

Science, Character, Elementary School: A Hybrid Systematic Literature Review and Bibliometric Analysis

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Abstract: The integration of science learning and character education in elementary schools has increasingly attracted scholarly attention; however, the field lacks a comprehensive synthesis mapping its intellectual development, dominant themes, and methodological trajectories. This study aims to systematically examine publication trends, thematic structures, research designs, and emerging gaps in science-character integration at the elementary education level. A hybrid Systematic Literature Review (SLR) combined with bibliometric analysis was conducted on 51 Scopus-indexed articles published between 1997 and 2025. Article selection followed the PRISMA protocol, while co-occurrence and co-authorship analyses were performed using VOSviewer to identify conceptual and collaboration patterns. The findings demonstrate a marked growth in publications after 2018, with Southeast Asia as the primary contributor. Three major thematic clusters emerged: inquiry-based and literacy-oriented science learning, character value development emphasizing responsibility and religiosity, and integrative contextual pedagogical approaches. Quantitative experimental designs dominated literature, primarily examining impacts on students' motivation, conceptual understanding, and character formation, whereas longitudinal and mixed-method studies remain scarce. The review highlights the need for interdisciplinary and culturally responsive pedagogical frameworks capable of integrating scientific competencies and character development. This study provides an evidence-based reference for researchers and educators seeking to advance holistic science education in elementary schools.

Keywords: Bibliometric analysis; Character education; Elementary school; Science education; Systematic literature review

Introduction

Education plays a fundamental role in preparing individuals to become scientifically literate and ethically responsible citizens capable of addressing increasingly complex global challenges. Rapid scientific and technological development, environmental crises, and social transformation require learners not only to understand scientific concepts but also to demonstrate responsibility, empathy, and ethical decision-making in real-world contexts (Peterson & Park, 2006; Rowley,

2019). Consequently, contemporary science education emphasizes the development of both cognitive competence and moral awareness from early schooling stages as essential components of sustainable societal development (Abrori et al., 2025; Paipetis, 2010). At the elementary school level, learning experiences play a critical role in shaping students' foundational knowledge structures and character formation, making the integration of science learning and character education a strategic priority in primary education systems (Muhtar et al., 2019a).

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Conceptually, science education promotes inquiry processes, evidence-based reasoning, and critical thinking as central elements of scientific literacy (Baek et al., 2022b, 2022a). In contrast, character education emphasizes the cultivation of virtues such as integrity, responsibility, respect, and self-discipline that guide ethical behavior and social participation (Khusniati, 2012; Shields, 2011; Umami et al., 2019). The integration of these domains is supported by constructivist learning theory, which views knowledge construction as socially situated and value-laden, as well as social learning theory that highlights modeling and interaction as mechanisms for value internalization (Kang et al., 2021; Martinelli, 2018). Inquiry-based and contextual science learning approaches therefore provide authentic opportunities for embedding character values within scientific practices and collaborative learning environments (G. Cheng & Chen, 2021; Zainil, Kenedi, Rahmatina, et al., 2024).

Despite increasing scholarly attention, research on the integration of science and character education at the elementary level remains fragmented across disciplines and research traditions. Existing studies often emphasize either instructional effectiveness in science learning or the development of specific character traits, with limited efforts to examine their interaction within integrated pedagogical frameworks (Hendrowibowo & Kristanto, 2024; Muhtar et al., 2019b). Furthermore, variations in research design, methodological approaches, and database coverage restrict the comparability and generalizability of findings (Bearman et al., 2012; Heck et al., 2024). To date, a comprehensive synthesis that systematically maps publication trends, thematic structures, and collaborative networks using combined systematic review and bibliometric approaches remains limited (Pham & Le, 2024; Silva et al., 2021).

To address these gaps, this study conducts a hybrid Systematic Literature Review guided by the PRISMA protocol alongside bibliometric analysis using VOSviewer on Scopus-indexed publications (Abrori et al., 2025; Umasangadji et al., 2024). Unlike previous narrative or single-method reviews, this approach integrates qualitative synthesis with quantitative mapping to provide a state-of-the-art overview of research linking science learning, character development, and elementary education. The analysis identifies dominant themes, geographical distributions, collaboration patterns, and emerging research directions to support curriculum innovation and evidence-based policy development.

Therefore, this study aims to: (1) examine whether the integration of science and character education at the elementary level remains a significant and evolving research focus; (2) analyze thematic and geographical

distributions of existing publications; and (3) identify theoretical and practical implications that can guide future research and pedagogical innovation. The urgency of this research lies in providing an evidence-based framework capable of strengthening the integration of scientific competence and character development in primary education, thereby contributing to the formation of responsible, ethical, and critical future citizens.

Method

This study employed a hybrid research design combining a Systematic Literature Review (SLR) and bibliometric analysis to comprehensively examine the integration of science and character education at the elementary school level. This hybrid approach allows both qualitative synthesis of research findings and quantitative mapping of publication trends, key contributors, and collaboration networks, thereby providing a comprehensive understanding of the research landscape (Pham & Le, 2024; Silva et al., 2021; Umasangadji et al., 2024).

Type of Research

This study adopted a hybrid qualitative-quantitative research design integrating systematic literature review and bibliometric analysis. The SLR enabled interpretive synthesis of theoretical and empirical findings, while bibliometric analysis quantitatively examined publication development, collaboration patterns, and thematic structures within the field.

Research Methods

Data collection was conducted using the Scopus database due to its extensive coverage of peer-reviewed international publications. The search was performed on July 27, 2025, covering publications from 1997 to 2025. Keywords—Science, Character, and “Elementary School”—were applied to article titles, abstracts, and keywords to ensure specificity and relevance (Moreno & Forero, 2024). The initial search retrieved 121 documents.

The selection process followed PRISMA guidelines to ensure transparency and reproducibility (Bearman et al., 2012; Heck et al., 2024; Umasangadji et al., 2024). Articles that did not match the exact keyword combination Science AND Character AND “Elementary School” (n = 31) were excluded, leaving 90 articles for further evaluation. Further exclusions were applied based on document type, removing book chapters (5), books (1), reviews (1), conference papers (23), and conference reviews (5), resulting in 55 eligible articles. Articles published in non-English languages—Korean

(2), Croatian (1), and Portuguese (1)—were excluded, leaving a final sample of 51 articles included for analysis.

Research Stages

The research procedure followed four sequential stages adapted from the PRISMA framework to ensure transparency, replicability, and methodological rigor (Bearman et al., 2012; Heck et al., 2024; Umasangadji et al., 2024). The search stage involved identifying relevant publications through keyword queries applied to article titles, abstracts, and keywords within the

Scopus database. Subsequently, during the screening stage, retrieved records were examined to remove articles that did not match the specified keyword combination or research focus. The eligible stage assessed the remaining articles according to predefined inclusion and exclusion criteria, including document type and publication language, to ensure data consistency and quality. Finally, in the included stage, a final dataset of 51 articles meeting all criteria was selected for bibliometric mapping and systematic synthesis to address the research questions.

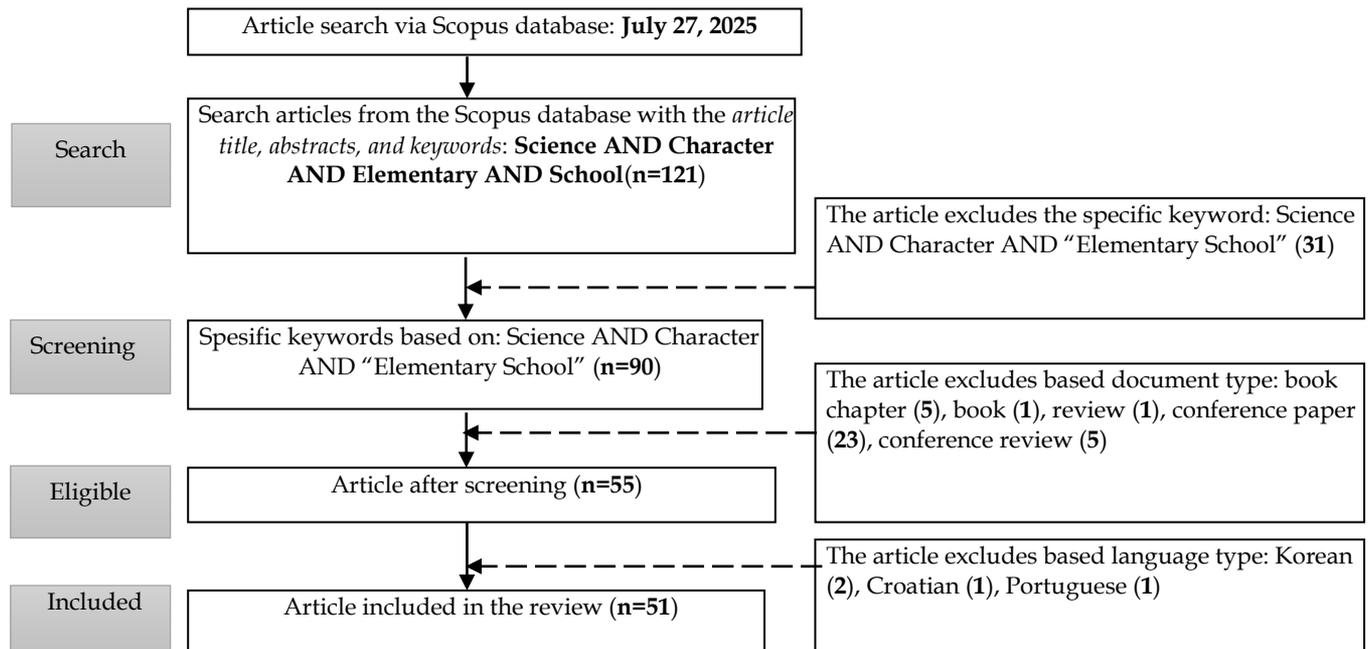


Figure 1. Systematic Literature Review information flow using PRISMA

Result and Discussion

Overview of the Literature on Science, Character, and Elementary Education

The findings of this study are derived from 51 Scopus-indexed articles focusing on the integration of science, character, and elementary school education. The reviewed literature provides insights into publication patterns, influential contributors, institutional affiliations, and geographical distribution within this research domain. Overall, the studies demonstrate increasing scholarly attention toward integrating cognitive scientific competencies with character development outcomes in primary education contexts.

Across the reviewed studies, dependent variables predominantly emphasize student learning outcomes and holistic competency development. Several studies examined students’ perceptions of scientists’ cognitive, affective, lifestyle, and professional characteristics using

the Modified Images of Scientists Questionnaire (MISQ)(Zhang et al., 2023b). Other research focused on twenty-first-century competencies, commonly conceptualized as the 6Cs—character, citizenship, critical thinking, creative thinking, collaboration, and communication—which reflect broader goals of holistic education in elementary settings (Zainil, Kenedi, Indrawati, et al., 2024). Character education outcomes were also widely investigated through religious and moral indicators, including faith, piety, environmental responsibility, tolerance, and clean living behaviors (Muhtar et al., 2019a), as well as creative character traits such as self-confidence and independence developed through instructional interventions (Maulana et al., 2022a).

In the science learning domain, dependent variables frequently measured conceptual understanding and learning performance. Students’ comprehension of biological concepts such as animal classification and anatomy was assessed as indicators of

scientific literacy (Kubiatko & Prokop, 2009a). Similarly, computational learning studies evaluated task performance through perceived task difficulty, completion ease, and success rates (G. Cheng & Chen, 2021). Integrative STEAM-oriented studies further expanded outcome measurements to include sociality, morality, emotional development, creativity, caring, and convergence competencies, reflecting interdisciplinary learning objectives (Baek et al., 2022b). These findings indicate that recent research increasingly positions science learning not only as cognitive knowledge acquisition but also as a platform for fostering social and ethical competencies.

Independent variables primarily relate to contextual and instructional influences shaping these outcomes. Contextual factors such as school level, gender, geographic region, and living environment were shown to influence students' scientific perceptions and learning experiences (Zhang et al., 2023b). Instructional variables, including STEM-based digital

learning approaches, student backgrounds, and teaching quality, were also frequently examined as predictors of competency development (Zainil, Kenedi, Rahmatina, et al., 2024). Other studies explored specific pedagogical interventions, such as religious character education models (Muhtar et al., 2019), comparative learning strategies including the MURRDERR model and conventional approaches (Maulana et al., 2022a), computational learning environments (G. Cheng & Chen, 2021), SSIBL-STEAM programs (Baek et al., 2022b), and contextual influences such as religious exposure and narrative type in children's judgment development (Davoodi et al., 2023a).

Taken together, the reviewed literature highlights the multidimensional interaction between instructional design, learner characteristics, and sociocultural contexts in shaping science learning and character formation at the elementary school level. The synthesis of dependent and independent variables across studies is summarized in Table 1.

Table 1. Summary of Dependent and Independent Variables

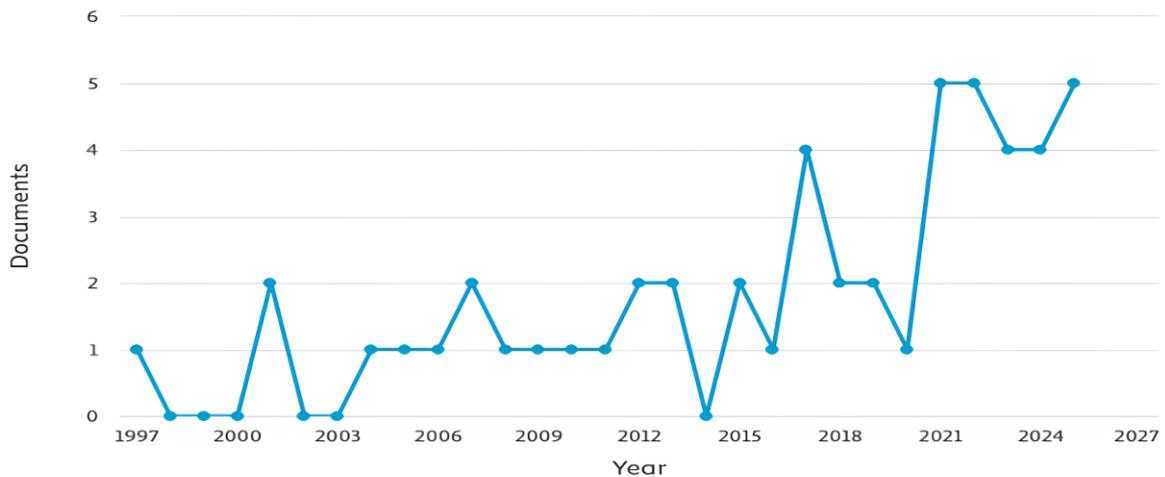
Dependent Variables (Measured Outcomes)	Independent Variables (Influencing Factors)	Author(s)
Students' perceptions of scientists (cognitive, affective, lifestyle, professional traits) via MISQ	School level, gender, region, living setting	(Zhang et al., 2023a)
6Cs competencies: Character, Citizenship, Critical Thinking, Creative Thinking, Collaboration, Communication	STEM-based digital learning, student background, teaching quality	(Zainil et al., 2024)
Religious character indicators: faith, piety, clean lifestyle, environmental care, tolerance	Implementation of religious character education model	(Muhtar et al., 2019b)
Creative character: self-confidence, independence	Learning strategy (MURRDERR vs. conventional), science vs. non-science background	(Maulana et al., 2022b)
Biology understanding: animal classification, anatomy, parental care, foraging strategy	Gender, age	(Kubiatko & Prokop, 2009b)
Learning performance: task completion ease, perceived difficulty, success rate in computational learning	Type of computational task or learning environment	(G.-M. Cheng & Chen, 2021)
STEAM competencies: creativity, caring, convergence;	SSIBL-STEAM program	(Baek et al., 2022a)
Character: morality, sociality, emotion		
Children's reality judgment	Religious exposure, age group, story type	(Davoodi et al., 2023b)

Publication Trends and Research Focus (RQ1)

Based on Scopus-indexed publications, research integrating science learning, character development, and elementary education remains relatively limited, with 51 articles identified between 1997 and 2025. The earliest study by Candela (1997) highlighted that elementary science learning supports both conceptual understanding and character formation, particularly collaboration and critical thinking. For many years, research growth remained gradual, indicating limited scholarly focus on explicitly combining science education with character development.

A significant increase in publications emerged after 2018 and accelerated from 2021 onward, with studies emphasizing hybrid STEM learning, socio-scientific issues, and positive learning habits that integrate cognitive and moral dimensions (Abrori et al., 2025; Atmojo et al., 2025; Muzaki, 2025). This trend reflects a shift toward interdisciplinary and value-oriented science education aligned with twenty-first-century competencies. Although the total number of studies remains modest, the growing momentum demonstrates increasing academic interest and highlights opportunities for further research on integrative pedagogical models at the elementary level.

Documents by year



Source: Scopus database

Figure 2. Documents by year

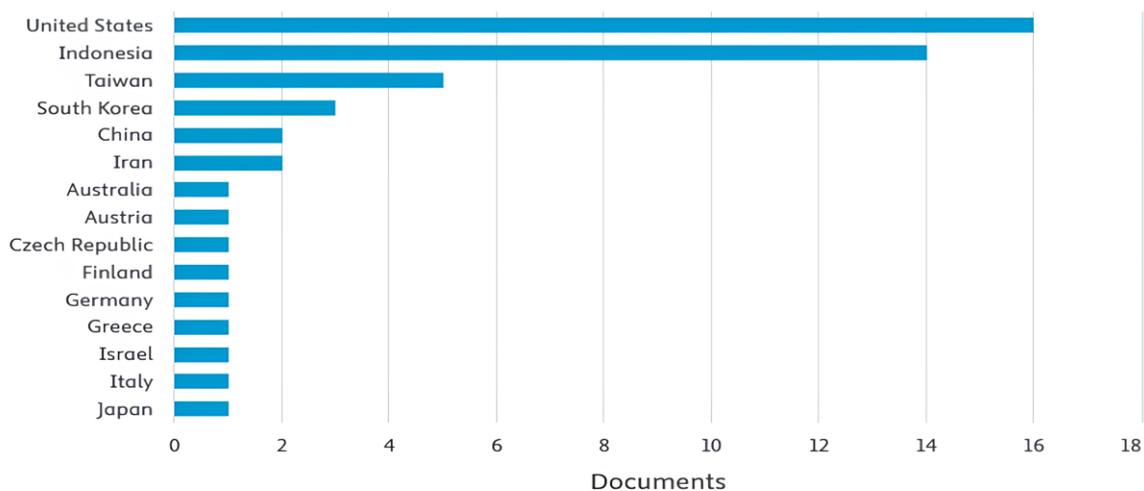
Geographic and Institutional Distribution (RQ2)

The geographical distribution of publications reveals a pronounced regional concentration in research addressing the integration of science, character education, and elementary schooling. Based on Scopus-indexed data, Indonesia represents the dominant contributor with 28 publications, followed by Malaysia with 16 articles. Contributions from Western countries remain comparatively limited, including the United Kingdom (6 publications) and the United States (4 publications), while other countries demonstrate only sporadic engagement with the topic (see Figure 3).

Despite the emergence of contributions from Europe, North America, and several Asian countries, global participation remains uneven. The dominance of research originating from Muslim-majority contexts. Consequently, empirical evidence regarding how science and character integration operates in secular or culturally diverse educational systems remains limited. Expanding investigations across non-Muslim-majority countries and varied sociocultural settings is therefore essential to evaluate the transferability, contextual adaptability, and universal relevance of integrative pedagogical approaches.

Documents by country or territory

Compare the document counts for up to 15 countries/territories.



Source: Scopus database

Figure 3. Number of articles by country or territory (top 15 countries)

Institutional productivity further reflects this concentration pattern. Indonesian higher education institutions, particularly Universitas Pendidikan Indonesia and Universitas Negeri Malang, demonstrate sustained research engagement and act as central nodes within the publication landscape. In contrast, most institutions outside this network contributed only single publications, indicating that research development in this field is still largely localized and dependent on individual research initiatives rather than long-term collaborative programs. Limited cross-institutional collaboration may also constrain theoretical diversification and methodological innovation.

Overall, although research on science and character integration in elementary education has gradually expanded since 1997, its development remains geographically clustered and institutionally fragmented. These findings highlight the urgent need for broader international collaboration, comparative cross-cultural studies, and interdisciplinary partnerships to strengthen theoretical generalization and support the development of globally applicable science-character education frameworks.

Collaboration and Bibliometric Analysis

Collaboration patterns among countries were analyzed using VOSviewer network visualization to examine the extent of international research cooperation in studies integrating science learning, character education, and elementary schooling. Total Link Strength (TLS) was used as an indicator of collaborative intensity, representing the frequency and strength of co-authorship connections between countries (see Figure 4 and Table 2).

Table 2: Network country link strength

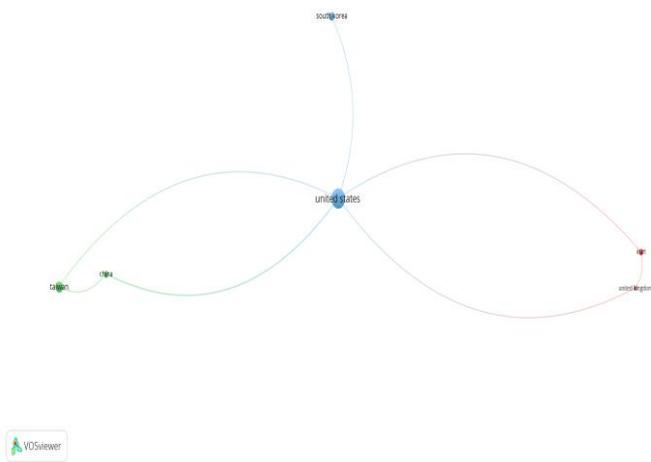
Country	Total link strength
United States	6
China	3
Indonesia	2
Iran	2
Taiwan	2
United Kingdom	2
Australia	1
Czech Republic	1
Italy	1
Malaysia	1
Slovakia	1
South Korea	1
Austria	0
Finland	0
Germany	0

Source: output VOSViewer software

The results indicate that the United States demonstrates the highest level of international collaboration (TLS = 6), suggesting a central role within the global research network. This finding reflects not only publication productivity but also the country's strong engagement in cross-national scholarly partnerships. Countries such as China (TLS = 3), Indonesia (TLS = 2), Iran (TLS = 2), Taiwan (TLS = 2), and the United Kingdom (TLS = 2) exhibit moderate collaborative participation, indicating emerging integration into international research networks despite differing levels of publication output.

In contrast, several countries – including Australia, the Czech Republic, Italy, Malaysia, Slovakia, and South Korea (TLS = 1) – demonstrate limited collaborative engagement, while Austria, Finland, and Germany recorded no detectable collaboration links (TLS = 0) within the analyzed dataset. These patterns suggest that research development in this field remains fragmented and often localized, with many studies conducted within national or institutional boundaries rather than through sustained international partnerships.

Several countries recorded low collaboration intensity (TLS ≤1), while Austria, Finland, and Germany showed no detectable collaboration links. Strengthening international collaboration – particularly among countries with low or absent network connectivity – could promote broader knowledge exchange, encourage comparative cross-cultural perspectives, and support the development of more universally applicable science-character education frameworks.

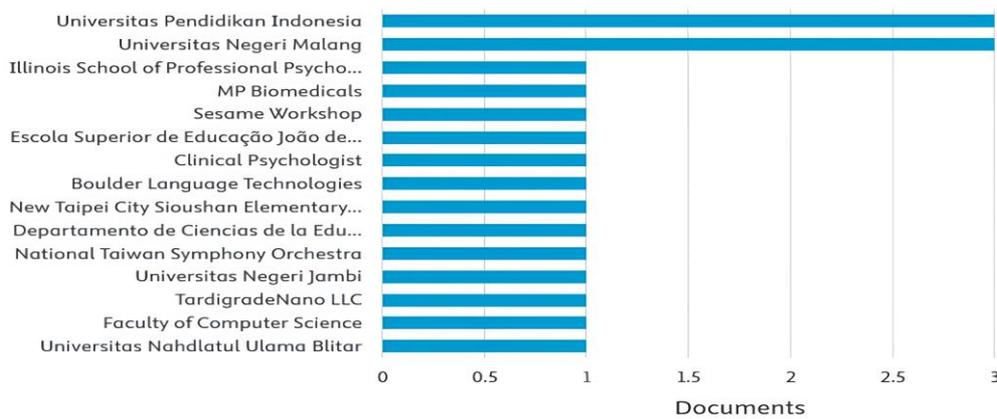


Source: output VOSViewer software

Figure 4. Network country visualization

Documents by affiliation

Compare the document counts for up to 15 affiliations.



Source: Scopus database

Figure 5. Network countries based on affiliation country visualization

Journal and Author Distribution

The dissemination of science, character, and “elementary school” in the premier 15 publications predicated on affiliations elucidates that the largest contributions came from higher education institutions in Indonesia, namely the Universitas Pendidikan Indonesia and the Universitas Negeri Malang, with three publications each. This reflects the high level of attention Indonesian academics have paid to the integration of science and character education at the elementary school level, in line with national policies emphasizing the strengthening of character education. Beyond that, other institutions only contributed one publication, such as the Illinois School of Professional Psychology, Sesame Workshop, and Escola Superior de Educação João de Deus, demonstrating the multidisciplinary involvement of both non-formal educational institutions and international research

institutions. This distribution indicates that although this topic has attracted global interest, research still tends to be local or individual, with not much being conducted through strong inter-institutional collaboration (see Figure 4).

Publication source analysis demonstrates that research on the integration of science learning, character education, and elementary schooling remains widely dispersed across multidisciplinary journals. Among the top fifteen sources, Asia Pacific Science Education, International Journal of Science Education, Journal of Chemical Education, and Jurnal Ilmiah Ilmu Terapan Universitas Jambi recorded the highest contributions, each publishing two articles (see Figure 6). The remaining journals contributed only a single publication, indicating limited concentration within specialized outlets.

Documents per year by source

Compare the document counts for up to 10 sources.

[Compare sources and view CiteScore, SJR, and SNIP data](#)



Source: Scopus database

Figure 6. Number of articles by sources (top 15 sources)

This distribution reflects the interdisciplinary nature of the topic, spanning science education, psychology, educational technology, and cultural studies. However, the absence of dominant publication venues suggests that the field has not yet consolidated into a mature or specialized scholarly discourse. Research dissemination remains fragmented, which may limit cumulative theoretical advancement and sustained academic dialogue.

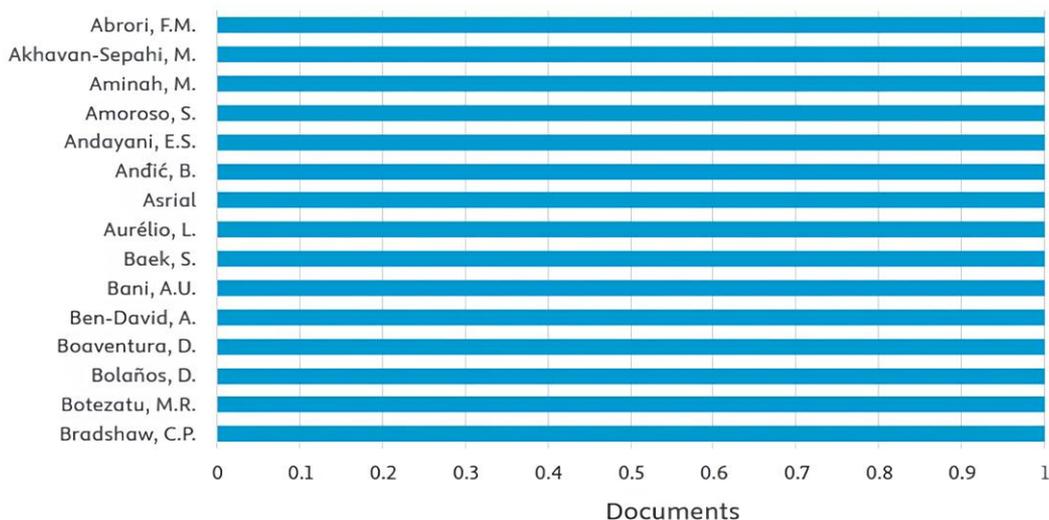
Institutional affiliation analysis confirms earlier findings, each contributing three publications. This pattern reflects strong national engagement aligned with educational policies emphasizing character education integration. Nevertheless, the participation of institutions such as Illinois School of Professional Psychology, Sesame Workshop, and Escola Superior de Educação João de Deus demonstrates emerging

multidisciplinary and international involvement. Despite this diversity, institutional collaboration remains relatively limited, suggesting that research initiatives are still predominantly localized.

Author productivity analysis reinforces this observation. Among the top fifteen contributing authors, each produced only a single publication related to the topic (see Figure 7). The absence of leading or repeatedly contributing scholars indicates that research communities focusing specifically on science-character integration in elementary education are still developing. This dispersed authorship pattern suggests opportunities for establishing sustained research networks capable of advancing theoretical coherence and methodological innovation.

Documents by author

Compare the document counts for up to 15 authors.



Source: Scopus database

Figure 7. Count of publications by author (top 15 authors)

Theoretical and Practical Implications (RQ3)

The analysis of 51 Scopus-indexed publications using VOSviewer provides important theoretical and practical implications for future research directions in science and character education at the elementary school level. The prominence of these terms confirms that existing studies are strongly centered on child development within formal primary education contexts.

From a theoretical perspective, these findings emphasize that effective integration of science learning and character development must be grounded in developmental psychology and age-appropriate pedagogy. The frequent occurrence of keywords such

as “Age Factors” (29), “Reading” (29), “Comprehension” (26), and “Learning” (24) highlights the importance of literacy development as a mediating component linking scientific understanding with moral and social value formation. The dominance of keywords such as “Child,” “Education,” and “Primary school” indicates a strong focus on child development and formal educational contexts.

Practically, the bibliometric results indicate that most interventions focus on improving students’ comprehension, learning engagement, and behavioral outcomes within classroom environments. However, the relatively limited presence of interdisciplinary and longitudinal research signals the need for future studies

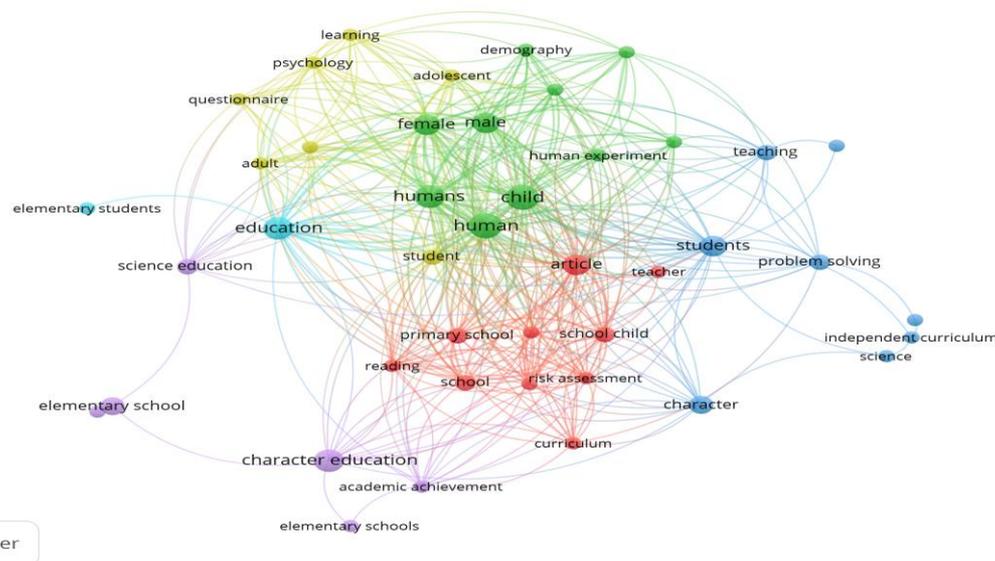
exploring transformative pedagogical models, cross-cultural comparisons, and sustainable implementation strategies. Strengthening collaboration among institutions and expanding research contexts beyond dominant regions may further support the development of adaptable and globally relevant science-character education practices.

Key Research Themes and Variables

Keyword co-occurrence analysis using VOSviewer reveals that research on science, character, and elementary education is strongly centered on child development within formal schooling contexts. The most dominant keywords include “Child” (TLS = 84), followed by “Education” (56), “Students” (47), “Primary School” (35), and “School Child” (35),

indicating that existing studies primarily focus on learning processes and developmental outcomes in early formal education environments (see Figure 8 and Table 3).

Additional frequently occurring terms such as “Age Factors” (29), “Reading” (29), “Comprehension” (26), and “Learning” (24) emphasize the importance of cognitive and literacy development as mediating components connecting scientific understanding with character formation. These findings suggest that effective integration of science and character education requires instructional approaches aligned with developmental readiness and literacy-based inquiry practices.



Source: output VOSViewer software

Figure 8. Co-occurrence framework and representations of key terms

Table 3. Keywords by authors

Keyword	Total link strength
Child	84
Education	56
Students	47
Primary school	35
School child	35
Age factors	29
Reading	29
Risk assessment	29
Risk factors	27
Adolescent	27
Adult	26
Comprehension	26
Learning	24
Psychology	23
Elementary student	23

Source: output VOSViewer software

From a practical perspective, the emergence of keywords such as “Risk Assessment” (29) and “Risk Factors” (27) indicates growing attention toward preventive and protective educational approaches. Character education within science learning is increasingly positioned as a mechanism to prevent negative behavioral outcomes by reinforcing responsibility, ethical awareness, and positive social values from an early age. Furthermore, interdisciplinary keywords including “Psychology” (23) and “Adolescent” (27) demonstrate opportunities for expanding research frameworks that integrate developmental psychology, science pedagogy, and character education studies.

The keyword structure highlights the need for a holistic conceptual framework integrating cognitive

(scientific understanding), affective (character development), and social (child interaction and school context) dimensions in elementary education.

Discussion

Consistent with the bibliometric findings highlighting inquiry-based learning and literacy development as a systematic process of constructing knowledge through observation, experimentation, and evidence-based reasoning (Ibanez et al., 2014; Paipetis, 2010). Contemporary perspectives emphasize inquiry-based learning, hypothesis testing, and continuous refinement of knowledge as central components of scientific practice (Antonovski, 2024; Rowley, 2019). Within elementary education, these principles support the development of critical thinking and scientific literacy through authentic engagement with scientific problems.

Character education complements this process by focusing on the cultivation of ethical dispositions, responsibility, and social awareness shaped through cultural and educational experiences (Peterson & Park, 2006; Wright & Huang, 2008). Character formation is particularly significant during early schooling years, when values such as honesty, creativity, cooperation, and national identity begin to develop through structured learning environments (Hendrowibowo &

Kristanto, 2024; Umami et al., 2019). Educational research further emphasizes that character is not solely inherited but can be strengthened through pedagogical design and social interaction (Martinelli, 2018).

The concentration of publications in Indonesia and Malaysia may reflect education policies emphasizing character development within formal curricula. This pattern also suggests a potential geographical research gap, particularly in non-Muslim contexts, where science-character integration remains less explored.

The limited international collaboration suggests opportunities to strengthen cross-country partnerships to enhance knowledge exchange and methodological diversity in science and character education research.

Elementary schools therefore function as critical environments where cognitive and moral development intersect. Beyond academic instruction, they provide structured opportunities for socialization, value internalization, and inclusive learning experiences (Paro, 2011; Trummel, 2024). Inquiry-based science instruction, differentiated learning strategies, and instructional tools such as interactive word walls have demonstrated effectiveness in promoting conceptual understanding while supporting collaborative and reflective learning practices (Jung et al., 2022; Reinhart, 2024).

Themes with Independent and Dependent Variables



Figure 9. classification of independent and dependent variables

The prominence of child-centered keywords implies that effective science-character integration must align with cognitive and socio-emotional developmental stages. This finding reinforces constructivist perspectives emphasizing age-appropriate moral and scientific learning.

Integrating scientific inquiry with character development aligns with broader educational goals aimed at fostering intellectual, moral, civic, and performance character simultaneously (Shields, 2011). Such integration positions science classrooms as spaces not only for knowledge acquisition but also for ethical reasoning and responsible decision-making.

Table 4. Findings from the SLR Data

Aspects	Findings from the SLR Data
Geographical Gap	Most studies originate from countries with Muslim-majority populations, such as Indonesia and Malaysia.
Research Gaps	There is limited research on the integration of science and character in elementary schools from non-Muslim countries.
Implications	Further studies from different national contexts are needed to understand the universality and effectiveness of science and character learning approaches at the elementary school level.
Broader Impact	Such integration can contribute to more inclusive, culturally relevant education and help shape global discourse on character-based science education.
Value Integration	Integrating local values and character in science education can support the development of holistic competencies across different regions.
Aspects	Findings from the SLR Data
Geographical Gap	Most studies originate from countries with Muslim-majority populations, such as Indonesia and Malaysia.

The synthesis of reviewed studies demonstrates consistent patterns in the relationship between independent and dependent variables (see Figure 9). Independent variables commonly include science literacy, STEM-based learning, integrated learning models, and project-based learning approaches. These pedagogical strategies function as predictors influencing dependent outcomes such as student achievement, ethical behavior, critical thinking ability, and social-emotional development.

Geographical analysis further reveals significant research concentration within Muslim-majority countries, particularly Indonesia and Malaysia (Table 4). This distribution highlights a contextual research gap, as comparatively limited studies examine science-character integration within non-Muslim educational contexts. Expanding research across diverse national and cultural environments is therefore essential for evaluating the universality and adaptability of integrative educational models.

The findings also indicate that incorporating local cultural values into science learning contributes to inclusive and contextually relevant education. Integrating responsibility, independence, and religiosity within scientific inquiry supports holistic competency development while strengthening global discussions on ethical and culturally responsive science education.

Conclusion

This systematic literature review synthesizes peer-reviewed studies on the integration of science

education and character development in elementary schools, highlighting increasing scholarly interest in holistic approaches that foster both cognitive and moral growth. Inquiry-based and integrative pedagogical strategies have been shown to enhance scientific literacy, critical thinking, and character values such as responsibility, independence, and ethical awareness. Research is largely concentrated in regions with policies emphasizing character education, indicating the influence of cultural and policy contexts and the need for more cross-cultural studies. Most studies focus on short-term outcomes and rely primarily on quantitative methods, revealing a gap for longitudinal, mixed-method, and transformative research that can provide deeper insights into sustained character formation alongside scientific competence. The conceptual framework derived from this synthesis illustrates the interconnected roles of instructional design, science-character integration, and student development outcomes, offering practical guidance for educators and policymakers. Limitations include the focus on major databases, potentially excluding relevant literature, and the concentration of studies in specific regions, which may limit generalizability. Future research should explore diverse cultural and educational contexts, employ longitudinal and mixed-method approaches, and examine innovative pedagogical models to strengthen both theoretical understanding and practical application. Broadly, this study underscores the value of integrating cognitive and moral education to support holistic child development and contribute to the global discourse on science and character education.

Author Contributions

All authors have real contributions in completing this manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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