

Knowledge Mapping and Evolution of Research on Curriculum Reform in Design Education: A Bibliometric Study (2006–2026)

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ABSTRACT

Against the backdrop of global higher education transformation and the restructuring of paradigms in the design industry, curriculum reform in design education has evolved from localized exploration into an important branch of design research. This study aims to systematically examine the knowledge structure, research hotspots, and thematic evolution of this field over the past two decades, providing theoretical support for future teaching practice. Using the Web of Science Core Collection as the data source, this study retrieved and screened 668 core publications published between 2006 and 2026. CiteSpace (6.2.R4) was employed to conduct analyses of co-cited references, keyword co-occurrence and clustering, timeline mapping, and burst detection, thereby constructing a visualized knowledge map of the field. The results show that: (1) both the number of publications and citation frequency exhibit a continuous upward trend, entering a period of rapid growth after 2019, reflecting the high sensitivity of design education reform to socioeconomic transformation; (2) core research is mainly concentrated in the fields of architecture and education research, forming a stable knowledge base supported by professional competency assessment, systematic methodologies, and empirical case studies. The United States dominates research output, while China shows strong growth momentum as a second-tier contributor; (3) research themes have evolved from early focuses on basic skill instruction and studio-based models, to sustainable design and environmental responsibility, and further to digitalization, intelligent technologies, and student-centered approaches; and (4) burst detection indicates that Artificial Intelligence (AI), Virtual Reality (VR), educational equity, and interdisciplinary integration represent the current and emerging research frontiers. This study outlines the evolutionary trajectory of design curriculum reform research and identifies the dual driving forces of industry–education integration and intelligent teaching, providing references for future research directions and curriculum system optimization.

Keywords: design education; curriculum reform; bibliometric analysis; knowledge mapping; CiteSpace.

INTRODUCTION

In the contemporary higher education system, curriculum reform in design education has increasingly been driven by the dual forces of knowledge-economy transformation and the growing emphasis on sustainable development [1]. Since the beginning of the twenty-first century, the process of globalization has continued to deepen, and societal expectations for design professionals have gradually shifted from single skill-based training toward cultivating interdisciplinary talents equipped with systems thinking, social responsibility, and integrative capabilities across multiple fields [2]. In this context, design education has gradually moved away from the traditional model of “technical skill transmission” toward an approach that emphasizes environmental understanding, public value, and comprehensive decision-making abilities [3].

Existing studies have provided important theoretical and practical support for this transformation. For example, the green infrastructure framework proposed by Benedict and McMahon (2006) emphasizes the holistic relationship between ecosystems and human communities, offering a methodological reference for introducing systemic environmental thinking into design education [4]. Tanner (2008) revealed through empirical research that school spatial design has measurable effects on learning performance, suggesting that educational space itself can become an evaluable design object within curriculum systems [5]. Calkins (2012) systematically reviewed the principles of sustainable landscape construction, enabling environmental responsibility and technical knowledge to be transmitted in a structured manner through coursework [6]. These studies collectively indicate that reform in design education is not merely concerned with updating teaching tools but also involves reconstructing educational goals oriented toward sustainable governance capacities.

However, the advancement of curriculum reform cannot be achieved solely through conceptual shifts. Its effectiveness largely depends on the degree to which educators and learners accept new methods and paradigms. The disciplinary characteristics of design education make this process particularly complex. On the one hand, studio-based pedagogy emphasizes open-ended problem exploration and individual expression, and learning outcomes are often difficult to evaluate using standardized indicators. On the other hand, design learning relies heavily on visual thinking and situated practice, causing uniform reform models to produce differentiated effects across teaching contexts. Bar-Eli (2013), through research on variations in drawing behavior, pointed out that students exhibit significant individual cognitive pathways during the design process, indicating that foundational teaching reform should pay attention to the structure of learning processes [7]. Research by Umeda and Deitz (2011) on the influence of classroom intervention tools on learning behavior further suggests that spatial and media factors may directly affect learning performance [8]. D'Arcy (2013), examining the interiority of temporary urban spaces, emphasized that spatial education should be embedded within specific cultural contexts [9]. Therefore, curriculum reform in design education is not only a matter of technological updating but also involves the comprehensive restructuring of cognition, behavior, and social context.

On this basis, related studies have gradually expanded toward methodological support and cross-disciplinary problem orientations. Seidl and Golobic (2015) proposed a method for identifying agricultural land protection zones, providing structured tools for planning decisions [10]. Appler (2012) demonstrated the relationship between public participation and spatial production through municipal archaeology practices [11]. Aristizábal and Ortiz (2015) explored pathways for achieving synergy between social equity and environmental performance in low-income housing projects [12]. Meanwhile, interdisciplinary research design has increasingly become an important support for pedagogical innovation. The interdisciplinary research framework proposed by Tobi and Kampen (2018) provides methodological foundations for problem-oriented courses addressing complex issues [13]. Ahern et al. (2016) further expanded the problem boundaries of design education through studies on cross-sector planning approaches [14].

In addition, the development of digital technologies has provided new teaching media for curriculum reform in design education. Al-Qawasmi et al. (2010) explored the application potential of e-learning in environmental design education [15]. Nytsch-Geusen and Mathur (2020) developed virtual reality interactive environments to support the understanding of spatial performance [16]. Bayir and Kiliç (2025) introduced augmented reality technology into interior architecture education to improve learning outcomes related to building systems [17]. At the same time, research on learning support mechanisms has continued to deepen. Matthews and Lippman (2020) examined evaluation methods for educational space design [18]; Smith and Lilly (2020) discussed student stress in creative courses [19]; López-León (2020) emphasized the role of feedback mechanisms in promoting critical thinking [20]; and Acar (2020) supported diagnostic teaching at the entry level from the perspective of cognitive ability assessment [21].

In recent years, design education research has further expanded toward issues of equity and inclusiveness. Ghaziani (2021) highlighted the value of participatory design processes in educational spaces [22]. Song (2023) proposed the concept of restorative design pedagogy [23]. Niu and Zhong (2022) explored environmental education spaces from the perspective of behavioral intervention [24]. Alhusban et al. (2022) examined the potential impacts of the COVID-19 pandemic on the future of design education [25]. Patel et al. (2022) developed prototype classrooms for special-

needs education to address learning diversity [26]. Tekin et al. (2025) summarized trends in biophilic design, providing a framework for health-oriented curricula [27].

Overall, existing studies have advanced the development of design curriculum reform from multiple perspectives. However, relevant findings remain dispersed across different topics and methodological systems, and a systematic overview of the overall knowledge structure is still lacking. With the continuous growth of literature, traditional reviews—often relying on qualitative analyses based on document interpretation and periodic summaries—lack sufficient objectivity and comprehensiveness. Therefore, it is necessary to introduce reproducible knowledge-mapping methods to conduct structured analyses of research networks. Accordingly, this study adopts bibliometric methods [28] to systematically analyze research articles related to curriculum reform in design education published in the Web of Science Core Collection between 2006 and 2026. The purpose is to understand the core issues and evolutionary trends in this field and to provide valuable references for future research. Specifically, this study addresses the following research questions:

RQ1: What are the overall dynamics of research on curriculum reform in design education from 2006 to 2026? Which major journals and disciplinary fields have published relevant studies?

RQ2: How are research contributions distributed across countries and institutions?

RQ3: What constitutes the knowledge base and key literature of research on curriculum reform in design education, and how have research themes evolved over time?

RQ4: What are the current research hotspots, emerging frontiers, and future directions in this field?

METHODS AND MATERIALS

Research Method

Bibliometrics, as an important quantitative research method, has been widely applied in recent years to analyze disciplinary development trends and to clarify knowledge structures [29,30]. With the assistance of specialized software tools, researchers can conduct visual analyses of large-scale bibliographic data, clearly presenting the relational networks among knowledge entities and their dynamic evolution, thereby uncovering the underlying knowledge structures and internal patterns of a research field [31]. This research approach not only helps to understand the overall development status and future directions of a specific field, but also enhances the objectivity and reliability of research conclusions through data support.

Among various bibliometric tools, CiteSpace has been widely favored by scholars because of its strong capabilities in temporal visualization and knowledge mapping [32]. The software runs on the Java platform and integrates multiple analytical methods, including co-citation analysis, keyword co-occurrence analysis, and burst detection, which can effectively reveal the evolutionary trajectory, research hotspots, and frontier trends of a knowledge domain. In particular, the timeline visualization function can intuitively display the longitudinal development of research themes, while burst detection helps identify emerging research trends. The combination of these two functions provides strong support for identifying different stages of disciplinary development and capturing frontier research topics [33,34].

Based on the above considerations, this study adopts CiteSpace (Version 6.2.R4) as the main analytical tool, supplemented by in-depth interpretation of literature content. By combining quantitative statistical analysis with qualitative interpretation, this study systematically analyzes the knowledge mapping and evolutionary logic of research on curriculum reform in design education from 2006 to 2026.

Data Source

Web of Science (WoS) is a comprehensive citation database widely recognized in the international academic community, indexing high-quality research outputs that have undergone rigorous peer review [35,36]. To ensure the authority and comparability of the data, this study selected the Web of Science Core Collection (WoSCC) as the data source, covering the Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI), and Arts &

Humanities Citation Index (A&HCI). In this study, the Topic (TS) field was used for retrieval, with the following search query:

TS = (“design education” OR “design curriculum” OR “design pedagogy” OR “design teaching reform” OR “curriculum reform”)

The time span was limited to 2006–2026, the document types were restricted to Article and Review, and the language was limited to English. All data were retrieved and exported in a single batch on January 1, 2026, in order to avoid differences caused by dynamic database updates.

The initial search yielded 1,471 publications. According to the predefined screening criteria, the following document types were excluded: Proceeding Paper (n = 550), Early Access (n = 50), Retracted Publication (n = 10), Editorial Material (n = 5), Meeting Abstract (n = 1), Open Publisher-invited Reviews (n = 3), and Enriched Cited References (n = 184), resulting in a total exclusion of 803 records. Finally, 668 publications were included as valid samples for the bibliometric analysis. The process of literature identification and screening is illustrated in Figure 1.

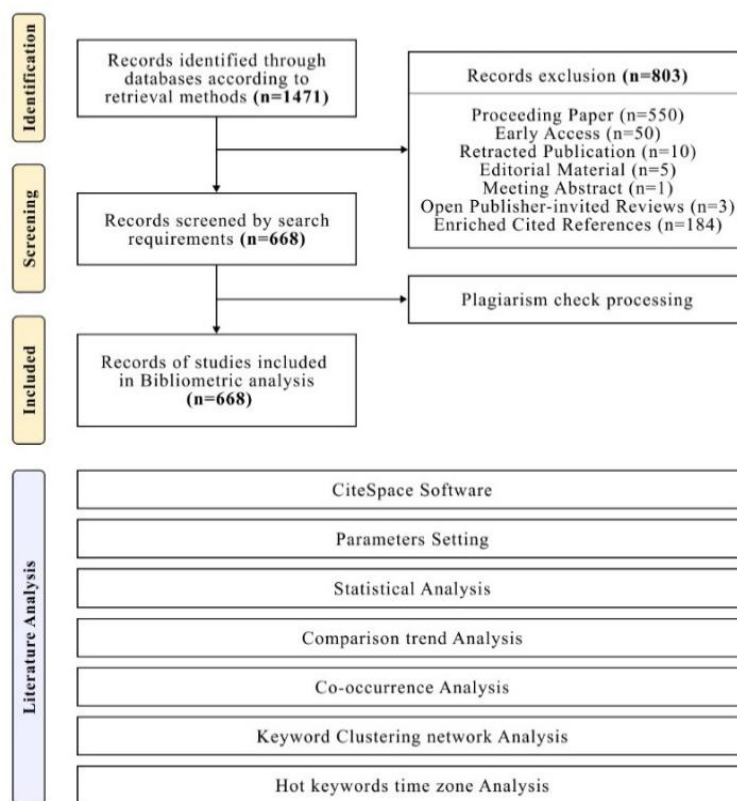


Figure 1. Literature Screening Process and Bibliometric Analysis Framework for Research on Curriculum Reform in Design Education

Data Standardization

The raw data exported from WoS often contain inconsistencies in the fields of authors, institutions, and keywords, such as spelling variations, the coexistence of abbreviations and full names, or different expressions referring to the same entity. If left untreated, these inconsistencies may lead to the fragmentation of network nodes and affect the stability of bibliometric results [37]. Therefore, data standardization was conducted prior to formal analysis [38].

(1) Author and institution standardization. Different spellings and abbreviations of author names were unified. For authors with identical names, manual verification was conducted by referring to their institutional affiliations. Institutional names, including full names, abbreviations, and historical name changes, were unified into standardized expressions to ensure the accuracy of collaboration network analysis [39].

(2) Journal name unification. The full names, abbreviations, and possible name changes of journals were standardized to avoid bias in source statistics.

(3) Keyword cleaning. Generic terms with low relevance to the research topic were removed; semantically similar expressions were merged; and capitalization as well as singular and plural forms were standardized to reduce redundant nodes and improve clustering clarity [40].

After standardization, the dataset was imported into CiteSpace for subsequent analyses of co-occurrence, clustering, and temporal evolution.

RESULTS

Overall Development Trend of Publication Output and Citation Characteristics

Table 1 presents the basic bibliometric characteristics of research on curriculum reform in design education from 2006 to 2026. The study covers a period of 20 years and includes 668 valid publications, involving 388 journals, 1,918 authors, 1,442 institutions, and 270 countries or regions, indicating that this research field has formed a relatively extensive international research network. In terms of citation characteristics, the sample publications contain 29,013 references, with a total of 8,450 citations, an H-index of 43, an average of 12.65 citations per article, and 422.5 citations per year on average. These indicators suggest that the field has gradually accumulated a relatively stable academic influence over the past two decades.

Table 1. Descriptive bibliometric characteristics of design curriculum reform research (2006–2026)

Description	Results	Description	Results
Timespan	2006–2026	References	29,013
Articles	668	Citing Articles	8,094
Journals	388	Citations	8,450
Authors	1,918	Average Citations Per Year	422.5
Institutions	1,442	Average Per Item	12.65
Countries	270	H-index	43

From the perspective of temporal evolution (see Figure 2), research output in this field shows clear stage-based growth characteristics. The period 2006–2012 represents a relatively slow development stage, during which the annual number of publications remained around ten and the field was still in an exploratory phase. From 2013 to 2018, the field entered a stage of steady growth, with the number of publications increasing year by year. After 2015, the annual number of publications consistently exceeded 30, indicating that the research topic had gradually attracted greater scholarly attention. After 2019, the growth trend accelerated significantly. In particular, between 2021 and 2024, the number of publications reached a peak, with more than 60 publications per year, suggesting that curriculum reform in design education has become an important direction in design education research.

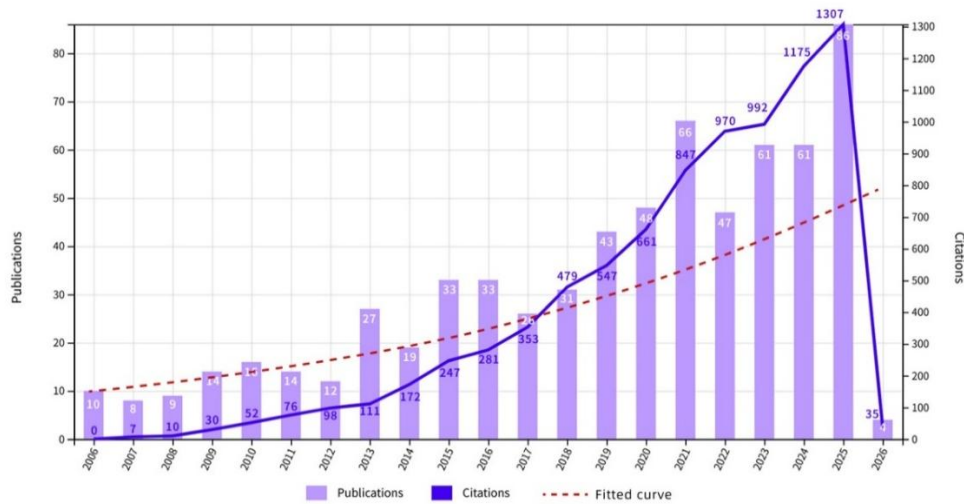


Figure 2. Annual Publication Output and Citation Trends of Research on Curriculum Reform in Design Education (2006–2026)

In terms of citation trends, the cumulative number of citations shows a continuous upward trajectory and has increased significantly in the past five years, indicating that early research has gradually formed an academic accumulation effect. The fitted trend line shows a linear upward pattern in overall citation growth, reflecting the steady expansion of academic influence in this field. The noticeable decline in 2026 is mainly due to the fact that the data for that year have not yet been fully recorded, and therefore does not affect the overall assessment of the development trend.

Overall, research on curriculum reform in design education has experienced a developmental process from initial exploration to rapid expansion. Both research output and academic influence have shown continuous growth, indicating that this field has gradually evolved from a marginal topic into an important branch of design education research.

Distribution Characteristics of Disciplines and Core Research Entities

Table 2 presents the main distribution patterns of research on curriculum reform in design education in terms of disciplinary categories, journal sources, countries, and institutions.

From the perspective of disciplinary categories, Architecture (124 publications) and Education & Educational Research (103 publications) rank first and second, respectively, indicating that research in this field mainly relies on the two core knowledge domains of architecture and education. Environmental Studies (67 publications) and Environmental Sciences (64 publications) follow closely, suggesting that environmental and sustainability-related issues occupy an important position in curriculum reform research. The inclusion of categories such as Green & Sustainable Science & Technology and Construction & Building Technology among the top ten further reflects the increasing prominence of technological and sustainability-oriented topics within the research themes.

In terms of journal distribution, Sustainability ranks first with 19 publications, followed by the Journal of Interior Design with 16 publications, while Archnet-IJAR and the International Journal of Art & Design Education each published 14 articles. Among the top ten journals, Q1 and Q2 journals account for the majority, indicating that research in this field has been consistently published in academic platforms with a certain level of international influence. The journal types cover design, architecture, and education, which is consistent with the disciplinary distribution structure.

Regarding national distribution, the United States ranks first with 201 publications, nearly three times that of China (70 publications), which ranks second. Australia (41 publications), Canada (36 publications), and the United Kingdom (32 publications) form the second tier. Overall, research output is mainly concentrated in North America

and English-speaking countries. It is worth noting that Turkey (26 publications) and Turkiye (23 publications) both appear in the top ten, reflecting differences in the representation of country names within the database.

At the institutional level, U.S. university systems dominate the rankings. Institutions such as the University System of Georgia (70 publications), Michigan State University (41 publications), and the Pennsylvania Commonwealth System of Higher Education (36 publications) rank among the top positions, indicating a clear pattern of systematic concentration in research output. Delft University of Technology (23 publications) represents European universities among the top ten institutions.

Overall, the results shown in Table 2 indicate that this field presents a structural pattern characterized by architecture and education as core disciplinary foundations, the United States as the primary research center, and the continuous expansion of sustainability- and technology-related topics.

Table 2. Multidimensional distribution of major contributors (Top 10)

Rank	WoS Category	Records	Journal	Pub.	JCR	Country	Pub.	Institution	Pub.
1	Architecture	124	Sustainability	19	Q2	USA	201	State University System of Florida	11
2	Education Educational Research	103	Journal of Interior Design	16	Q1	China	70	University System of Georgia	70
3	Environmental Studies	67	Archnet-IJAR International Journal of Architectural Research	14	Q1	Australia	41	Michigan State University	41
4	Environmental Sciences	64	International Journal of Art & Design Education	14	Q2	Canada	36	Pennsylvania Commonwealth System of Higher Education PCSHE	36
5	Green Sustainable Science Technology	42	Interiors-Design Architecture Culture	12	Q4	England	32	University System of Ohio	32
6	Construction Building Technology	37	International Journal of Technology and Design Education	8	Q2	South Korea	28	Arizona State University	28
7	Engineering Civil	36	Journal of Asian Architecture and Building Engineering	8	Q1	Turkey	26	Arizona State University Tempe	26

8	Public Environmental Occupational Health	36	Journal of Green Building	8	Q2	Germany	23	Pennsylvania State University	3	2
9	Art	33	Land	8	Q2	Spain	23	University of North Carolina Delft	3	2
10	Education Scientific Disciplines	31	Landscape Journal	8	Q1	Turkiye	23	University of Technology	3	2

Co-citation Analysis of References

To reveal the knowledge base and thematic structure of research on curriculum reform in design education, this study conducted a reference co-citation analysis of the sample literature using CiteSpace, and constructed a reference co-citation network (Fig. 3) and reference co-citation clusters (Fig. 4). The analysis covers the period 2006–2026, with a time slice of one year, the node type set as Cited Reference, and the threshold selected as g-index (k = 25).

The co-citation network contains 106 nodes and 1,121 links, with a network density of 0.0044. The modularity value Q is 0.9465, and the weighted mean silhouette value S is 1.000. According to the evaluation criteria of CiteSpace, when $Q > 0.3$, the network is considered to have a significant clustering structure, while $S > 0.7$ indicates high reliability of the clustering results. Therefore, the co-citation network obtained in this study demonstrates a clear structural division and high clustering consistency.

As shown in the co-citation network structure (Fig. 3), several publications exhibit relatively high connectivity within the network and form important knowledge nodes. Among them, Steinitz C (2020) occupies a central position in the network and shows strong co-citation relationships with multiple publications. In addition, Aydin S (2020), Chang YS (2020), Thompson J (2021), Page Matthew J (2021), and Shen XW (2023) also demonstrate relatively high levels of network connectivity [41–45]. These core publications mainly address research topics such as design education methods, environmental design practice, and curriculum evaluation, and to a certain extent constitute an important knowledge base for this research field [46].

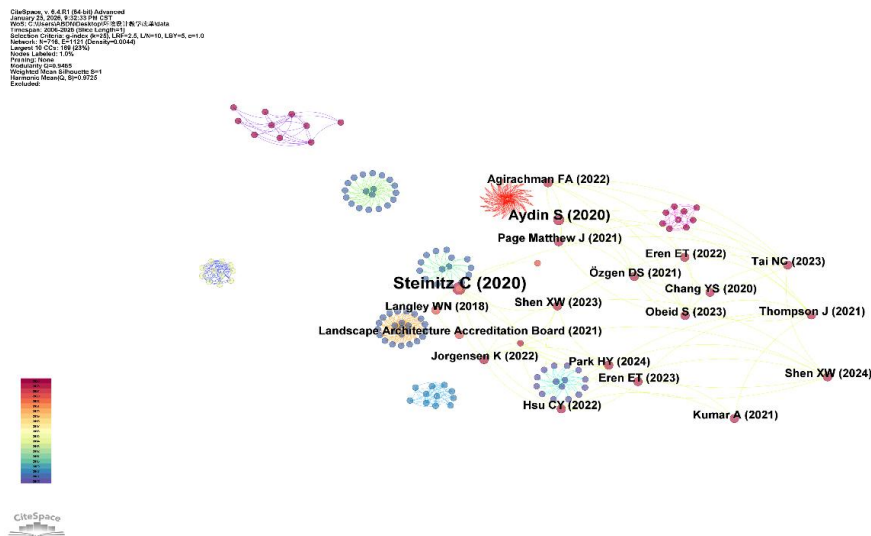


Fig. 3 Reference co-citation network generated by CiteSpace

Based on the co-citation network, CiteSpace further generated a clustering structure (Fig. 4). The results identify 10 major clusters, namely #0 road, #1 greening, #2 professional education, #3 case study, #4 guadalajara, #5 evaluation, #6 systems approach, #7 indoor air quality, #8 principle, and #9 community driver. Among them, #2 professional education is the largest cluster, indicating that professional education systems and curriculum structures constitute an important theme in current research. Meanwhile, clusters such as #0 road and #1 greening reflect the significance of environmental design and urban spatial issues in design curriculum research, whereas clusters such as #5 evaluation and #3 case study demonstrate the frequent application of curriculum evaluation and case study approaches in related studies. Overall, the clusters are interconnected through multiple co-citation relationships and collectively constitute the main knowledge structure of research on curriculum reform in design education.

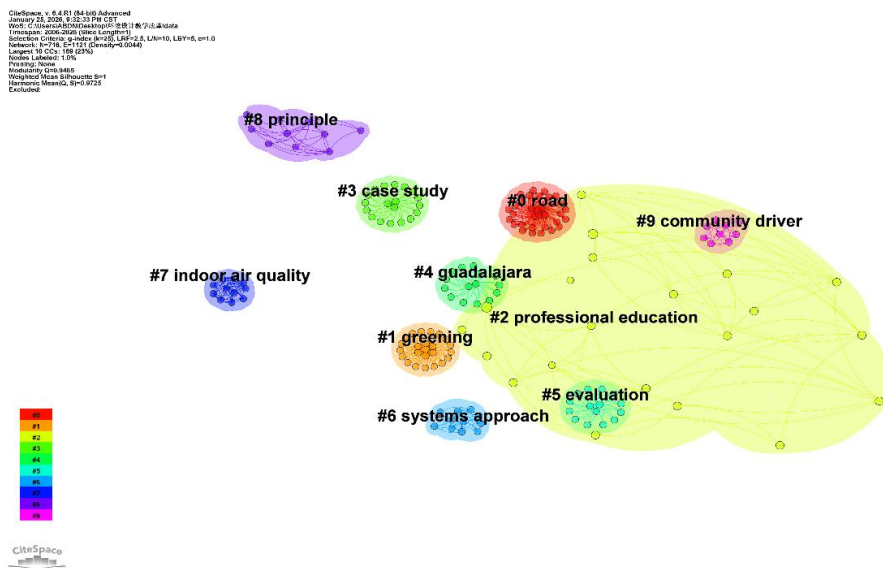


Fig. 4 Reference co-citation clustering map generated by CiteSpace

Keyword Clustering and Identification of Research Hotspots

To identify the research hotspots and keyword structure of curriculum reform in design education, this study conducted a clustering analysis of keywords using CiteSpace, generating a keyword clustering map (Fig. 5) and calculating the frequency and centrality of keywords (Table 3). The analysis covers the period 2006–2026, with a time slice of one year, and the threshold set to g-index (k = 25).

From the overall network characteristics, the keyword network contains N = 505 nodes and E = 1,316 links, with a network density of 0.0103. The clustering quality indicators show a modularity value Q = 0.6501 and a weighted mean silhouette value S = 0.8795. These results indicate that the keyword network has a relatively clear clustering structure and high clustering consistency, suggesting that the results have good interpretability.

As shown in Fig. 5, keyword clustering forms several relatively stable thematic clusters, mainly including #0 higher education, #1 landscape design, #2 landscape architecture, #3 education, #4 mixed integer linear programming, #5 environmental design, #6 design education, #7 socio-emotional development, #8 sustainable forestry initiative, and #11 incidental captures. Overall, these clusters can be summarized into three categories of research themes. The first category includes education system and curriculum reform topics represented by #0 higher education, #3 education, and #6 design education. The second category includes disciplinary directions and practical contexts represented by #1 landscape design, #2 landscape architecture, and #5 environmental design. The third category includes methodological and model-oriented topics represented by #4 mixed integer linear programming.

To further verify the keyword support for research hotspots, Table 3 presents the keywords with high frequency and centrality. Ranked by frequency, design (43), education (32), interior design (32), performance (28), landscape architecture (25), and impact (22) rank among the top positions. This indicates that research attention mainly focuses on the implementation effects and impact evaluation of curricula within the context of design education, and further

extends to subfields such as interior design and landscape architecture. Ranked by centrality, design (0.25), impact (0.21), and performance (0.16) exhibit relatively high betweenness centrality, suggesting that these keywords play stronger connecting roles between different research themes. At the same time, keywords such as education (0.11), landscape design (0.11), and behavior (0.11) show bridging characteristics across themes.

Taken together, Fig. 5 and Table 3 demonstrate a strong consistency between keyword clusters and core keywords in terms of thematic orientation. The major research hotspots mainly revolve around the curriculum reform framework of higher education / education / design education, and are closely intertwined with disciplinary directions such as landscape design / landscape architecture / environmental design / interior design, while also incorporating evaluation-oriented themes represented by impact and performance, as well as method-oriented topics.

Table 3. Top 10 keywords by frequency and centrality

Rank	Keyword	Frequency	Rank	Keyword	Centrality
1	design	43	1	design	0.25
2	education	32	2	impact	0.21
3	interior design	32	3	performance	0.16
4	performance	28	4	education	0.11
5	landscape architecture	25	5	landscape design	0.11
6	impact	22	6	behavior	0.11
7	design education	20	7	children	0.1
8	landscape design	19	8	landscape architecture	0.09
9	built environment	16	9	interior design	0.08
10	children	15	10	city	0.07

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 Web: C:\Users\user\Desktop\图5\图5\data
 Language: zh-CN (China)
 Algorithm: CF (Centrality Modularity Q=0.9812, L=0.1, M=0.1, LB=0, LU=0, EE=0)
 Network: N=505, E=1319 (Density=0.0125)
 Labels: L (CF= 360 (71%))
 Nodes Labeled: 1.0%
 Pruning: None
 Modularity Q=0.9812
 Weighted Mean Silhouette S=0.8795
 Harmonic Mean(Q, S)=0.7476
 Excluded:

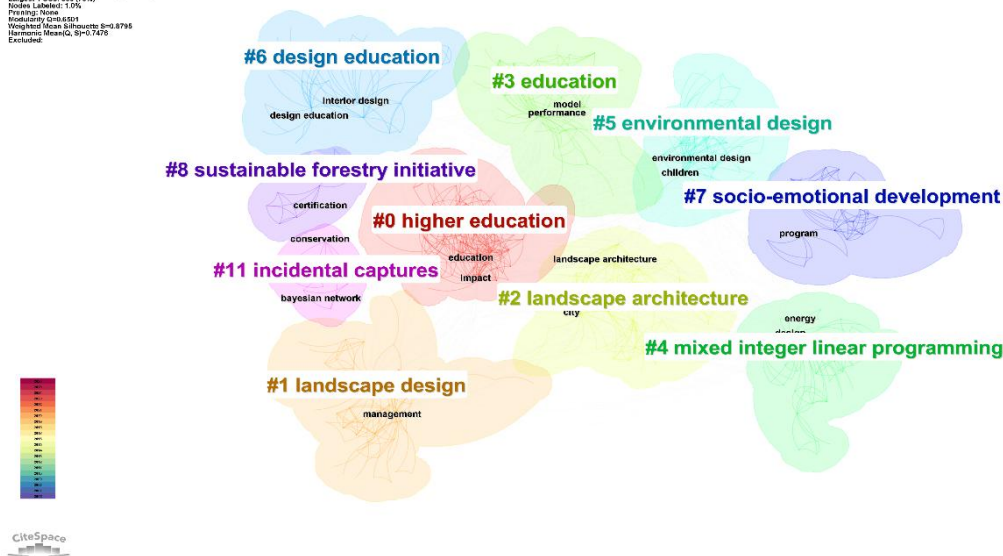


Figure 5. Keyword clustering map of teaching reform research in design disciplines

Temporal Evolution of Research Hotspots

To further reveal the evolutionary process of research hotspots in curriculum reform in design education, this study generated a keyword time-zone map (Fig. 6) using CiteSpace. The map displays the emergence and evolution paths of keywords along a temporal sequence, where the node size represents the frequency of keyword occurrence, and the node color indicates the time of appearance. Keywords from different years form developmental trajectories of research themes through co-occurrence relationships [47].

From the overall evolutionary trend, early studies (approximately 2006–2012) mainly focused on core disciplinary keywords such as design, interior design, landscape architecture, and landscape design, and gradually extended to teaching- and practice-related topics such as environmental design, design education, and built environment. During the period 2013–2018, research themes began to expand toward environmental and sustainability-related issues. Keywords such as biodiversity conservation, sustainability, physical activity, and health gradually appeared and were connected with studies on teaching models such as design studio and active learning. In recent years (approximately 2019–2026), the keyword network has further expanded toward educational innovation and technological applications. Keywords such as design pedagogy, augmented reality, professional development, and interior architecture education have gradually emerged, indicating that research on curriculum reform in design education is increasingly focusing on digital technologies, professional competence development, and future educational models [48].

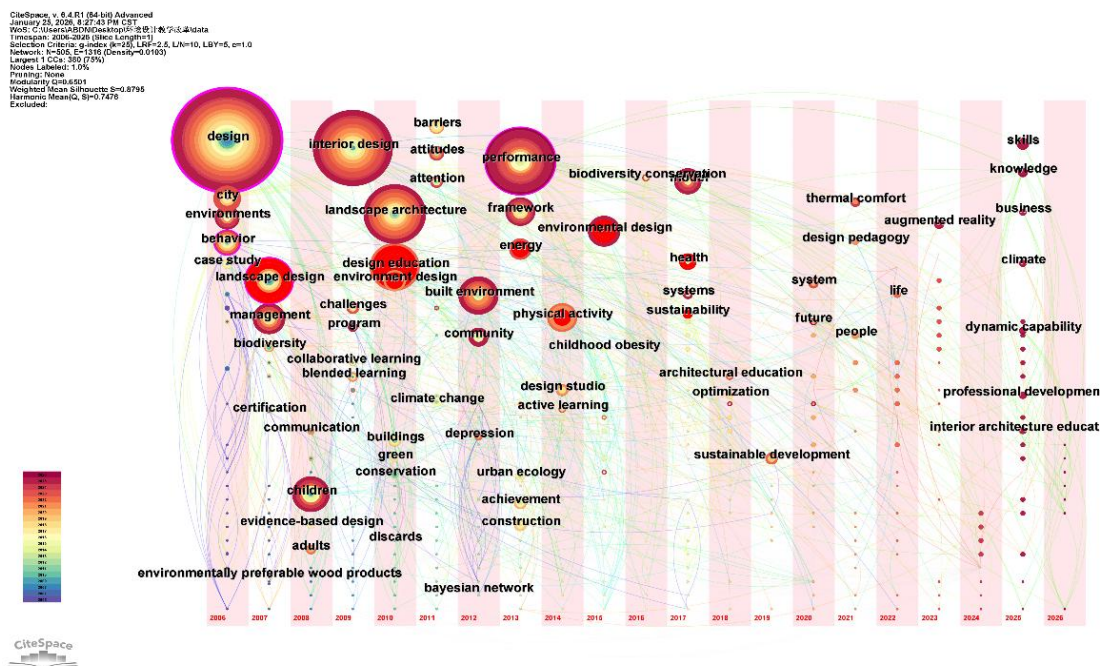


Fig.6 Keyword time-zone map of teaching reform research in design disciplines

Evolution of Research Themes and Emerging Trends

To further reveal the evolutionary pathways and emerging trends of research themes in curriculum reform in design education, this study conducted a combined analysis of the keyword timeline map (Fig. 7) and keyword citation bursts (Fig. 8) to examine the temporal distribution and burst characteristics of keywords. Figure 7 presents the developmental trajectories of different research themes over time based on keyword clustering results, including major clusters such as #0 higher education, #1 landscape design, #2 landscape architecture, #3 education, #4 mixed integer linear programming, #5 environmental design, and #6 design education. From the temporal distribution, early studies mainly focused on foundational disciplinary topics such as design, education, landscape design, and interior design, and gradually extended to design practice-related topics such as environmental design and built environment. Subsequently, some studies began to introduce teaching approaches and sustainability-related topics

such as active learning, design studio, and sustainability, indicating that research themes gradually expanded from disciplinary foundations to teaching practice and environmental issues.

Meanwhile, the keyword burst results shown in Fig. 8 further reveal the changing trends of research frontiers. During the period 2006–2026, a total of 15 keywords exhibited significant citation bursts. Among them, environmental design (strength = 4.5), design education (3.39), and energy (3.43) demonstrated relatively strong burst intensity in different periods, reflecting sustained scholarly attention to environmental design and design education topics. In recent years (2023–2026), burst keywords include technology, higher education, students, and artificial intelligence, indicating that current research frontiers are gradually shifting toward digital technology applications, innovation in educational models, and the development of design education in the context of artificial intelligence.

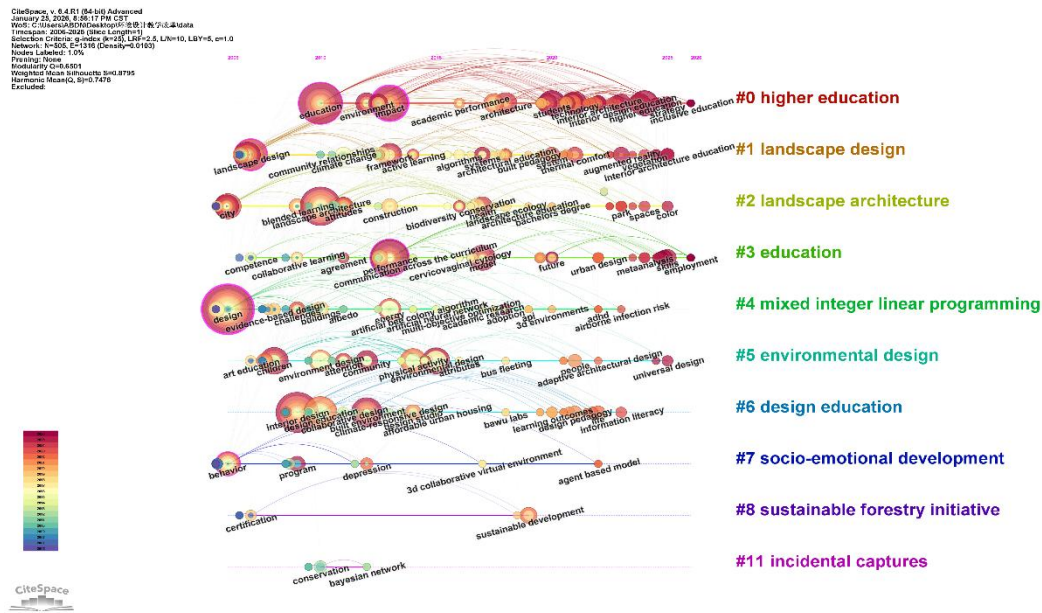


Fig.7 Keyword timeline map of environmental design teaching reform research (2006–2026)

Top 15 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2006 - 2026
energy	2013	3.43	2013	2016	[Timeline bar with red burst segment]
design education	2010	3.39	2013	2021	[Timeline bar with red burst segment]
physical activity	2014	3.88	2014	2015	[Timeline bar with red burst segment]
environmental design	2015	4.5	2015	2018	[Timeline bar with red burst segment]
environment design	2010	3.35	2015	2016	[Timeline bar with red burst segment]
sustainability	2017	2.39	2017	2018	[Timeline bar with red burst segment]
spatial design	2018	2.86	2018	2022	[Timeline bar with red burst segment]
architecture	2018	2.37	2020	2024	[Timeline bar with red burst segment]
perceptions	2021	3.01	2021	2022	[Timeline bar with red burst segment]
technology	2021	2.34	2021	2026	[Timeline bar with red burst segment]
landscape design	2007	3.4	2023	2024	[Timeline bar with red burst segment]
health	2017	2.41	2023	2024	[Timeline bar with red burst segment]
higher education	2024	4.78	2024	2026	[Timeline bar with red burst segment]
students	2020	3.38	2024	2026	[Timeline bar with red burst segment]
artificial intelligence	2024	3.2	2024	2026	[Timeline bar with red burst segment]

Fig.8 Top 15 keywords with the strongest citation bursts (2006–2026)

DISCUSSION

General Discussion

Based on the results of the bibliometric analysis, research on curriculum reform in design education from 2006 to 2026 demonstrates clear evolutionary characteristics. From multiple dimensions—including overall development trends, patterns of research contribution, knowledge foundations, and research themes—the field has gradually formed a research framework centered on digital design education, practice-oriented teaching, and the development of interdisciplinary curriculum systems. Combined with existing studies, the development of this field can be comprehensively discussed from the perspectives of research dynamics, academic contributions, knowledge foundations, and research frontiers.

First, in terms of overall research dynamics, studies on curriculum reform in design education show a continuous growth trend. This phenomenon is closely related to global higher education reform and the transformation of the design industry structure. As a highly practice-oriented discipline, environmental design requires its curriculum system to continuously adapt to changes in social demand and industrial development. Previous studies have pointed out that traditional environmental design curricula often place excessive emphasis on the transmission of theoretical knowledge, while practical teaching components remain relatively insufficient, which to some extent affects the cultivation of students' design competence and professional capabilities. Consequently, in recent years increasing attention has been given to the optimization of curriculum structures and the innovation of practice-oriented teaching models [49]. Meanwhile, as the demand for interdisciplinary design talents continues to increase, universities have begun to explore more open and diversified teaching models, such as project-based practice, case-based teaching, and studio-based instruction, in order to enhance students' comprehensive abilities [50]. These studies collectively indicate that design education is gradually transforming from a traditional classroom-based teaching model to a more practice-oriented educational system.

Second, in terms of the pattern of research contributions, studies on curriculum reform in design education show a certain regional concentration. Universities in China have made particularly notable contributions in this field, which is closely related to the increasing emphasis placed on the cultivation of applied talents within China's higher education system in recent years. With the rapid development of the design industry, environmental design programs have expanded quickly in Chinese universities, and the corresponding curriculum systems and teaching models have undergone continuous adjustments. Some studies have suggested that, in the context of the information age, environmental design education needs to improve talent cultivation through updating course content, integrating digital technologies, and strengthening university–industry collaboration, thereby better adapting to the needs of social development [51]. In addition, several studies emphasize that, under the current transformation of higher education, deepening industry–education integration can effectively strengthen the connection between universities and industry, thereby improving students' practical abilities and employment competitiveness [52]. Therefore, from the perspectives of countries and institutions, the development of research on curriculum reform in design education not only reflects changes in academic interests but also demonstrates how different educational systems explore new approaches to talent cultivation.

Third, regarding the evolution of the knowledge base and research themes, research on curriculum reform in design education has gradually shifted from studies focusing on single teaching models to multidisciplinary integration. Early research mainly concentrated on improving design course structures and teaching methods, whereas recent studies increasingly focus on the integration of digital technologies and design education. For example, some studies propose constructing new design curriculum systems by integrating environmental protection concepts with big data technologies, thereby promoting interdisciplinary development in design education [53]. Meanwhile, with the widespread application of digital technologies in the design industry, computer-aided design software has gradually become an important tool in environmental design teaching. Related research indicates that introducing digital technologies into design courses can not only enhance students' design expression abilities but also help them better understand spatial structures and design logic, thereby improving teaching effectiveness [54]. These studies collectively constitute an important knowledge foundation for contemporary reform in design education.

Finally, in terms of research hotspots and future development directions, studies on curriculum reform in design education are gradually moving toward a more diversified and integrative orientation. Topics such as digital teaching models, innovation and entrepreneurship education, and cultural heritage integration have gradually become emerging research focuses. For instance, some studies point out that, in the context of the rapid development of digital and intelligent technologies, universities can promote innovation in design talent cultivation models through digitally empowered education, integrating digital technologies, design practice, and innovation-oriented education to cultivate design professionals with comprehensive capabilities [55]. In addition, some studies approach design education from the perspective of regional culture, emphasizing the integration of local cultural resources into environmental design courses in order to enhance students' cultural identity and social responsibility [56]. These studies suggest that future curriculum reform in design education should not only focus on the development of technical skills but also take into account cultural values and social needs.

Overall, research on curriculum reform in design education over the past two decades has undergone a transition from reflection on teaching models to digitalization and interdisciplinary integration. With the continued development of digital technologies and the design industry, research in this field is expected to further deepen in areas such as intelligent design education, interdisciplinary curriculum systems, and practice-oriented teaching.

Research Contributions

Compared with previous studies on design education reform, existing research has mainly focused on case analyses of single teaching models or specific curriculum practices, while lacking systematic analyses of the overall research structure and development trends. For example, some studies mainly examine teaching reform in environmental design programs from the perspective of curriculum practice. By analyzing specific cases such as practical teaching, innovation and entrepreneurship education, or studio-based teaching models, these studies propose corresponding strategies for improving teaching methods [57]. Similarly, other studies focus on the reform of foundational courses in environmental design, emphasizing the introduction of new teaching methods and educational concepts into the curriculum system in order to enhance students' practical design abilities [58]. In addition, some research approaches design education reform from a broader perspective of professional education, discussing the challenges faced by environmental art and design education in practical teaching and talent cultivation, and proposing corresponding reform strategies [59]. Although these studies provide valuable practical insights into design education reform, they are largely based on case studies and experiential summaries, and therefore lack systematic analyses at the macro level.

In contrast, this study provides a systematic review of research on curriculum reform in design education from 2006 to 2026 from a bibliometric perspective, offering new academic contributions in terms of research perspective, methodology, and findings. First, in terms of research perspective, this study goes beyond the limitations of single case studies and systematically analyzes the development dynamics and knowledge structure of research on curriculum reform in design education from the perspective of the overall literature structure, thereby revealing the academic evolution of this field. Second, in terms of research methodology, this study combines bibliometric analysis with visualized knowledge mapping methods to systematically examine research hotspots, knowledge foundations, and thematic evolution, providing a new methodological approach for understanding the development of design education research. Finally, in terms of research findings, this study not only identifies the major developmental stages of research on curriculum reform in design education, but also reveals important research directions such as digital design education, industry–education integration, and interdisciplinary curriculum systems, providing valuable references for future research.

Therefore, compared with previous studies that mainly summarize teaching practice experiences, this study systematically reveals the overall developmental landscape of research on curriculum reform in design education at a macro level, offering a new academic perspective for understanding the research structure and future development directions of this field.

Research Limitations

Although this study employed CiteSpace to systematically review research on curriculum reform in design education from 2006 to 2026, several limitations remain due to objective constraints.

First, the limitation of a single data source: this study primarily relies on the Web of Science Core Collection. Although this database is highly authoritative, design studies are a practice-oriented discipline, and many frontier teaching cases, industry reports, and conference papers in art and design may be scattered across other databases such as Scopus, the Avery Index, or databases with specific disciplinary contexts. Future research could incorporate multi-source data integration to capture a more comprehensive global landscape of design education.

Second, the lag in keyword analysis: bibliometric analysis depends on keywords provided by authors. In design-related disciplines, emerging concepts often require time to stabilize as commonly used keywords. Consequently, knowledge mapping based on keywords may not immediately capture the most recent teaching experiments or micro-level innovations. Future studies could incorporate full-text semantic mining to address this limitation.

Third, the ambiguity of disciplinary boundaries: curriculum reform in design education often intersects deeply with disciplines such as architecture, computer science, and sociology. Although this study identifies certain interdisciplinary characteristics, further exploration is needed to understand how non-design disciplines may in turn reshape the logic of design education.

Finally, the need for deeper qualitative interpretation: knowledge mapping methods are effective in revealing structural relationships, but when interpreting the underlying educational philosophy behind curriculum reform, additional qualitative approaches—such as grounded theory or expert interviews—may be necessary to provide deeper insights.

CONCLUSION

This study conducted a systematic analysis of research on curriculum reform in design education from 2006 to 2026 based on bibliometric and knowledge mapping methods, using data retrieved from the Web of Science database. Through CiteSpace (Version 6.2.R4), analyses were performed on publication and citation trends, disciplinary and source distributions, clustering structures, keyword co-occurrence, as well as temporal evolution and burst detection. At a macro level, this study outlines the research dynamics, knowledge foundations, thematic structures, and emerging trends in this field. The main conclusions are summarized as follows.

(1) The research scale has continuously expanded, entering an accelerated development stage after 2019.

Both the annual number of publications and the cumulative citation trend indicate that research on curriculum reform in design education showed steady growth between 2006 and 2026, with a noticeable acceleration after 2019. This suggests that the topic has gradually evolved from early exploratory studies into an important direction in design education research and has generated a sustained accumulation of knowledge.

(2) The field demonstrates clear interdisciplinary characteristics, with well-defined disciplinary and journal source structures.

The distribution of subject categories shows that research mainly relies on the core domains of Architecture and Education & Educational Research, while also intersecting with related categories such as environmental studies, sustainability, and the built environment. Journal sources display a multi-platform structure, with research findings consistently published in international journals related to design, architecture, and education, reflecting the dissemination and convergence of curriculum reform research across different academic communities.

(3) Contributions from countries and institutions exhibit a concentrated pattern, with the international research network dominated by several core regions.

At the national level, the United States holds a leading position in both publication output and research influence, while China forms the second tier. Several English-speaking countries and European universities also maintain stable research outputs in this field. At the institutional level, a pattern of systematic concentration can be observed, indicating that research on curriculum reform in design education demonstrates both global diffusion and relatively concentrated research centers.

(4) The knowledge base shows a clear clustering structure, with thematic evolution shifting from “curriculum/professional education frameworks” toward “technology-driven and learner-oriented approaches.”

The co-citation network and clustering results reveal that the field has developed a clearly structured knowledge base, forming relatively stable thematic clusters such as professional education, evaluation, case study, and systems approach. Keyword clustering results indicate that research hotspots consistently revolve around the curriculum reform framework of higher education / education / design education, and are closely linked with disciplinary areas such as landscape design, landscape architecture, environmental design, and interior design. At the same time, evaluation-oriented keywords such as impact and performance play connecting roles across themes. Temporal evolution and burst detection analyses further show that recent research frontiers increasingly emphasize topics such as technology, students, and artificial intelligence, indicating that curriculum reform in design education is rapidly extending toward digitalization, intelligent technologies, and learner-centered outcomes.

Overall, from the perspective of knowledge mapping, this study provides a reproducible macro-level evidence framework for research on curriculum reform in design education from 2006 to 2026, which helps scholars understand the structural characteristics of the field, identify key research themes, and recognize potential research frontiers. Future research may further advance by expanding data sources, refining thematic boundaries, strengthening methodological robustness tests, and linking research findings more closely with the evaluation of teaching practice effectiveness, thereby enhancing the explanatory power and practical value of research on design curriculum reform.

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AUTHOR CONTRIBUTIONS

Conceptualization, Z.H. and X.H.; methodology, Z.H. and G.Z.; software, Z.H.; validation, X.H. formal analysis, Z.H. and X.H.; investigation, W.C. and Z.H.; resources, Z.H.; data curation, Z.H.; writing-original draft preparation, Z.H.; writing-review and editing, X.H.; visualization, Z.H.; supervision, X.H. and G.Z.; project administration, Z.H. All authors have read and agreed to the published version of the manuscript.

DATA AVAILABILITY STATEMENT

The data presented in this study are available upon request from the first author.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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