyond – A qualitative case study in England. Teaching and Teacher Education, 125, 104072. https://doi.org/10.1016/j.tate.2023.104072
52. Zhao, L., Wu, X., & Luo, H. (2022). Developing AI Literacy for Primary and Middle School Teachers in China: Based on a Structural Equation Modeling Analysis. Sustainability, 14(21), 14549. https://doi.org/10.3390/su142114549
53. Betancourt-Odio, M. A., Sartor-Harada, A., Ulloa-Guerra, O., & Azevedo-Gomes, J. (2021). Self-Perceptions on Digital Competences for M-Learning and Education Sustainability: A Study with Teachers from Different Countries. Sustainability, 13(1), 343. https://doi.org/10.3390/su13010343
54. Chen, J., Yang, Y., Xu, F., Xu, W., Zhang, X., Wang, Y., & Zhang, Y. (2021). Factors Influencing Curriculum Leadership of Primary and Secondary School Teachers from the Perspective of Field Dynamic Theory: An Empirical Investigation in China. Sustainability, 13(21), 12007. https://doi.org/10.3390/su132112007
55. Fröberg, A., Wiklander, P., Baena-Morales, S., & Lundvall, S. (2023). How to teach about sustainable development in physical education? Examples from the perspectives of certified teachers in Sweden. Frontiers in Education, 8, 1294763. https://doi.org/10.3389/feduc.2023.1294763
56. Lin, X.-F., Chen, L., Chan, K. K., Peng, S., Chen, X., Xie, S., Liu, J., & Hu, Q. (2022). Teachers' Perceptions of Teaching Sustainable Artificial Intelligence: A Design Frame Perspective. Sustainability, 14(13), 7811. https://doi.org/10.3390/su14137811
57. Mróz, A., & Ocetkiewicz, I. (2021). Creativity for Sustainability: How Do Polish Teachers Develop Students' Creativity Competence? Analysis of Research Results. Sustainability, 13(2), 571. https://doi.org/10.3390/su13020571
58. Thor, D., & Karlsudd, P. (2020). Teaching and Fostering an Active Environmental Awareness Design, Validation and Planning for Action-Oriented Environmental Education. Sustainability, 12(8), 3209. https://doi.org/10.3390/su12083209
59. Wamsler, C., Brossmann, J., Hendersson, H., Kristjansdottir, R., McDonald, C., & Scarampi, P. (2018). Mindfulness in sustainability science, practice, and teaching. Sustainability Science, 13(1), 143–162. https://doi.org/10.1007/s11625-017-0428-2
60. Id Babou, A., Selmaoui, S., Alami, A., Benjelloun, N., & Zaki, M. (2023). Teaching Biodiversity: Towards a Sustainable and Engaged Education. Education Sciences, 13(9), 931. https://doi.org/10.3390/educsci13090931
61. Colás-Bravo, P., Magnoler, P., & Conde-Jiménez, J. (2018). Identification of Levels of Sustainable Consciousness of Teachers in Training through an E-Portfolio. Sustainability, 10(10), 3700. https://doi.org/10.3390/su10103700
62. Ichinose, T. (2017). An Analysis of Transformation of Teaching and Learning of Japanese Schools that Significantly Addressed Education for Sustainable Development. Journal of Teacher Education for Sustainability, 19(2), 36–50. https://doi.org/10.1515/jtes-2017-0013

63. Thi Ngoc Lien, N., Thi To Khuyen, N., Thi Tho, N., Ngan Hoa, N., Thi Hanh, N., Cam Tho, C., Duy Hai, T., & Van Bien, N. (2021). Teachers' feelings of safeness in school-family-community partnerships: Motivations for sustainable development in moral education. International Journal of Evaluation and Research in Education (IJERE), 10(1), 97. https://doi.org/10.11591/ijere.v10i1.20798
64. Lin, W., Yin, H., & Liu, Z. (2022). The Roles of Transformational Leadership and Growth Mindset in Teacher Professional Development: The Mediation of Teacher Self-Efficacy. Sustainability, 14(11), 6489. https://doi.org/10.3390/su14116489
65. Pehoiu, G. (2019). Percept of Teachers Regarding Integration of Education for Environment and Sustainable Development in Primary Schools. Revista Romaneasca Pentru Educatie Multidimensionala, 11(2), 256. https://doi.org/10.18662/rrem/128
66. Bernsteiner, A., Schubatzky, T., & Haagen-Schützenhöfer, C. (2023). Misinformation as a Societal Problem in Times of Crisis: A Mixed-Methods Study with Future Teachers to Promote a Critical Attitude towards Information. Sustainability, 15(10), 8161. https://doi.org/10.3390/su15108161
67. Fiel'ardh, K., Fardhani, I., & Fujii, H. (2023). Integrating Perspectives from Education for Sustainable Development to Foster Plant Awareness among Trainee Science Teachers: A Mixed Methods Study. Sustainability, 15(9), 7395. https://doi.org/10.3390/su15097395
68. Ghorbani, S., Mirshah Jafari, S. E., & Sharifian, F. (2018). Learning to Be: Teachers' Competences and Practical Solutions: A Step Towards Sustainable Development. Journal of Teacher Education for Sustainability, 20(1), 20–45. https://doi.org/10.2478/jtes-2018-0002
69. Imai, I., Tsuchiya, Y., Ogino, K., Ueno, K., Tomita, H., Makide, K., & Tominaga, K. (2022). Development of teaching material for green and sustainable chemistry in Japan. Chemistry Teacher International, 4(2), 191–202. https://doi.org/10.1515/cti-2021-0029
70. Letouzey-Pasquier, J., Gremaud, B., Blondin, S., & Roy, P. (2023). Development of teachers' practices in the field of education for sustainable development (ESD): A discursive community of interdisciplinary practices focusing on the theme of chocolate. Environmental Education Research, 29(8), 1155–1169. https://doi.org/10.1080/13504622.2022.2128056
71. Nguyen, L.-H.-P., Bui, N.-B.-T., Nguyen, T.-N.-C., & Huang, C.-F. (2022). An Investigation into the Perspectives of Elementary Pre-Service Teachers on Sustainable Development. Sustainability, 14(16), 9943. https://doi.org/10.3390/su14169943
72. Purwianingsih, W., Novidsa, I., & Riandi, R. (2022). Program for Integrating Education for Sustainable Development (ESD) into Prospective Biology Teachers' Technological Pedagogical Content Knowledge (TPACK). Jurnal Pendidikan IPA Indonesia, 11(2), 219–228. https://doi.org/10.15294/jpii.v11i2.34772
73. Uleanya, C., Uleanya, M. O., & Oluyemi, S. (2019). Revisiting high school teachers' education: Solution to sustainable development in rural Africa. Cogent Social Sciences, 5(1), 1653545. https://doi.org/10.1080/23311886.2019.1653545
74. Agbedahin, A. V. (2019). PuciharSustainable development, Education for Sustainable Development , and the 2030 Agenda for Sustainable Development: Emergence, efficacy, eminence, and future. Sustainable Development, 27(4), 669–680. https://doi.org/10.1002/sd.1931
75. Anđić, D., & Mažar, S. (2023). Teachers' Connectedness to Nature, Education for Sustainable Development and the Contemporary Teaching of the Subject "Nature and Society" in Croatian Schools. Journal of Teacher Education for Sustainability, 25(1), 86–97. https://doi.org/10.2478/jtes-2023-0006
76. Brown, S., Küçük, Z. D., Rickard, A., Lonergan, J., Abernethy, R., McNerney, L., McNerney, E., Foley, R., Behan, A., Byrne, A., Essel, B., Ffrench, J., Faull, J., & Cahalane, C. (2024). The role of teacher agency in using GIS to teach sustainability: An evaluation of a lower secondary school story mapping GIS initiative in Ireland. International Research in Geographical and Environmental Education, 33(1), 56–71. https://doi.org/10.1080/10382046.2023.2214044
77. Colmenares-Quintero, R. F., Barbosa-Granados, S., Rojas, N., Stansfield, K. E., Colmenares-Quintero, J. C., Ruiz-Candamil, M., & Cano-Perdomo, P. (2022). Learning and Teaching Styles in a Public School with a Focus on Renewable Energies. Sustainability, 14(23), 15545. https://doi.org/10.3390/su142315545
78. Holo, O. E., Kveim, E. N., Lysne, M. S., Taraldsen, L. H., & Haara, F. O. (2023). A review of research on teaching of computer programming in primary school mathematics: Moving towards sustainable classroom action. Education Inquiry, 14(4), 513–528. https://doi.org/10.1080/20004508.2022.2072575
79. Koç, A., & Bastas, M. (2019). The Evaluation of the Project School Model in Terms of Organizational Sustainability and Its Effect on Teachers' Organizational Commitment. Sustainability, 11(13), 3549. https://doi.org/10.3390/su11133549
80. Sadłowska-Wrzesińska, J., Piosik, K., & Nejman, Ż. (2022). Psychosocial Context of OSH-Remote Work of Academic Teachers in the Perspective of Sustainable Development. International Journal of Environmental Research and Public Health, 19(22), 14783. https://doi.org/10.3390/ijerph192214783

81. Chen, T.-C., Yu, J., & Golmohammadi, A.-M. (2022). Application of Sustainable Education Innovation in the Integrated Teaching of Theory and Practice Adopted in the Auto Chassis Course. Discrete Dynamics in Nature and Society, 2022, 1–16. https://doi.org/10.1155/2022/7737231
82. Kwon, M., & Choi, Y. (2022). Exploring Categories of Self-Development of Novice Physical Education Teachers through Teacher Learning Community Activities. Sustainability, 14(7), 3718. https://doi.org/10.3390/su14073718
83. Mubin, M. N., Kim, M., & Fauziah, A. (2023). Cluster-Mentoring for Sustainable Competency: A Case Study of PTK Training for Islamic Education Teachers in Junior High Schools. Jurnal Pendidikan Agama Islam, 20(1), 51–65. https://doi.org/10.14421/jpai.v20i1.6720
84. Naidoo, J., & Reddy, S. (2023). Embedding Sustainable Mathematics Higher Education in the Fourth Industrial Revolution Era Post-COVID-19: Exploring Technology-Based Teaching Methods. Sustainability, 15(12), 9692. https://doi.org/10.3390/su15129692
85. Ozeren, E., Arslan, A., Yener, S., & Appolloni, A. (2020a). The Predictive Effect of Teachers' Perception of School Principals' Motivating Language on Teachers' Self-Efficacy via a Cultural Context. Sustainability, 12(21), 8830. https://doi.org/10.3390/su12218830
86. Sund, P., & Gericke, N. (2020). Teaching contributions from secondary school subject areas to education for sustainable development – a comparative study of science, social science and language teachers. Environmental Education Research, 26(6), 772–794. https://doi.org/10.1080/13504622.2020.1754341
87. Peng, Y., Alias, B. S., Wan, X., & Mansor, A. N. (2024). Linking Curriculum Implementation To School SDG: A Systematic Review. Journal of Lifestyle and SDGs Review, 4(2), e02019-e02019. https://doi.org/10.47172/2965-730X.SDGsReview.v4.n02.pe02019

Appendix A

Table A1. List of studies review.

Authors	Year	Title	Country of study	Study design
Agbedahin	2019	"Sustainable development, Education for Sustainable Development, and the 2030 Agenda for Sustainable Development: Emergence, efficacy, eminence, and future"	Not mentioned	Theoretical
Al-Hailet al.	2021	"Partnering for sustainability: Parent-teacher-school (pts) interactions in the qatar education system"	Qatar, Asia	Qualitative
Alkaher & Carmi	2024	"Population growth as the elephant in the room: Teachers' perspectives and willingness to incorporate a controversial environmental sustainability issue in their teaching"	Israel, Asia	Mixed methods
Alkhawaldeh	2017	"School-based Teacher Training in Jordan: Towards On-school Sustainable Professional Development"	Jordan, Asia	Qualitative
Al-Thani et al.	2021	"Education as a critical factor of sustainability: Case study in qatar from the teachers' development perspective"	Qatar, Asia	Qualitative
Anđić & Mažar	2023	"Teachers' Connectedness to Nature, Education for Sustainable Development and the Contemporary Teaching of the Subject 'Nature and Society' in Croatian Schools"	Croatia, Europe	Quantitative
Aslam et al.	2023	"Challenges in Implementing STEM Education: Insights from Novice STEM Teachers in Developing Countries"	Pakistan, Asia	Qualitative
Id Babou et al.	2023	"Exploring empowering practices for teachers' sustainable continuing professional development"	Sweden, Europe	Qualitative
Bendtsen et al.	2022	"Misinformation as a Societal Problem in Times of Crisis: A Mixed-Methods Study with Future Teachers to Promote a Critical Attitude towards Information"	Various countries (Mixed)	Mixed methods
Bernsteiner et al.	2023	"Self-perceptions on digital competences for M-learning and education sustainability: A study with teachers from different countries"	Various countries (Mixed)	Quantitative
Betancourt-Odio et al.	2021	"Planetary health and sustainability teaching in UK medical education: A review of medical school curricula"	UK, Europe	Quantitative
Bevan et al.	2023	"Social sustainability and professional development: Assessing a training course on intercultural education for in-service teachers"	Italia, Europe	Qualitative
Biasutti et al.	2019	"The role of teacher agency in using GIS to teach sustainability: An evaluation of a lower secondary school story mapping GIS initiative in Ireland"	Ireland, Europe	Qualitative
Brown et al.	2024	"Factors influencing curriculum leadership of primary and secondary school teachers from the perspective of field dynamic theory: An empirical investigation in china"	China, Asia	Quantitative
Chen et al.	2022	"From places to paths: Learning for sustainability, teacher education and a philosophy of becoming"	Scotland，Europe	Mixed methods
Chen et al.	2021	"Application of Sustainable Education Innovation in the Integrated Teaching of Theory and Practice Adopted in the Auto Chassis Course"	China, Asia	Quantitative
Clarke & Mcphie	2016	"Identification of levels of sustainable consciousness of teachers in training through an e-portfolio"	Italia, Europe	Qualitative
Colás-Bravo et al.	2018	"Learning and Teaching Styles in a Public School with a Focus on Renewable Energies"	Colombia, South America	Quantitative

Authors	Year	Title	Country of study	Study design
Colmenares-Quintero	2022	"Outdoor learning environment as a teaching tool for integrating education for sustainable development in kindergarten, Egypt"	Egypt, Africa	Theoretical
El-Aasar et al.	2024	"Promoting Sustainable Social Emotional Learning at School through Relationship-Centered Learning Environment, Teaching Methods and Formative Assessment"	Not mentioned	Theoretical
Ferreira et al.	2020	"Integrating Perspectives from Education for Sustainable Development to Foster Plant Awareness among Trainee Science Teachers: A Mixed Methods Study"	Indonesia, Asia	Mixed methods
Fiel'ardh et al.	2023	"How to teach about sustainable development in physical education? Examples from the perspectives of certified teachers in Sweden"	Sweden, Europe	Qualitative
Fröberg et al.	2023	"Teacher training in lifelong learning—The importance of digital competence in the encouragement of teaching innovation"	Andalusia, Spain, Europe	Qualitative
Garzón Artacho et al.	2020	"Learning to Be: Teachers' Competences and Practical Solutions: A Step Towards Sustainable Development"	Iran, Asia	Mixed methods
Ghorbani et al.	2018	"Education 4.0: Defining the teacher, the student, and the school manager aspects of the revolution"	Turkey, Asia & Europe	Qualitative
Hımmetoglu et al.	2020	"A review of research on teaching of computer programming in primary school mathematics: Moving towards sustainable classroom action"	Not mentioned	Theoretical
Holo et al.	2023	"ARCS-Assisted Teaching Robots Based on Anticipatory Computing and Emotional Big Data for Improving Sustainable Learning Efficiency and Motivation"	Not mentioned	Theoretical
Hsieh et al.	2020	"The Teaching Quality Evaluation of Chinese-Foreign Cooperation in Running Schools from the Perspective of Education for Sustainable Development"	China, Asia	Quantitative
Huang et al.	2023	"An Analysis of Transformation of Teaching and Learning of Japanese Schools that Significantly Addressed Education for Sustainable Development"	Japan, Asia	Qualitative
Ichinose	2019	"Teaching Biodiversity: Towards a Sustainable and Engaged Education"	Morocco, Africa	Mixed methods
Ichinose	2017	"The effectiveness of the methods and approaches of ESD for 2030 sustainable development goals; from analysis of the questionnaire survey to the school teachers"	Japan, Asia	Quantitative
Imai et al.	2022	"Development of teaching material for green and sustainable chemistry in Japan"	Japan, Asia	Theoretical
Jekabsone & Ratniece	2023	"Integrating Sustainability Into Curriculum of Legal Education in Latvia: An Insight Into the Main Issues"	Latvia, Europe	Theoretical
Jeronen et al.	2016	"Teaching Methods in Biology Education and Sustainability Education Including Outdoor Education for Promoting Sustainability-A Literature Review"	Not mentioned	Theoretical
Jiang et al.	2023	"Effectiveness of Cooperative Learning Instructional Models in Training In-Service Physical Education Teachers in Southwest China"	China, Asia	Quantitative
Koç & Bastas	2019	"The evaluation of the project school model in terms of organizational sustainability and its effect on teachers' organizational commitment"	Turkey, Asia & Europe	Mixed methods

Authors	Year	Title	Country of study	Study design
Kwon & Choi	2022	"Exploring Categories of Self-Development of Novice Physical Education Teachers through Teacher Learning Community Activities"	Korea, Asia	Qualitative
Leal Filho et al.	2019	"Sustainable Development Goals and sustainability teaching at universities: Falling behind or getting ahead of the pack?"	17 countries (Mixed)	Mixed methods
Leal Filho et al.	2018	"The role of transformation in learning and education for sustainability"	7 countries (Mixed)	Qualitative
Letouzey-Pasquier et al.	2023	"Development of teachers' practices in the field of education for sustainable development (ESD): A discursive community of interdisciplinary practices focusing on the theme of chocolate"	Swiss, Europe	Qualitative
Lin et al.	2022	"The Roles of Transformational Leadership and Growth Mindset in Teacher Professional Development: The Mediation of Teacher Self-Efficacy"	China, Asia	Quantitative
Lin et al.	2022	"Teachers' Perceptions of Teaching Sustainable Artificial Intelligence: A Design Frame Perspective"	China, Asia	Qualitative
Liu et al.	2021	"Examining the professional quality of experienced efl teachers for their sustainable career trajectories in rural areas in China"	China, Asia	Mixed methods
Ma et al.	2023	"The effect of teacher support on Chinese university students' sustainable online learning engagement and online academic persistence in the post-epidemic era"	China, Asia	Quantitative
Maashi et al.	2022	"Sustainable professional development for STEM teachers in Saudi Arabia"	Saudi Arabia, Asia	Mixed methods
Moreno-Guerrero et al.	2020	"Educational Innovation in Higher Education: Use of Role Playing and Educational Video in Future Teachers' Training"	Spain, Europe	Quantitative
Mróz & Ocetkiewicz	2021	"Creativity for sustainability: How do polish teachers develop students' creativity competence? Analysis of research results"	Poland, Europe	Quantitative
Naidoo & Reddy	2023	"Embedding Sustainable Mathematics Higher Education in the Fourth Industrial Revolution Era Post-COVID"	KwaZulu-Natal, South Africa	Qualitative
Nguyen et al.	2022	"An Investigation into the Perspectives of Elementary Pre-Service Teachers on Sustainable Development"	Southern Vietnam, Asia	Mixed methods
Nguyen et al.	2020	"STEM education in secondary schools: Teachers' perspective towards sustainable development"	Vietnam, Asia	Qualitative
Opuni-Frimpong et al.	2022	"Sustainable Development Goal for Education: Teachers' Perspectives on Climate Change Education in Senior High Schools (SHS)"	Ghana, Africa	Quantitative
Ovcharuk et al.	2020	"The use of digital learning tools in the teachers' professional activities to ensure sustainable development and democratization of education in European countries"	Europe	Qualitative
Ozeren et al.	2020	"The predictive effect of teachers' perception of school principals' motivating language on teachers' self-efficacy via a cultural context"	Not mentioned	Quantitative
Peedikayil et al.	2023	"Teachers' attitude towards education for sustainable development: A descriptive research"	India, Asia	Quantitative
Pehoiu	2019	"Percept of Teachers Regarding Integration of Education for Environment and Sustainable Development in Primary Schools"	Romania, Europe	Quantitative

Authors	Year	Title	Country of study	Study design
Purwianingsih et al.	2022	"PROGRAM FOR INTEGRATING EDUCATION FOR SUSTAINABLE DEVELOPMENT (ESD) INTO PROSPECTIVE BIOLOGY TEACHERS' TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE (TPACK)"	Indonesia, Asia	Qualitative
Sá & Serpa	2020	"The COVID-19 pandemic as an opportunity to foster the sustainable development of teaching in higher education"	5 continents and 26 countries (Mixed)	Qualitative
Sabarudin et al.	2022	"Cluster-Mentoring for Sustainable Competency: A Case Study of PTK Training for Islamic Education Teachers in Junior High Schools"	Indonesia, Asia	Qualitative
Sadłowska-Wrzesińska et al.	2022	"Psychosocial Context of OSH-Remote Work of Academic Teachers in the Perspective of Sustainable Development"	Poland, Europe	Quantitative
Sánchez-Prieto et al.	2021	"Incident factors in the sustainable development of digital teaching competence in dual vocational education and training teachers"	Spain, Europe	Quantitative
Sebastián-López & González	2020	"Mobile learning for sustainable development and environmental teacher education"	Europe	Quantitative
Şemin	2019	"Competencies of principals in ensuring sustainable education: Teachers' views"	Turkey, Asia & Europe	Qualitative
Spahiu & Lindemann-Matthies	2015	"Effect of a toolkit and a one-day teacher education workshop on ESD teaching content and methods-A study from Kosovo"	Europe	Quantitative
Stevenson et al.	2017	"Approaches to embedding sustainability in teacher education: A synthesis of the literature"	Not mentioned	Theoretical
Sund & Gericke	2020	"Teaching contributions from secondary school subject areas to education for sustainable development – a comparative study of science, social science and language teachers"	Sweden, Europe	Qualitative
Tascı	2015	""Sustainability" Education by Sustainable School Design"	Turkey, Asia & Europe	Theoretical
Thi Ngoc Lien et al.	2021	"Teachers' feelings of safeness in school-family-community partnerships: Motivations for sustainable development in moral education"	Vietnam, Asia	Quantitative
Thompson	2018	"The construct of 'respect'in teacher-student relationships: Exploring dimensions of ethics of care and sustainable development"	Jamaica, North America	Mixed methods
Thor & Karlsudd	2020	"Teaching and fostering an active environmental awareness design, validation and planning for action-oriented environmental education"	Sweden, Europe	Qualitative
Tun	2019	"Fulfilling a new obligation: Teaching and learning of sustainable healthcare in the medical education curriculum"	UK, Europe	Qualitative
Uleanya et al.	2019	"Revisiting high school teachers' education: Solution to sustainable development in rural Africa"	Nigeria and South Africa, Africa	Quantitative
Vasconcelos et al.	2016	"Sustainable development and its connection to teaching geoethics"	Portugal,Europe	Qualitative
Wamsler et al.	2018	"Mindfulness in sustainability science, practice, and teaching"	Not mentioned	Mixed methods

Authors	Year	Title	Country of study	Study design
Wu et al.	2022	"Exploring Factors of Middle School Teachers' Satisfaction with Online Training for Sustainable Professional Development under the Impact of COVID"	China, Asia	Quantitative
Xu & Yue	2019	"Talent leadership strategies enhance teacher's professional competencies in 21st century education for sustainable development"	Not mentioned	Theoretical
Yeh & Barrington	2023	"Sustainable positive psychology interventions enhance primary teachers' wellbeing and beyond – A qualitative case study in England"	England, Europe	Qualitative
Yli-Panulaet al.	2019	"Teaching and Learning Methods in Geography Promoting Sustainability"	Not mentioned	Theoretical
Zhang et al.	2021	"Investigating the Influencing Factors of Teachers' Information and Communications Technology-Integrated Teaching Behaviors toward 'Learner-Centered' Reform Using Structural Equation Modeling"	China, Asia	Quantitative
Zhang et al.	2023	"The Consensus of Global Teaching Evaluation Systems under a Sustainable Development Perspective"	Seven countries (Mixed)	Theoretical
Zhao et al.	2022	"Developing AI Literacy for Primary and Middle School Teachers in China: Based on a Structural Equation Modeling Analysis"	China, Asia	Quantitative

Table A1. (*Continued*)