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A hybrid systematic review and bibliometric analysis of character education in science and social studies

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Abstract

Character education is increasingly crucial amid growing social complexity. However, its integration within science and social studies remains fragmented. This study aims to map research trends, identify dominant character values, and examine key gaps in this field. A hybrid approach combining a systematic literature review and bibliometric analysis was applied to 131 Scopus-indexed articles (2016–2025). The findings reveal a growing body of research with a fragmented yet interconnected intellectual structure. Five categories of character values were identified, with social–civic and moral–ethical values as the most dominant, followed by scientific, environmental, and social–emotional values. Six main pedagogical approaches were integrated learning, project-based learning, and citizenship-based approaches. Key gaps include the absence of an integrated conceptual framework, limited use of experimental and longitudinal designs, and insufficient development of context-sensitive character assessment tools. These findings highlight the need for more integrated models, rigorous research designs, and practical strategies to support effective character education in science and social studies.

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1. Introduction

Rapid technological advances, increasing social complexity, and various global humanitarian crises have reinforced the urgency of strengthening moral values in modern life (Agazzi, 2019; Bauer & Hermann, 2024; Kendal, 2022). Societies in various countries face multidimensional challenges that include digital disinformation, social conflict, environmental degradation, and declining empathy, all of which impact social cohesion and the ethical judgment of the younger generation (González-Bailón & Lelkes, 2023; Shahbazi & Bunker, 2024;

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Tomassi et al., 2025; Vonhm, 2025). Without a strong moral foundation, future generations risk growing up to be technologically proficient but morally weak individuals, threatening social harmony and the sustainability of communal life (Claudy et al., 2024; Mills & Wilner, 2023).

This urgency is further heightened by the declining role of families and traditional institutions in providing consistent moral role models (Elsayed, 2024; Maihasni et al., 2025). Numerous children today are more exposed to digital environments than to direct interaction with role models, resulting in a lack of internalization of moral values (Swider-Cios et al., 2023). Character education in childhood is considered crucial because it can strengthen children's social-emotional development, foster prosocial behavior, and form the basis of their integrity and responsibility through positive interactions in the family and school environments (Mei-Ju et al., 2014). This view is in line with Piaget (2013) and Kohlberg (1981) theories of moral development, as well as empirical findings showing that character education at an early age contributes to increased empathy, self-control, and social responsibility (Mondi et al., 2021).

Classroom learning is a strategic space for strengthening moral values, as it involves intense social interaction between teachers, students, and learning materials (Yuan et al., 2025). The classroom is not only an arena for knowledge transfer, but also a social environment where students practice negotiating norms, values, and responsibilities through meaningful learning activities (Valiente et al., 2020). Two subjects, namely Natural and Social Sciences, have great potential for integrating character education. These two fields naturally explore human relationships with the environment, social dynamics, and the ethical implications of scientific and social phenomena, providing ample opportunities for students to connect academic concepts with moral reflections relevant to real life (Al-Barakat et al., 2025; Yildiz, 2023).

Despite attention to character education continuing to increase, research examining its integration within science and social studies education remains fragmented (Oldham & McLoughlin, 2025). Several studies focus on general character education programs or social-emotional learning without clearly explaining how specific character values are embedded within discipline-based learning contexts (Chowkase, 2023; Dussault & Thompson, 2024; Lawson et al., 2019). In addition, existing research tends to examine isolated values or single pedagogical approaches, without providing an integrated mapping of multidimensional character values and their relationship with instructional approaches across science and social studies education. As a result, the conceptual and pedagogical structure of character education within these disciplines remains underdeveloped, limiting the formulation of coherent and applicable models for classroom practice. Differences in curricula, cultures, and educational policies across countries further contribute to inconsistencies in how character values are conceptualized and implemented (Aliyeva et al., 2022; Allern et al., 2022; Asrori et al., 2025; Hatiboğlu et al., 2019).

To address potential conceptual ambiguity, this study defines ‘character values’ as a multidimensional construct encompassing moral–ethical values (e.g., honesty, integrity), social–emotional competencies (e.g., empathy, self-regulation), civic dispositions (e.g., responsibility, respect for diversity), scientific attitudes (e.g., critical thinking, objectivity), and environmental awareness. This conceptualization positions character education as an integrative framework that intersects with related constructs such as moral education, values education, and Social and Emotional Learning (SEL), while extending beyond them by explicitly linking value development to disciplinary learning contexts. In this regard, SEL is viewed as a component focusing on emotional and interpersonal competencies, whereas moral and values education emphasize normative and ethical dimensions. Character education, therefore, serves as a broader framework that integrates these perspectives within educational practice.

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From a methodological perspective, the previous study, Umar et al. (2024), has attempted to combine systematic literature review and bibliometric analysis. However, their focus remains on character education in general and does not specifically address its integration within science and social studies. In response to the identified gap, this study employs a hybrid approach that combines a systematic literature review with bibliometric analysis to provide a comprehensive mapping of research trends, multidimensional character values, and pedagogical approaches. This approach enables both in-depth conceptual synthesis and the visualization of the intellectual structure of the field, thereby offering a more integrated understanding of character education within discipline-based learning contexts (Marzi et al., 2025). However, to date, no study has comprehensively integrated these two approaches to systematically map the multidimensional character values and pedagogical approaches within science and social studies.

Furthermore, within the context of primary education, the integration of character values in science and social studies is particularly significant, as these subjects provide authentic opportunities to connect knowledge with real-life social, environmental, and ethical issues (Sari & Kumalasani, 2025). However, despite its importance, the existing body of research in this area remains fragmented and lacks a comprehensive synthesis that systematically maps both the multidimensional character values and the pedagogical approaches used within these disciplinary contexts.

In primary education settings, the integration of character values requires developmentally appropriate pedagogical strategies that translate abstract values into concrete, observable behaviors through structured classroom interactions, guided reflection, and contextualized learning activities. Teachers play a central role in this process by embedding values into daily instructional practices, classroom routines, and formative assessment strategies. This includes designing learning experiences that integrate moral reasoning, social responsibility, and scientific thinking in ways that are accessible to young learners.

Therefore, a comprehensive mapping of research is essential not only to advance theoretical understanding but also to support primary teacher education, particularly in designing value-integrated instruction, aligning curriculum and pedagogy, and developing context-sensitive assessment practices for character development in science and social studies classrooms.

In light of this gap, this study aims to examine global research trends in character education in science and social studies, identify the character values that have been the focus of previous studies, and map the conceptual and empirical gaps that can serve as a basis for further research. This study seeks to answer the following questions.

RQ1: What are the patterns of publication, topic distribution, and intellectual structure of global research on character education in science and social studies?

RQ2: What character values are most dominant, and how are these values conceptualized in research on science and social studies?

RQ3: What are the research gaps and opportunities for future studies on character education in science and social studies?

2. Method

2.1. Research approach

This study uses a hybrid systematic literature review and bibliometric analysis approach to gain a comprehensive understanding of the integration of character education into science and social studies. This approach was chosen, as it combines the strengths of quantitative analysis

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in bibliometrics with the depth of qualitative analysis produced through a systematic review of scientific literature (Page et al., 2021; Passas, 2024). Thus, the research not only maps publication trends and patterns but also analyzes core concepts, emerging character values, and relevant research gaps (Marzi et al., 2025). The entire process is based on the PRISMA 2020 guidelines, which serve as the standard for reporting systematic reviews.

2.2. Search strategy and data sources

The literature search was conducted systematically in the Scopus database, as it has broad international coverage and is relevant for bibliometric analysis. The search was conducted on November 30, 2025, using a combination of keywords and Boolean operators (AND, OR) as follows:

TITLE-ABS-KEY ("character education" OR "moral education" OR "character values" OR "moral values" OR "values education" OR "value-based education" OR "social and emotional learning" OR "SEL") AND ("science education" OR "science learning" OR "science teaching" OR "social studies education" OR "social studies learning" OR "citizenship education" OR "civics education")

Inclusion criteria are (1) articles published between 2016 and 30 November 2025, (2) written in English or Indonesian, and (3) published as peer-reviewed journal articles. Exclusion criteria include publications not related to character education in science or social studies, non-full-text articles, and non-article document types.

The publication range was set for ten years, from 2016 to November 30, 2025. The dataset includes all articles indexed in Scopus up to the retrieval date, including early-access and in-press publications where available. This period was selected because it represents a crucial phase in the development of character education research and its integration into science and social studies, in line with various national curriculum updates and the increased attention to approaches such as social and emotional learning and value-based education after 2016. The ten-year range is also in line with common practice in bibliometric studies to capture research trends clearly without extending the period excessively.

The study selection process follows the PRISMA 2020 guidelines and consisted of identification, screening, eligibility, and inclusion stages. The screening process was conducted by two independent reviewers to ensure objectivity and minimize bias. Discrepancies between reviewers were resolved through discussion until consensus was reached. Despite no formal inter-rater reliability coefficient being calculated, iterative comparison, cross-checking, and consensus-based validation were applied to enhance the consistency and reliability of the selection process.

Data extraction was conducted systematically using a predefined extraction framework. The unit of analysis is individual articles. The extracted variables include (1) bibliographic information (authors, year, country, journal), (2) research objectives, (3) methodological design, (4) learning context, (5) character values addressed, (6) pedagogical approaches used, and (7) key findings. To ensure consistency, the extraction process was conducted iteratively, and the results were cross-checked between reviewers.

Prior to analysis, data are cleaned to improve accuracy. This includes normalizing keywords, merging synonymous terms (e.g., “character education”, “values education”, and “moral education”), and removing duplicates or irrelevant terms.

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2.3. Data analysis

Data analysis was conducted using two complementary approaches, namely bibliometric analysis and qualitative analysis based on a systematic literature review. Both were used in an integrated manner to answer the three research questions.

Bibliometric analysis was used to answer RQ1 and part of RQ3. Bibliometric data were analyzed directly in the Scopus database to map research trends, subsequently exported to VOS viewer for further analysis. The analysis includes (1) co-occurrence analysis of author keywords, (2) co-citation analysis of references, and (3) bibliographic coupling at the document level. Threshold parameters were iteratively adjusted to obtain interpretable and stable thematic groupings.

For the VOS viewer analysis, the full-counting method was used. In the co-occurrence analysis, the unit of analysis was set to all keywords, with a minimum threshold of 3 occurrences. For co-citation analysis, the unit of analysis was cited references, with a minimum threshold of 3 citations. In the bibliographic coupling analysis, the unit of analysis was documents, with a minimum threshold of 5 documents. These parameter settings were selected to ensure the inclusion of sufficiently relevant items while maintaining the clarity and interpretability of the resulting network visualizations.

The systematic literature review (SLR) was used to answer RQ2 and to complement the identification of research gaps in RQ3. All articles that passed the selection were analyzed using a thematic approach. Thematic analysis was conducted using an inductive coding approach, allowing themes to emerge directly from the data. This process comprises three stages of data extraction, thematic coding, and narrative synthesis.

In the data extraction stage, each article was examined to identify the research objectives, methodological design, learning context, character values developed, and main results. In addition, thematic coding was carried out to group the character values and pedagogical approaches used in science and social studies. These values were subsequently categorized to identify patterns of value integration and thematic differences between studies.

To enhance reliability and auditability, coding was conducted iteratively, and categories were refined through repeated cross-study comparisons. Cross-checking between reviewers and consensus-based validation were applied to minimize subjectivity and ensure consistency in coding decisions. The coding results were synthesized narratively to answer RQ2 and compared with bibliometric findings to identify conceptual, methodological, and contextual gaps that form the basis for future research development (RQ3).

3. Results

A systematic search of the Scopus database yielded 363 records. The study selection process followed the PRISMA 2020 guidelines and is presented in Figure 1.

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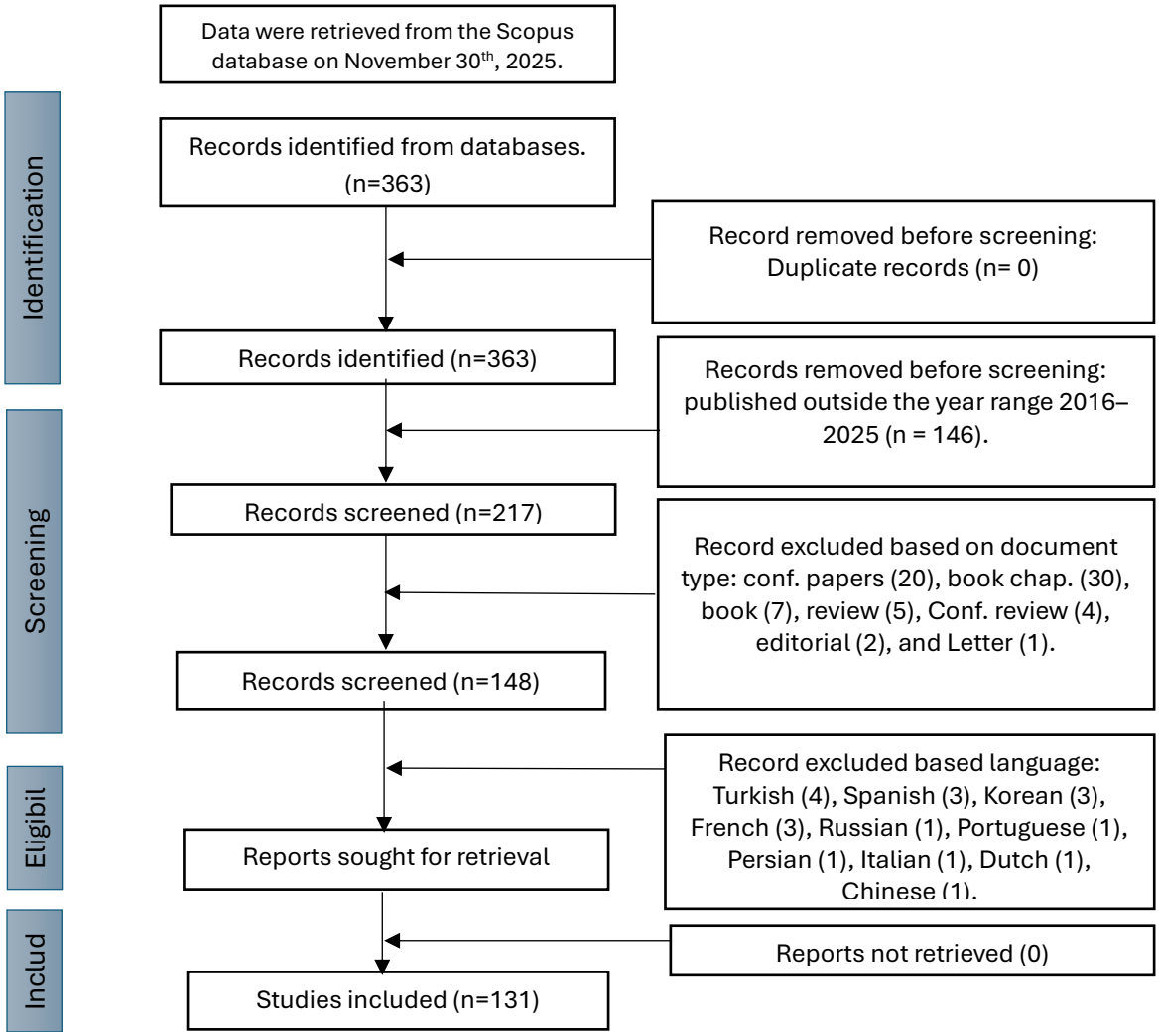


Figure 1. PRISMA 2020 flowchart of selection study process (2016-2025)

Of the 363 identified records, as illustrated above, 146 articles are excluded because they are published outside the defined time range (2016–November 30, 2025). The remaining 217 records are screened based on document type, resulting in the exclusion of 69 non-journal publications, including conference papers, book chapters, books, reviews, conference reviews, editorials, and letters.

Subsequently, 148 articles are assessed for eligibility based on language criteria, leading to the exclusion of 17 articles published in languages other than English or Indonesian. All remaining articles are available in full text, and no records are excluded at this stage. Finally, a total of 131 articles meets all inclusion criteria and are included in the analysis.

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Bibliometric analysis was conducted on 131 articles to examine publication trends over time. The annual distribution of publications is presented in Figure 2.

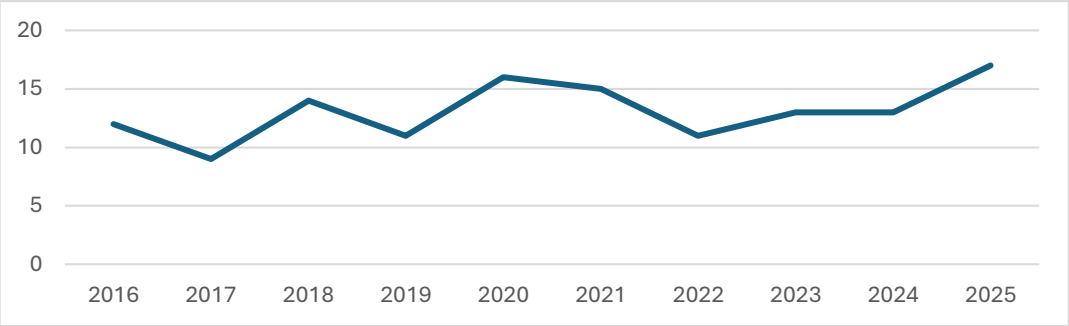


Figure 2. Annual distribution of publications (2016-2025)

To enhance transparency and auditability, the distribution is summarized in Table 1.

Table 1. Annual distribution of publications (2016-2025)

Year	Number of Publications
2016	12
2017	9
2018	14
2019	11
2020	16
2021	15
2022	11
2023	13
2024	13
2025	17

The number of publications per year indicates 2016 (n = 12), 2017 (n = 9), 2018 (n = 14), 2019 (n = 11), 2020 (n = 16), 2021 (n = 15), 2022 (n = 11), 2023 (n = 13), 2024 (n = 13), and 2025 (n = 17). The total number of publications across all years is 131, confirming the dataset's consistency. The trend shows moderate fluctuations in the early years, followed by a noticeable increase after 2019, peaking in 2025. This pattern indicates growing scholarly attention to character education in science and social studies education in recent years.

Table 2. Distribution of publications by country/region

Countries/Regions	Number of studies
United States	28
Indonesia	22
United Kingdom	18
Turkey	10
China	6
Hong Kong	5
South Africa	5
South Korea	5
Spain	5
Australia	4

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Countries and regions (e.g., Hong Kong) are reported based on institutional affiliations as indexed in the Scopus database. The United States contributes the most publications (n = 28), followed by Indonesia (n = 22) and the United Kingdom (n = 18). Other contributing countries include Turkey (n = 10) and China (n = 6), as well as several regions, including Hong Kong (n = 5), which is consistently treated as a distinct research region in this study. South Africa, South Korea, and Spain each contribute five publications, while Australia contributes four. This distribution reveals that the dataset includes contributions from various regions of the world and reflects the geographical variation of research on the analyzed theme.

The distribution of publication sources indicates that research in this field is published across a wide range of journals. Table 2 presents journals with at least three publications. These findings provide an overview of the most active publication sources publishing research related to character education in science and social studies.

Table 3. Most productive journals (≥3 publications)

Journal Names	Number of studies
Journal of Moral Education	10
Journal of Social Science Education	5
Frontiers in Education	4
Compare: A Journal of Comparative and International Education	4
International Journal of Instruction	3
Educational Practice and Theory	3
Citizenship Teaching and Learning	3

Co-occurrence analysis of author keywords using VOS viewer identifies five thematic clusters that represent the conceptual structure of research on character education in science and social studies, as shown in Figure 3. The analysis uses a minimum threshold of 3 occurrences and includes all keywords, as specified in the Methods section.

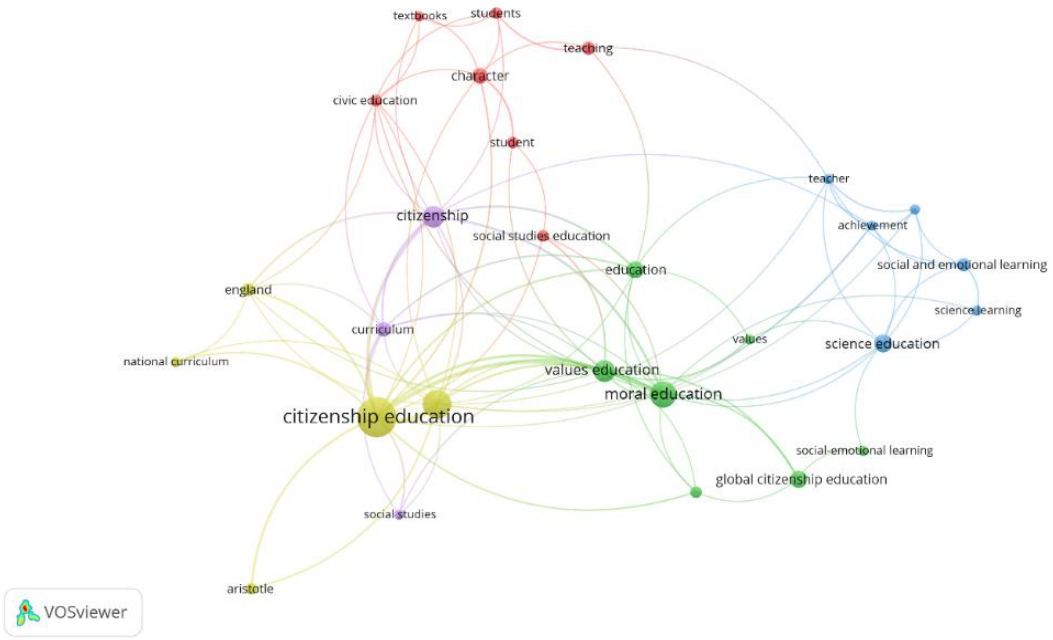


Figure 3. Keyword co-occurrence network visualization generated using vos viewer

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The first cluster focuses on character and citizenship education in student contexts. The second cluster highlights values, morality, and perspectives on global citizenship. The third cluster is associated with science education, learning outcomes, and teacher roles. The fourth cluster connects character education with curriculum and policy contexts. The fifth cluster emphasizes social education and citizenship-related learning. These clusters are interpreted in relation to RQ1 as reflecting the intellectual structure of the field, and in relation to RQ3 as indicating areas of thematic concentration and potential research gaps, particularly in the limited integration across clusters.

Co-citation analysis uses cited references as the unit of analysis, with a minimum threshold of 3 citations (Figure 4). Co-citation refers to the frequency with which two or more references are cited together within the same articles, indicating a shared conceptual or theoretical relationship. In this study, co-citation data are derived from the reference lists of the 131 selected articles. The visualization reveals a chain-like, moderately connected structure, rather than clearly separated, densely interconnected clusters. Several references serve as essential nodes within the network, including works on moral education, citizenship and ethical education, and educational research and policy.

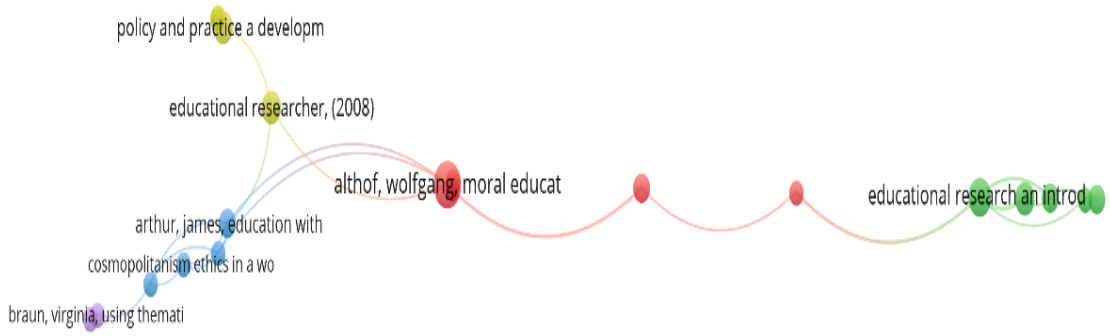


Figure 4. Co-citation network visualization generated using vos viewer

Bibliographic coupling analysis is conducted at the document level, with a minimum threshold of 5 documents (Figure 5). The clusters are formed based on bibliographic coupling among documents, in which items sharing similar reference patterns are grouped using the VOS viewer's clustering algorithm and threshold parameters. The visualization shows a chain-like structure, indicating sequential intellectual linkages among key studies rather than highly dense clustering. Several prominent nodes, such as Veugelers (2020), Peterson (2020), Bamber (2018), Thornberg (2016), Sarkadi (2022), and Garner (2018), serve as central reference points connecting different parts of the network.



Figure 5. Bibliographic coupling network of documents in character education research within science and social studies education

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After bibliometric mapping, the analysis continued with a systematic review of 131 articles that met the selection criteria to identify character values integrated into science and social studies education and the learning approaches used. These SLR findings are presented in the following two sections.

Thematic analysis of the 131 articles identifies five main themes of character values integrated into science and social studies, as summarized in Table 3. A single article is classified into more than one theme (overlapping), due to the multidimensional nature of character.

Table 4. Character values integrated in science and social studies

Main Themes	Subthemes of Character Values	Number of studies	Representative Studies	Context
Social and Civic Values	Civic responsibility; appreciation of diversity; tolerance; equality; justice; solidarity; global awareness	95	Biesta (2016); Veugelers (2020); Banks (2021)	Citizenship, multicultural, civic education
Moral and Ethical Values	Honesty; integrity; personal responsibility; ethical decision-making; moral commitment	75	Kristjánsson (2017); Arthur (2017); Narvaez (2018)	Moral & character education
Scientific Values	Critical thinking; scientific curiosity; scientific honesty; experimental discipline; accuracy; scientific attitude	32	Osborne (2018); Lederman (2019); Kind (2017)	Scientific thinking, inquiry, epistemic understanding
Environmental and Sustainability Values	Ecological responsibility; environmental concern; sustainability awareness; environmentally friendly behavior	22	Wals (2020); Stevenson (2017); Kopnina (2020)	Sustainability, environmental education
Social-Emotional Values	Empathy; caring; cooperation; collaboration; self-awareness; self-regulation	13	Schonert-Reichl (2017); Jones (2017); Immordino-Yang (2016)	SEL, emotional development

The results indicate that social and civic values are the most dominant theme, with 95 studies emphasizing aspects such as responsibility, tolerance, justice, and global awareness, primarily situated within citizenship and multicultural education contexts. This is followed by moral and ethical values (75 studies), which focus on personal responsibility, ethical decision-making, and moral commitment in relation to character and moral education. Scientific values appear in 32 studies, highlighting critical thinking, scientific curiosity, honesty, and inquiry-based understanding within epistemic and disciplinary contexts. Meanwhile, environmental and sustainability values (22 studies) underscore responsibility for the environment and awareness of sustainability, and social-emotional values (13 studies) address empathy, collaboration, and self-regulation within social-emotional learning frameworks. Overall, the distribution emphasizes values that connect knowledge to social responsibility and real-world engagement.

A thematic analysis of 131 articles identifies six main themes of learning approaches to integrating character education into science and social studies, as shown in Table 4. The total

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frequency exceeds the number of articles (n = 131) because a single study employs multiple instructional approaches. Therefore, the coding is non-mutually exclusive.

Table 5. Learning approaches used in the study

Main Approach Themes	Number of Studies	Representative Studies	Contextual Mapping
Integrated Learning	78	Komalasari & Saripudin (2017); Isdaryanti et al. (2018); de Oliveira Moraes et al. (2021)	Cross-curricular and interdisciplinary learning is widely applied in primary education, science education, and social studies
Project-Based Learning (PjBL)	52	Krajcik et al. (2023); Saripudin et al. (2021); Maestrales et al. (2022)	Civic education, democratic participation, and community engagement
Citizenship-Based Approach	49	Peterson (2020); Englund (2016); Starkey (2018)	Civic education, democratic participation, and community engagement
Social and Emotional Learning (SEL)	21	Elmi (2020); Krajcik et al. (2023); Peterson (2020)	Focus on emotional regulation, empathy, and interpersonal competencies in school settings
Case Study-Based Approach	18	Hong (2023); Kartal (2020); Jabbari & Duncan (2024)	Ethics education and moral reasoning through real-life or simulated cases
Reflective Approach	15	Krajcik et al. (2023); Saripudin et al. (2021); Sarkadi et al. (2020)	Reflective practice in teacher education and professional learning contexts

The findings reveal that integrated learning is the most widely used approach, with 78 studies highlighting its application in cross-curricular and interdisciplinary contexts, particularly in primary, science, and social education. Project-Based Learning (PjBL) follows with 52 studies, emphasizing its role in promoting civic education, democratic participation, and community engagement. The citizenship-based approach appears in 49 studies, with a focus on fostering civic engagement and democratic values. Meanwhile, social and emotional learning (SEL) is represented in 21 studies, underscoring the development of emotional regulation, empathy, and interpersonal skills in school settings. Less frequently applied are the case study-based approach (18 studies), which supports ethical reasoning through real-life or simulated scenarios, and the reflective approach (15 studies), which emphasizes reflective practice in teacher education and professional learning contexts. Overall, the distribution reveals a preference for holistic and participatory approaches that integrate cognitive, social, and ethical dimensions of learning.

4. Discussion

4.1. Bibliometric implications

Bibliometric analysis of the 131 selected articles indicates a gradual increase in publication output over the period 2016–2025, with a more noticeable rise after 2019, as shown in Figure 2. This trend suggests a growing scholarly interest in the integration of character education within science and social studies, especially in response to increasing

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social complexity and the demand for 21st-century competencies (Fernández Espinosa & López González, 2024; Nanda et al., 2025). Character education is no longer viewed as an additional component but is increasingly positioned as an integral element in discipline-based learning, including science and social education (Sajadi, 2025).

The geographical distribution of publications, as presented in Table 1, reveals that the United States (n = 28), Indonesia (n = 22), and the United Kingdom (n = 18) are the leading contributors. This interpretation is strictly based on the dataset and reflects the concentration of research activity in countries with established traditions in character, citizenship, or values-based education (Kennedy, 2012; Reynolds et al., 2019). Other contributing regions, such as Turkey, China, and Hong Kong, indicate a broader but still uneven global distribution of research.

The wide distribution of journals, covering general education, science education, social studies, civics education, and values education, confirms that the issue of character education is interdisciplinary and lies at the intersection of science, social studies, and character building of students (Hoge, 2002; Milara & Orduña, 2024). The diversity of publication outlets illustrates that the integration of values in science and social studies is not limited to one academic tradition but develops through various theoretical and pedagogical approaches.

Keyword co-occurrence analysis using VOS viewer identified five thematic clusters (Figure 3), namely, (1) character and citizenship education, (2) values and morality, (3) science education and learning outcomes, (4) curriculum and policy, and (5) social education and citizenship learning. These clusters were derived from the co-occurrence patterns of author keywords across the 131 articles and represent the field's conceptual structure. The relationships among these clusters appear loosely connected rather than strongly integrated, indicating that research themes tend to develop in parallel rather than converging into a unified conceptual framework. This interpretation is consistent with the visualization, in which inter-cluster linkages exist but are not densely connected.

Co-citation analysis (Figure 4) further underscores this finding by showing a chain-like intellectual structure, in which key references are linked sequentially rather than forming tightly bound clusters. This pattern explicates that the field is still undergoing theoretical consolidation, with multiple perspectives coexisting without a dominant paradigm (Nucci et al., 2024; OECD, 2017).

This study contributes by empirically demonstrating, through the mapping of 131 articles, that character education in science and social studies is not yet structured around a single theoretical core. Instead, it operates as a multi-perspective and evolving field, where integration across domains remains limited.

4.2. Synthesis of values

The results of the thematic analysis reveal that the character values developed in science and social studies can be grouped into several themes. In light of the analysis of 131 articles (Table 3), five main categories that have been identified were social–civic values (n = 95), moral–ethical values (n = 75), scientific values (n = 32), environmental values (n = 22), and social–emotional values (n = 13).

The dominance of social–civic values in science and social learning can be explained by the epistemological characteristics and objectives of these fields, which are inherently oriented toward the relationships between individuals, society, and the environment. The prominence of social–civic values in both domains reflects a shift in the educational paradigm, from a mere focus on knowledge acquisition toward the development of individuals who are capable of

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contributing ethically and responsibly to social life, thereby positioning science and social learning as strategic spaces for cultivating civic character that is contextual and relevant to global challenges (Banks, 2016; Osborne, 2010).

The integration of moral–ethical values into science and social learning positions education not merely as a process of knowledge transmission, but as a means of cultivating ethical awareness and social responsibility among students. Moral–ethical values are not merely additional content; rather, they function as a normative framework that connects knowledge, attitudes, and actions (Lickona, 2009). Approaches such as socio-scientific issues have also proven effective in developing moral reasoning, as students are trained to evaluate complex scientific dilemmas from multiple value perspectives (Sadler, 2011; Zeidler et al., 2005). Learning that emphasizes values such as justice, responsibility, and respect for diversity enables students to internalize moral principles within real-life contexts (Banks, 2004; Veugelers, 2021).

The dominance of social, civic, and moral–ethical values indicates that research in this field is primarily oriented toward developing citizenship and ethical responsibility. This implies that science and social studies are frequently positioned not only as domains of knowledge acquisition but also as platforms for fostering social awareness and ethical reasoning (Hodson, 2003; Oldham & McLoughlin, 2025)

In addition to social and emotional values, scientific character values emerge as essential characteristics directly related to scientific practice. The presence of scientific values in these studies reflects the awareness that science literacy is not only about mastering concepts and procedures, but also about internalizing scientific attitudes that support integrity and responsibility in scientific inquiry (Atabey & Topçu, 2025; Ijatuyi et al., 2025; Mashami et al., 2025; Mejía & Garcés-Flórez, 2025). These values also strengthen character integration in science through an approach that demands honesty with data, evaluation of evidence, and fact-based argumentation.

On the other hand, environmental and sustainability values were increasingly prominent themes, especially in studies that combined science and social studies within an environmental learning framework. Values such as ecological responsibility, care for nature, and sustainability awareness are in line with the development of education for sustainable development, which emphasizes the interconnection between natural and social systems and the importance of responsible behavior towards the environment (Asif et al., 2020; Barrera Verdugo & Durán-Sandoval, 2024).

Social-emotional values such as empathy, cooperation, and self-regulation also appear in the literature. However, their relatively lower frequency (n = 13) indicates that Social and Emotional Learning (SEL) is widely emphasized in broader educational discourse (Cipriano et al., 2024; Durlak et al., 2011). Its integration within science and social studies remains less systematically represented in the analyzed dataset. This imbalance implies that curriculum design still prioritizes cognitive, moral, and civic dimensions, while underemphasizing emotional competencies.

4.3. Learning approaches for character education integration

SLR findings indicate that the integration of character values into science and social studies is implemented through a range of pedagogical approaches. As regards Table 4, six dominant approaches were integrated learning (n = 78), project-based learning (n = 52), citizenship-based approaches (n = 49), Social and Emotional Learning (n = 21), case study-based approaches (n = 18), and reflective approaches (n = 15).

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The prominence of integrated learning indicates that character education is most frequently implemented through cross-disciplinary, contextualized learning designs, thereby enabling the simultaneous integration of multiple value domains. This approach reflects the idea that science and social studies provide ample space to build connections between science, society, and values (Erianjoni et al., 2025; Ijatuyi et al., 2025; Rodríguez et al., 2024). Project-based learning and citizenship-based approaches further emphasize authentic engagement with real-world issues, supporting the development of responsibility, collaboration, and civic participation. This approach aligns with the literature emphasizing that authentic, product-oriented activities can effectively foster social character and responsibility, as well as strengthen empathy, solidarity, and commitment to public life through direct engagement in meaningful social experiences (Bernal-Guerrero et al., 2019; Chu et al., 2011; Nabors et al., 2019).

In primary education contexts, these approaches can be operationalized through developmentally appropriate practices such as thematic learning, simple collaborative projects, and classroom-based civic activities that connect lesson content with students' everyday experiences. For example, project-based learning involves small-scale environmental or community projects, while integrated learning can be implemented through thematic units that link science and social topics with moral and social values (Pangestu et al., 2024; Rizal et al., 2025). Teachers play a crucial role in structuring these activities through guided interaction, clear classroom routines, and scaffolding strategies that support young learners' cognitive and socio-emotional development (Darling-Hammond et al., 2020). Moreover, formative assessment practices, such as observation, reflective discussion, and portfolio-based evaluation, are essential to capture students' character development in authentic learning contexts (Black & Wiliam, 2009).

Reflective and Social and Emotional Learning (SEL) approaches play a crucial role in developing self-awareness and emotional competencies. Reflection, in particular, is a key element in moral development and the formation of personal dispositions, as it encourages students to connect scientific concepts or social phenomena with values, lived experiences, and ethical consequences in real-life contexts. At the same time, the growing implementation of SEL programs in science and social studies indicates an increasing recognition of the link between discipline-based learning and students' emotional well-being (Dussault & Thompson, 2024). However, their lower frequency compared to integrated and project-based approaches indicates that affective and reflective dimensions are less dominant in discipline-based implementation.

In primary classrooms, reflective and SEL approaches can be adapted through age-appropriate strategies such as guided questioning, storytelling, journaling, and collaborative dialogue, which help students articulate their thoughts, emotions, and value-based judgments (Tillott et al., 2024; Zieher et al., 2024). These strategies not only support emotional regulation and empathy development but also strengthen students' ability to make ethical decisions in everyday contexts (Immordino-Yang et al., 2019).

Despite the diversity of approaches, the findings indicate that no single pedagogical model dominates the field. Moreover, numerous studies do not clearly explain how character values are operationalized within instructional processes. This reinforces the bibliometric finding that the field lacks a unified framework linking values, pedagogy, and learning outcomes.

4.4. Research gaps and future research agenda

Bibliometric synthesis and literature analysis indicate that research on the integration of character education in science and social studies still leaves several gaps. Based on the

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integration of bibliometric and thematic findings, several key gaps can be identified from the 131 analyzed articles.

First, the absence of a dominant theoretical framework, evidenced by the loosely connected keyword clusters (Figure 3) and the chain-like co-citation structure (Figure 4), indicates that the field lacks conceptual integration. Existing perspectives, such as moral education, citizenship education, and SEL, continue to develop in parallel rather than being systematically connected (Nucci et al., 2024; OECD, 2017). Second, the thematic distribution of values shows an imbalance, with strong emphasis on social–civic and moral–ethical values, while social–emotional and environmental values are less consistently represented. This indicates that research has not yet fully addressed the integration of multiple value domains within science and social studies. Third, from a methodological perspective, the limited use of experimental, longitudinal, and advanced quantitative designs restricts the ability to establish causal relationships between pedagogical approaches and character development outcomes (Clement & Bollinger, 2017; Tian & Tang, 2025).

These gaps have essential implications for practice. The absence of an integrated framework suggests that curriculum design often adopts a fragmented approach, where values are addressed separately rather than holistically. In addition, the limited development of assessment instruments indicates that character outcomes are often insufficiently measured or inconsistently evaluated (Duckworth & Yeager, 2015; OECD, 2017). Therefore, future research should focus on developing integrated conceptual models, designing discipline-specific character assessment tools, and employing more rigorous methodological approaches to strengthen empirical evidence and support effective implementation in science and social studies.

5. Conclusion and implications

This study employed a hybrid approach, combining bibliometric analysis and systematic literature review, to examine the development of character education in science and social studies, drawing on 131 articles. The findings provide three main contributions aligned with the research questions in a more systematic and evidence-based manner.

First, addressing RQ1, the bibliometric analysis reveals a gradual increase in research over the past decade and identifies a fragmented yet interconnected intellectual structure, as indicated by the five thematic clusters and the chain-like co-citation network. This implies that the field is still in a phase of theoretical consolidation, with no single dominant paradigm guiding the integration of character education in science and social studies.

Second, addressing RQ2, the thematic analysis identifies five main categories of character values, with social–civic and moral–ethical values emerging as the most dominant, followed by scientific, environmental, and social–emotional values. Importantly, the findings demonstrate that these values are not isolated but form a relational, multi-layered structure, in which moral values provide a normative foundation, social–civic values reflect societal orientation, and scientific and environmental values function as discipline-specific extensions within science and social studies learning.

Third, addressing RQ3, the study identifies several key gaps, including the absence of an integrated conceptual framework, the limited use of experimental and longitudinal research designs, and the lack of context-sensitive character assessment instruments. These gaps indicate the need for stronger theoretical integration and more rigorous empirical approaches in future research.

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From a practical perspective, these findings have crucial implications for primary education and teacher development. The absence of an integrated framework suggests that curriculum design should move toward holistic value integration, where moral, social, scientific, and environmental values are explicitly connected within learning activities. A key implication of this study is the need for an integrated framework in primary education that systematically connects character values, pedagogical approaches, and assessment practices. For example, social–civic and moral–ethical values can be integrated through project-based and socio-scientific learning activities, while scientific and environmental values can be embedded in inquiry-based and contextual learning.

In this regard, approaches such as project-based learning (PjBL) and socio-scientific issue-based instruction offer promising avenues for embedding character values within authentic, contextually relevant learning experiences. In primary classrooms, these approaches can be implemented through developmentally appropriate strategies such as thematic learning, simple collaborative projects, and guided discussions that connect academic content with students' real-life experiences.

Furthermore, teachers need more systematic strategies to assess character development in discipline-based learning. At the primary level, character development can be assessed through observable indicators, such as students' participation in collaborative activities, their responsibility in completing tasks, their ability to express ethical reasoning in discussions, and their engagement in reflective activities. This includes the use of observable behavioral indicators, reflective activities, and context-based assessment tools that align with the characteristics of science and social studies. The development of valid and reliable assessment instruments is therefore essential to ensure that character education is not only implemented but also meaningfully evaluated.

Overall, this study contributes by providing an empirical mapping of the intellectual structure, value dimensions, and pedagogical approaches in character education within science and social studies. By highlighting the relational nature of values and the absence of a dominant paradigm, the study offers a foundation for developing more integrated models, robust methodologies, and contextually relevant practices in discipline-based character education.

6. Limitation

This study has several limitations. First, it relies exclusively on the Scopus database, thereby limiting coverage of relevant studies indexed in other databases. Second, the inclusion of only English- and Indonesian-language publications introduces a language bias. Third, the use of predefined keywords has restricted the retrieval of relevant studies. Fourth, review-type documents were excluded, which limits the comprehensiveness of theoretical perspectives. Finally, bibliometric analysis emphasizes publication and citation patterns, which do not fully capture the depth of pedagogical and conceptual nuances.

Credit authorship contribution statement

Fadilla Aisah Nurikhsani contributed to the study's conceptualization, research design development, data collection, data analysis, and drafting of the manuscript. **Wasino** contributed to supervision, refinement of the research framework, methodological guidance, and critical revision of the manuscript. **Eko Handoyo** contributed to supervision, data analysis, validation of findings, and review and editing of the manuscript. **Sarwi** supported the interpretation of results, provided methodological insights, and contributed to the final review of the manuscript.

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Declaration of competing interest
The authors declare that they have no financial or personal relationships that could be interpreted as influencing the impartiality of this research.

Data Availability Statement
The data supporting the findings of this study are available from the corresponding author upon reasonable request. The dataset consists of bibliographic records retrieved from the Scopus database and processed data generated during the systematic review and bibliometric analysis. Due to database licensing restrictions and to ensure transparency in the data selection process, the search strategy, inclusion criteria, and data extraction framework are fully described in the Methods section. All derived data used in the analysis can be provided by the authors for verification purposes.

Ethical Declaration
This study uses publicly available secondary data and does not involve human participants; therefore, ethical approval was not required.

Declaration of AI statement
Portions of this manuscript were refined with the assistance of an artificial intelligence tool, namely ChatGPT (OpenAI), primarily for improving language quality, grammar, and clarity of expression. The use of this tool was limited to editorial support and did not involve generating substantive scientific content, conducting data analysis, or interpreting results. All outputs generated by the AI were critically reviewed, revised, and validated by the authors. The authors retain full responsibility for the accuracy, integrity, and originality of the manuscript.

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