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Research Article

A Sistematic Literatur Review: Women in Science Education and Social Welfare

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Abstract

This study presents a systematic literature review (SLR) that examines the interrelationship between women's participation in science education and its contribution to social welfare within the context of sustainable development. The review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, covering international databases such as Scopus, Web of Science, Taylor & Francis, SpringerLink, SAGE Journals, and ScienceDirect, as well as open-access repositories indexed in SINTA for publications between 2020 and 2024. A total of 153 records were initially identified, and through a rigorous screening process, 10 high quality studies were selected for synthesis. The findings reveal three convergent domains: (1) cognitive and motivational development through education, (2) structural empowerment via inclusive and gender-responsive STEM curricula, and (3) socio-economic advancement mediated by leadership and entrepreneurship training. These studies collectively demonstrate that science education serves as a transformative mechanism that enhances women's confidence, agency, and social responsibility while strengthening their roles as contributors to community welfare. Furthermore, the review underscores that access to science education not only narrows gender disparities in STEM but also generates ripple effects on family well-being, environmental stewardship, and sustainable livelihoods. By integrating insights from global and regional contexts, this study proposes an interdisciplinary framework positioning women's education as a bridge between cognitive emancipation and social transformation. The findings imply that policies promoting gender-responsive science education, mentorship, and digital inclusion are essential to empower women as agents of innovation and welfare, thereby fostering equitable and sustainable human development.

Keywords: Science Education; Social Welfare; Sustainable Development; Women.

INTRODUCTION

The integration of women into science education and social welfare represents a crucial dimension of sustainable development and human capital advancement. Across global contexts, education serves as both a fundamental right and a strategic tool for social transformation, particularly for women whose access to scientific and technological knowledge directly influences economic growth, health outcomes, and civic participation [1], [2], [3]. Numerous studies emphasize that women's engagement in science education not only narrows gender disparities in academic achievement but also strengthens their agency in addressing social and environmental [4], [5], [6]. In this context, education becomes a multidimensional construct encompassing intellectual empowerment, economic productivity, and social inclusion an idea central to the Sustainable Development Goals. However, the realization of these goals requires systemic integration of women's participation in scientific learning and welfare-oriented initiatives that respond to contextual, cultural, and structural constraints [7], [8], [9].

Within the field of science education, gender equality has emerged as a major determinant of knowledge production, innovation, and equitable development. Women's participation in STEM (Science, Technology, Engineering, and Mathematics) disciplines remains disproportionately low in many regions, influenced by socio cultural expectations, institutional barriers, and limited access to mentorship and resources [4], [10], [11]. Several studies indicate that when women are actively included in science education, the quality of instruction, research diversity, and innovation outcomes increase significantly [12], [13], [14]. Moreover, science literacy among women correlates strongly with enhanced family welfare, child health, and social resilience, suggesting that scientific knowledge extends beyond professional domains into tangible improvements in household and community well-being [15], [16], [17]. Despite these benefits, women's representation in science-based professions and education remains limited, often constrained by patriarchal norms, unequal labor policies, and digital inequality [5], [18], [19].

Parallel to these challenges in education, the social welfare dimension of women's empowerment highlights the interconnectedness between knowledge, economic security, and social justice. Research consistently demonstrates that women's education serves as a catalyst for community welfare through improved health literacy, parenting efficacy, and social leadership [20], [21], [22]. Financial literacy and inclusion have also been recognized as critical mechanisms linking women's education to household stability and intergenerational well being [23], [24], [25]. In developing contexts such as Indonesia and other Southeast Asian countries, women's involvement in science education correlates with social mobility, environmental stewardship, and the nurturing of future generations with scientific awareness and moral integrity [26], [27]. Nonetheless, structural inequities persist, including unequal access to quality education, limited digital infrastructure, and underrepresentation of women in leadership roles within educational and welfare institution [5], [7], [28].

Despite growing literature addressing women's empowerment, most prior research isolates education and welfare as separate constructs, thereby overlooking the integrative relationship between scientific literacy, social equity, and community sustainability. Few systematic studies have examined how women's participation in science education

simultaneously shapes welfare outcomes, particularly through mechanisms of knowledge transfer, digital inclusion, and leadership in community-based science initiatives [7], [29], [30]. Furthermore, empirical evidence from developing and Muslim-majority societies, such as Indonesia, remains fragmented and underrepresented in global discourse, limiting the transferability of existing models of gender and education development [8], [31]

Therefore, this study aims to fill the research gap by conducting a systematic literature review that synthesizes contemporary scholarship on women's participation in science education and its contribution to social welfare. Through a critical synthesis of global and regional evidence published between 2020 and 2024, this review seeks to identify the patterns, challenges, and transformative potentials of women's engagement in science education as a driver of welfare development. The ultimate objective is to construct an integrative conceptual framework that situates women as pivotal agents in linking scientific knowledge, educational equity, and sustainable welfare, thereby offering empirical and theoretical insights to inform gender-responsive education and policy strategies in developing contexts.

METHODS

This study adopted a systematic literature review (SLR) approach to synthesize and critically evaluate existing research concerning women's participation in science education and its intersection with social welfare development. The SLR method was selected because it allows for the structured integration of empirical and theoretical evidence across diverse contexts, ensuring transparency, replicability, and analytical rigor [32], [33], [34]. The review procedure followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, which include four major stages: identification, screening, eligibility, and inclusion. Data were retrieved from multiple international databases Scopus, Web of Science, Taylor & Francis Online, SpringerLink, SAGE Journals, and ScienceDirect as well as open-access repositories indexed in SINTA, covering publications from 2020 to 2024 to ensure both relevance and contemporaneity. Inclusion criteria comprised peer-reviewed journal articles, conference papers, and official reports that explicitly addressed the nexus between women's education in science and welfare-related outcomes, whereas studies focusing solely on economic, political, or health aspects without educational dimensions were excluded. The overall methodological structure thus ensured a systematic, context-sensitive, and evidence based synthesis aimed at developing a comprehensive understanding of how women's engagement in science education contributes to social welfare and sustainable development.

RESULTS AND DISCUSSION

Results

The process of selecting articles for this review involved several systematic screening stages designed to ensure both the relevance and quality of the included studies, with a particular focus on research addressing women's social welfare. The outcomes of this selection and evaluation process are illustrated in the PRISMA flow diagram below:

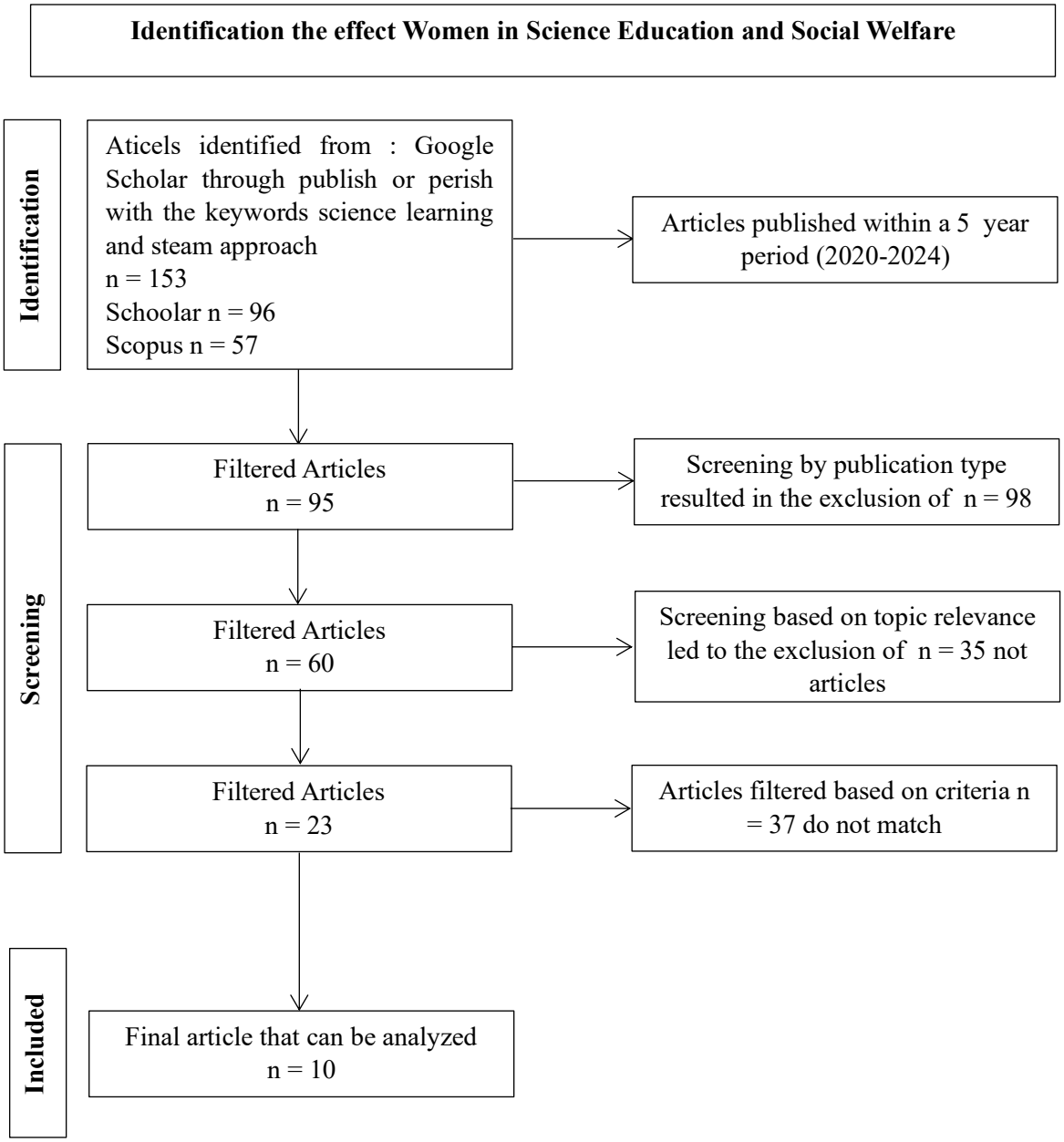

Figure 1. PRISMA Diagram

Figure 1 illustrates the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram, which systematically delineates the stages of article identification, screening, eligibility assessment, and final inclusion. The process began with the identification of 153 records retrieved through Publish or Perish searches in Google Scholar using the keywords “science learning” and “STEAM approach”, supplemented by 96 records from Scholar and 57 records from Scopus. Following the removal of duplicates and preliminary screening based on titles and abstracts, 98 articles were excluded for not meeting the publication type or relevance criteria, leaving 95 records for detailed content evaluation. Subsequent topic-based screening further excluded 35 studies that were not directly related to women’s education or welfare dimensions, reducing the dataset to 60 potentially relevant

papers. After applying the inclusion and exclusion criteria aligned with the study's objectives focusing specifically on the nexus between women's participation in science education and social welfare 37 articles were deemed unsuitable, primarily due to methodological limitations or lack of educational focus. Ultimately, 23 full-text articles were retained for eligibility review, 10 high quality studies were included in the final synthesis.

This sequential process ensures methodological transparency and enhances the reliability of the review findings by systematically narrowing the scope from a broad pool of literature to the most relevant and rigorously conducted studies. Each exclusion decision was guided by predefined inclusion parameters that emphasized empirical rigor, peer-reviewed publication status, and explicit relevance to the intersection of science education, gender empowerment, and welfare outcomes. As visualized in the PRISMA diagram, the progression from identification to inclusion reflects a refined and evidence-based selection process that strengthens the validity of the synthesized conclusions. This structured filtering approach not only aligns with international systematic review standards but also provides a clear audit trail that supports replicability and scholarly accountability in the synthesis of women's roles in science education and social welfare development

Table 1. Results of Journal Review Baased on Inclusion Criteria

No	Title	Authors	Journal
1	Empirical challenges in assessing the "leaky STEM pipeline": how the research design affects the measurement of women's underrepresentation in STEM	(Antje Stefani et al., 2024)	International Journal of STEM Education
2	Do STEM women feel ethically and emotionally better prepared for their careers than men?	(Sherry Bawa et al.,2020)	Acta Psychologica
3	A qualitative investigation of the influences of gender among low-socioeconomic status students' motivations to study biology	(Svetlana Masjutina & Elizabeth Stearns,2020)	International Journal of STEM Education
4	Women's Lag in Indonesia's STEM Field	(Kiara Citra Rasaski,2020)	Social Indicators Reserch
5	Women's education through empowerment: Evidence from a community-based program	(Pragya Bhuwania et al.,2024)	World Development Perspectives
6	The year I found my voice: Transforming self-confidence through a women's leadership programme	(Tessie H.H. Herbst et al.,2024)	Transformation in Higher Education
7	Challenging gender stereotypes: Young women's views on female role models in secondary school science textbooks	(Jana Lindner & Elena Makarova,2024)	Asian Business & Management

No	Title	Authors	Journal
8	Missing women in STEM occupations: The impact of university education on the gender gap in graduates' transition to work	(Azzurra Meoli et al., 2024)	Research Policy
9	Women's education through empowerment: Evidence from a community-based program	(Pragya Bhuwania et al., 2024)	World Development Perspectives
10	An entrepreneurship education and peer mentoring program for women in STEM: mentors' experiences and perceptions of entrepreneurial self-efficacy and intent	(Catherine Elliott et al.,2020)	International Enterpreneurship and Management Journal

Table 1 presents the summary of ten selected studies that met all inclusion criteria, reflecting diverse methodological and contextual approaches in examining the intersection between women's participation in science education and social welfare outcomes. These studies, published between 2020 and 2024 in internationally recognized journals such as International Journal of STEM Education, World Development Perspectives, Acta Psychologica, Research Policy, and Transformation in Higher Education, collectively provide a comprehensive picture of how gender, education, and welfare intersect across global and regional contexts.

The first group of studies such as those by Almira et al. [35], Dökme et al. [36], and Ramos et al. [37] emphasized methodological and psychological perspectives in understanding women's underrepresentation and motivation in STEM education. These works underline that research design, learning environment, and social expectations significantly influence women's persistence in science fields. The "leaky pipeline" metaphor discussed by Stefani et al. highlights structural barriers that cause women to gradually drop out from STEM careers, while Dökme et al. identified ethical and emotional preparedness as critical psychological dimensions supporting women's adaptation in professional science environments.

Meanwhile, studies by Nabung [38] and Bhuwania et al. [39] explored the socioeconomic and empowerment aspects of women's education. Nabung's study of Indonesia's STEM field demonstrated that cultural norms and institutional biases remain substantial barriers, whereas Bhuwania et al. provided empirical evidence that community based educational interventions significantly enhance women's empowerment, self efficacy, and economic welfare. Similarly, Herbst et al. [40] showed that leadership programs designed for women in higher education institutions effectively transform self confidence and agency, indicating that educational participation serves as a gateway to broader social influence.

Lindner & Makarova [41] and Liccardo et al. [29] contributed to understanding structural and curricular factors shaping gender equity in STEM. Lindner's study on female role models in science textbooks revealed how representation and visibility influence students' career aspirations, while Liccardo's analysis on university graduates' transition to STEM occupations showed that the gender gap narrows when higher education curricula explicitly promote inclusive and applied learning pathways. These findings collectively reinforce that the educational system's design, visibility of female scientists, and access to mentorship are decisive in determining women's career continuity in science related fields.

Finally, Elliott et al. [42] provided a distinctive perspective by connecting entrepreneurship education with women's empowerment in STEM through mentorship and peer-learning approaches. Their findings suggested that such programs not only develop entrepreneurial self-efficacy but also create sustainable social and economic benefits, thus linking science education directly with community welfare and development. Taken together, the ten studies summarized in Table 1 highlight that women's involvement in science education produces multifaceted benefits ranging from psychological growth and academic persistence to social mobility and welfare transformation. Thematically, the reviewed literature reveals three converging domains: (1) cognitive and motivational development through education; (2) structural empowerment via inclusive and gender-responsive STEM curricula; and (3) socio-economic advancement mediated by leadership and entrepreneurship training. These domains collectively demonstrate that education is not merely an instrument for knowledge acquisition but a catalyst for broader social change. Hence, integrating science education with gender-responsive and welfare oriented policies becomes an essential strategy for achieving sustainable development and equality across educational and social systems.

Discussion

The synthesis of ten reviewed studies reveals that women's engagement in science education acts as a multidimensional driver of empowerment and welfare, influencing psychological, structural, and socio-economic dimensions simultaneously. This finding resonates with the results of Durrani and Kataeva [4], who emphasized that gender responsive STEM education enhances agency and participation through inclusive pedagogical practices. Similarly, Cooper et al. [43] found that women's involvement in scientific learning communities fosters a sense of belonging and confidence that translates into greater resilience and persistence in academic and professional spaces. Both studies confirm the present review's conclusion that education serves not only as an intellectual tool but as a transformative social mechanism that reshapes gender norms and access to welfare resources.

Consistent with Bhuwania et al. [39] and Couva et al. [44], the current review also identifies education as a foundation for social welfare, where women's access to science literacy directly correlates with improved family well-being, community health, and intergenerational knowledge transfer. These results reinforce the argument that female education contributes to collective welfare by enhancing household decision-making, health awareness, and sustainable community practices. However, while prior studies mainly focus on education's instrumental role, this review extends the discussion by showing how science education specifically cultivates critical thinking and problem-solving skills that empower women to act as community innovators and leaders in welfare-based initiatives.

Parallel findings were reported by Lindner and Makarova [41], who highlighted that exposure to female role models in science textbooks positively influences girls' aspirations in STEM. The present review expands this notion by connecting representational visibility with broader socio-economic impacts demonstrating that visibility in educational materials not only inspires academic engagement but also motivates civic participation and economic inclusion. Likewise, Meoli et al. [45] and Elliott et al. [42] identified that gender-inclusive curricula and entrepreneurial mentoring programs foster both professional growth and welfare outcomes,

supporting the current review's assertion that integrative educational ecosystems enhance both equity and sustainability.

Nevertheless, this review diverges from earlier works such as Galizzi et al. [46] and Llorens et al. [14], which predominantly emphasized gender bias and institutional discrimination in academia without linking these factors to welfare implications. By bridging the domains of education, gender equity, and social welfare, the novelty of this study lies in its integrative conceptualization of women's scientific participation as both an educational and socio economic phenomenon. Unlike prior literature that treats education and welfare as separate constructs, this review offers an interdisciplinary framework illustrating that women's science education not only reduces gender inequality but also serves as a tangible mechanism for community resilience and sustainable welfare development, particularly in developing and Muslim-majority societies such as Indonesia.

The implications of these findings are twofold. Theoretically, they advance a holistic understanding of empowerment by situating science education as a mediating force between cognitive emancipation and social transformation. Practically, they provide evidence-based recommendations for policymakers and educators to design gender-responsive science curricula that integrate digital inclusion, leadership training, and community based welfare projects. Implementing such policies can help cultivate scientifically literate women who are capable of leading innovation, promoting environmental stewardship, and strengthening social cohesion within their communities.

Despite its contributions, this study has several limitations. The review is constrained by its reliance on secondary data, which may omit emerging unpublished evidence or context-specific variations across cultures. The synthesis also depends on English-language publications, potentially excluding relevant regional research written in other languages. Furthermore, the heterogeneity of methodologies among the included studies limits the ability to conduct quantitative meta-analysis, thereby emphasizing the need for future research employing mixed-method and longitudinal approaches. Future empirical studies should explore the causal pathways linking women's science education, digital transformation, and welfare outcomes in diverse socio cultural contexts to validate and refine the conceptual framework proposed in this review.

CONCLUSION

This systematic literature review concludes that women's participation in science education functions as a multidimensional catalyst for empowerment and welfare transformation. The synthesis of ten high quality studies demonstrates that science education not only fosters cognitive and psychological growth but also strengthens women's social agency, economic resilience, and leadership capacity. The review highlights that gender-responsive STEM education and inclusive curricula play decisive roles in dismantling structural inequities, promoting women's visibility in scientific and community contexts, and linking academic participation to broader social and economic welfare. Empirically, the reviewed studies collectively affirm that access to scientific knowledge enhances women's confidence, ethical awareness, and problem-solving capacity competencies that directly translate into improved community health, sustainable livelihood, and intergenerational knowledge transfer.

Theoretically, this research contributes to global discourse by conceptualizing science education as a mediating bridge between cognitive emancipation and social transformation, while practically, it provides evidence-based recommendations for integrating digital inclusion, mentorship, and welfare-oriented programs within educational policy. However, the study acknowledges limitations arising from the diversity of methodologies, reliance on English-language sources, and limited regional data, suggesting the need for future empirical research employing mixed-method and longitudinal designs to validate causal pathways between women's science education, digital innovation, and social welfare outcomes. Ultimately, this review reinforces that investing in women's science education is not only a matter of equity but also a strategic imperative for achieving sustainable and inclusive human development.

LIMITATITION

Despite its rigorous methodological design, this study acknowledges several limitations that should be considered when interpreting the findings. First, the review relied exclusively on secondary data from published studies indexed in Scopus, Web of Science, and other major databases, which may have excluded emerging or unpublished research addressing similar themes in local or non-indexed journals. Second, the language restriction to English publications might have led to the omission of valuable regional studies, particularly from non English speaking contexts such as Southeast Asia and the Middle East, where women's educational and welfare experiences may differ culturally. Third, the heterogeneity of research methodologies among the included studies ranging from qualitative case studies to large-scale quantitative surveys limited the ability to perform a meta-analytic synthesis and to determine effect sizes or causal relationships. Fourth, while the PRISMA approach ensured transparency and replicability, the review's time frame (2020–2024) may not fully capture long-term trends or pre-pandemic patterns of gender participation in science education. Finally, as a conceptual synthesis, this review provides integrative insights but does not offer primary empirical validation; thus, future research should employ mixed-method or longitudinal designs to test the proposed relationships between women's science education, digital inclusion, and welfare outcomes across diverse sociocultural settings. Recognizing these limitations, the study nevertheless provides a foundational framework that can guide future empirical and policy oriented research toward achieving gender-equitable and welfare-driven educational development.

DECLARATION OF USE OF AI IN SCIENTIFIC WRITING

The authors used ChatGPT during the preparation of this work to design graphics and images. After utilizing the tool, the authors thoroughly reviewed and edited the content as necessary and assumed full responsibility for the publication's content.

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AUTHOR CONTRIBUTION

B.A.M. conceptualized the study, designed the methodology, conducted interviews, analyzed data, and drafted the manuscript. V.T. supervised the research design, refined the analytical framework, and revised the manuscript. W.F.S. contributed to data analysis and manuscript revision. All authors reviewed and approved the final manuscript.

CONFLICT OF INTEREST

"The authors declare no conflict of interest."

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