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Research Focus and Trends of "Design Thinking" in Education: A Bibliometric Analysis

Li Jia [1], Nur Atiqah Jalaludin [1], Mohamad Hidir Mhd Salim [2], Mohamad Sattar Rasul [1]

[1] *Faculty of Education, Universiti Kebangsaan Malaysia, Bangi, Selangor, Malaysia*
[2] *Institute of Visual Informatics, Universiti Kebangsaan Malaysia, Bangi, Malaysia*

***Abstract* - The growing interest in design thinking within education has drawn increasing attention from researchers. However, the extent of its focus and impact in the field remains unclear. This study conducted a bibliometric analysis of 276 documents indexed in the Web of Science database from 2005 to December 31, 2024, to assess past and present research and guide future studies. The bibliometrix package in R was used to analyze bibliographic data and visualize key findings. The results indicate a notable increase in publications, particularly since 2021. Various bibliometric indicators reveal the progression of design thinking research while identifying the most influential authors, publication sources, institutions, and countries. Additionally, co-citation and collaboration network analyses provide insights into the intellectual and social structures of the field. Further examination of research themes, identifying "design thinking", "creativity", and "project-based learning" as core and emerging areas. Analyzing thematic evolution over time, finding growing attention to "performance" and "self-efficacy" in recent years. Finally, factor analysis distinguishes between traditional theoretical frameworks and competency-based innovation education models, highlighting a paradigm shift from theory-driven research to application- and skills-based education.**

The findings contribute to a deeper understanding of the dynamic evolution of design thinking in education, offering valuable insights for future research.

***Keywords* - Design thinking, bibliometric analysis, R studio, research trends, education innovation.**

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Corresponding author: Nur Atiqah Jalaludin,
Faculty of Education, Universiti Kebangsaan Malaysia, Bangi, Selangor, Malaysia
Email: nuratiqah.jalaludin@ukm.edu.my

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1. Introduction

Design Thinking (DT) has become a robust methodology for solving complex problems, driving innovation, and fostering user-centered approaches in various fields, including business and technology, education, as well as social sciences [1], [2]. This human-centered process encourages organizations and individuals to think creatively, challenge assumptions, and explore new possibilities by treating users' needs and experiences with empathy [3], [4]. It represents a shift from traditional problem-solving approaches, emphasizing iterative cycles of ideation, prototyping, and testing to develop solutions that are not only innovative but deeply responsive to human needs and desires [5], [6]. Furthermore, DT has become a transformative force in modern problem-solving and innovative approaches [2]. Rooted in empathy, creativity and rationality, it transcends traditional boundaries and fosters a culture of innovation that is deeply attuned to people's needs and experiences.

This approach is not just a linear process but a way of thinking that emphasizes the human dimension of the problems it seeks to solve, making it an essential tool for designers, strategists, educators, and leaders [5].

Design thinking is an iterative process of creative problem-solving and innovation that puts people at the center [6]. The origins of DT date back to the mid-20th century when it emerged in the design world as a systems approach [7]. DT is defined as inspiration, ideation, and implementation, this indicates research on DT in the non-design field has begun [8].

Besides, Stanford University pioneered the five principles of DT that remain the cornerstone of today's mainstream framework. The DT process is applied through four fundamental questions combined with ten essential tools [9]. The famous design company, IDEO, defined "Design thinking is a human-centered approach to innovation that draws from the designer's toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success" [10]. The core of DT involves five stages: empathize, define, ideate, prototype and test [6]. Overall, the five processes of DT are a methodology for solving complex problems and a method that uses systematic reasoning and intuition to explore ideal future states.

Alongside the expansion of DT, bibliometric analysis has become an essential tool for evaluating research trends, mapping intellectual landscapes, and identifying influential contributions. Originating as a quantitative approach to assessing academic literature, bibliometric analysis systematically examines publication data to track the development of research fields [11], [12]. Besides, it is the statistical analysis of publications and citations to assess their impact and understand a research field's past, present, and future directions. It helps identify the basic structure of a research field [13]. This method enables researchers to uncover influential works, emerging trends, and interdisciplinary connections through citation analysis, co-citation networks, and keyword mapping [14]. With the increasing availability of research databases such as Web of Science and Scopus, bibliometric methods offer valuable insights into the progression and impact of academic disciplines [15].

Hence, by employing bibliometric methods, researchers can systematically evaluate the body of work in their field through various evaluative and relational techniques.

On the other hand, relational techniques allow for more profound research by examining the interrelationships between authors, citations, and institutional relationships. These advanced methods provide a more comprehensive understanding of the dynamics of a field and help identify influential research, emerging trends, and gaps in the literature [12], [16].

Given the expanding body of literature on DT, this study employs bibliometric analysis to explore publication trends, key journals, regions, and institutions in DT research in education. Identifying influential authors, co-citation networks, and research collaborations, and examining key themes, keyword trends, and thematic evolution in the field. There are three questions:

RQ1: What are the main publication trends and leading contributors in Design Thinking research in education?

RQ2: How do co-citation and collaboration networks shape the field's intellectual and social structure?

RQ3: What are the key themes and emerging trends in Design Thinking applications in education?

2. Methodology

This study used the Biblioshiny web application for bibliometric analysis. It has powerful statistical methods and built-in data visualization capabilities and provides visualization techniques to display conceptual knowledge structures [17]. The Bibliometrix and Biblioshiny open-source packages are new, advanced bibliometric analysis tools for use in the R-studio [18]. Bibliometrix allows the entire scientific literature analysis and data processing process to be completed. Biblioshiny captures the core code of Bibliometrics and creates an online data analysis framework. Using an interactive web interface, biblioshiny function enables users to perform relevant bibliometric and visual analysis [19]. Furthermore, the software can conduct comprehensive bibliometric analysis using quantitative and scientific methods, making it one of the best software for calculating data and displaying graphs.

The scope of the study was conducted in Web of Science (WOS) because the WOS is one of the world's leading databases, with 21,762 high-impact journals [20], and notably, detailed bibliometric information such as authors, countries, citations, and abstracts.

In addition, SSCI (Social Sciences Citation Index), SCIE (Science Citation Index Extension), AHCI (Arts & Humanities Citation Index), and ESCI (Emerging Resources Citation Index) journals are all easily accessible in WOS [21]. This study was conducted in January 2025, and the screening time ranged from 1 January 1997 to 31 December 2024. An advanced search using a defined string of terms across titles, abstracts, and keywords yielded 1,716 preliminary results. The document language was refined, resulting in 1656 articles. Then, selecting the research area (Education Educational Research), generating 514 articles, and finally choosing SSCI、SCIE、AHCI and ESCI, 276 articles were selected in this research (Table 1).

Table 1. Literature screening process

Database	Web of Science
Time	1 January 1997- 31 December 2024
Keywords	TI="design* think*" AND AB="design* think*" AND AK="design* think*"
Language	English
Research area	Education
WOS Index	SSCI、SCIE、AHCI and ESCI

3. Results

To systematically examine the research, a multi-dimensional bibliometric analysis was conducted on acurated dataset of 276 publications indexed in the WOS. The results are organized around four analytical dimensions that collectively capture the volume, distribution, impact, and structure of scholarly output within the field.

First, the descriptive characteristics of the publication set are analyzed to reveal temporal trends, dominant publication sources, and the dispersion of research across journals. This is followed by a geographic and institutional analysis that maps the distribution of research productivity and influence across countries and affiliations, providing insight into global participation and academic leadership.

Subsequently, a document-level analysis identifies influential works, recurring terminologies, and evolving thematic priorities, offering a window into the intellectual focus and developmental trajectory of the field.

Finally, a structural analysis explores the social, intellectual, and conceptual architecture of the literature through co-authorship, co-citation, and co-word networks, as well as thematic and factorial mapping.

These analytical layers collectively illuminate both the established foundations and emerging directions of scholarly inquiry.

3.1. Basic Characteristics

To establish a foundational understanding of the research landscape, this section provides a bibliometric overview of the 276 publications retrieved from the WOS database.

Using the biblimetric package in R, the analysis focuses on key descriptive indicators, including the annual growth trend of publications, leading publishers and journals, and the distribution pattern of publications based on Bradford's Law. These metrics collectively reveal the dynamics, concentration, and dissemination channels of scholarly output in this field.

3.1.1. Yearly Trend of Publication Number

To a certain extent, the number of published papers can reflect year-to-year changes in research topics and future development trends. Figure 1 uses Microsoft Excel to display the number of published documents each year from 2005 to 2024. The horizontal axis represents the year, and the vertical axis represents the amount of literature. Judging from the number of literatures, academic research was in its infancy from 2005 to 2015, and the number of published documents each year was relatively low. However, it is worth noting that eight papers were published in 2013. Since 2016, the output of literature related to Design Thinking. There has been an increase, which may be due to increased interest in the concept of "Design Thinking", especially in the last three years, where productivity has been much higher than before. It has continued to grow steadily since 2019, and the number of publications in 2024 is 1.5 times that of 2023. Therefore, it is expected that research on design thinking in the field of education in 2025 will exceed that of the previous year.

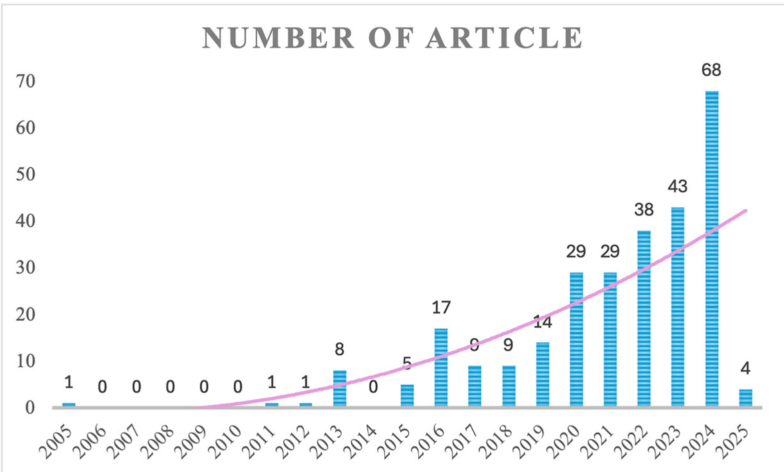


Figure 1. The trend of publication in "Design Thinking" from the year 2005 to 2024

3.1.2. Most Publisher

This part uses biblimetric package to explore publishers, journals, and impact. The selected documents involved 53 publishers.

Table 2 shows the top 10 publishers; the top 1 is from Springer Nature (51 literature), followed by Elsevier (46 literature), and 38 literatures in Taylor & Francis.

Table 2. The top 10 publishers of 276 publications

No.	Publishers	Record Count	% of 276
1	Springer Nature	51	18.35%
2	Elsevier	46	16.55%
3	Taylor & Francis	38	13.67%
4	Tempus Publications	17	6.12%
5	Wiley	17	6.12%
6	Sage	17	6.12%
7	Emerald Group Publishing	9	3.24%
8	MDPI	9	3.24%
9	Frontiers Media Sa	7	2.52%
10	SPRINGER INT PUBL AG	6	2.16%

3.1.3. Most Published Journals Bradford's Law

Bradford's Law is a key bibliometric principle that describes the uneven distribution of relevant literature across journals in each field [22]. The data presented in the Table 3 illustrates this principle by categorizing journals into different zones based on their frequency of relevant articles. The first zone, the core journals, contains the most influential sources contributing a substantial portion of the literature.

For instance, thinking skills and creativity ranks first with 28 articles, followed closely by the International Journal of Technology and Design Education with 26 articles. The cumulative frequency of articles in the top five journals reaches 89, reinforcing that a few sources dominate scholarly communication in this domain. These journals serve as foundational pillars for research, offering concentrated and high-impact knowledge.

Table 3. The top 10 journals of 276 publications

No.	Journals	Rank	Freq	Zone
1	Thinking Skills and Creativity	1	28	Zone 1
2	International Journal of Technology and Design Education	2	26	Zone 1
3	International Journal of Engineering Education	3	17	Zone 1
4	Education Sciences	4	9	Zone 1
5	International Journal of Art & Design Education	5	9	Zone 1
6	Frontiers in Education	6	7	Zone 1
7	Tech Trends	7	5	Zone 2
8	Education and Information Technologies	8	4	Zone 2
9	Educational Technology Research and Development	9	4	Zone 2
10	International Journal of Management Education	10	4	Zone 2

The shift from Zone 1 to Zone 2 reflects the fragmentation of information, with Zone 2 journals contributing fewer articles, indicating a declining frequency of relevant publications. This shift suggests that researchers seeking comprehensive insights must expand their searches beyond core sources. Scholars should prioritize foundational literature from Zone 1 journals while acknowledging that Zone 2 and beyond journals may offer valuable niche perspectives. Understanding the importance of the hierarchy of journals helps scholars strategically choose publishing venues for maximum visibility and impact [23]. Zone 1 journals have higher citation frequency and relevance, resulting in a more significant scholarly impact than fringe journals. This perspective highlights the role of Bradford's Law in shaping research trends, guiding systematic literature reviews, and informing scholarly communication policies [24].

3.2. Publication Distribution Analysis

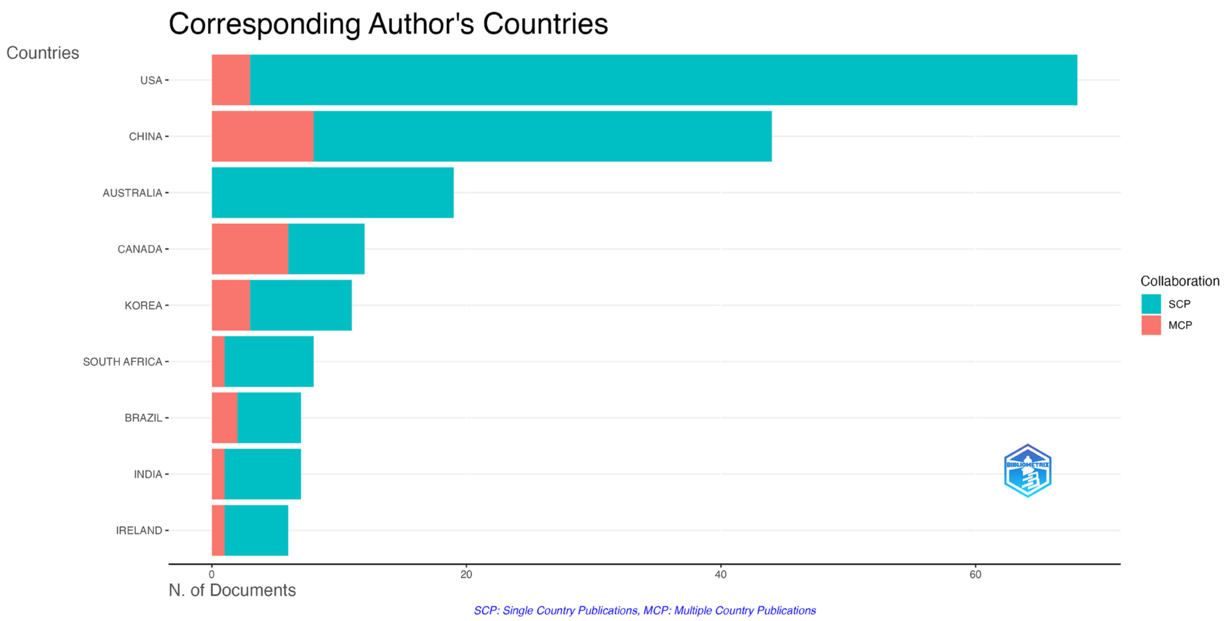
This section examines the geographical and institutional distribution of research output to identify patterns of scholarly contribution within the field. Using the bibliometric package, the analysis is based on corresponding authors' affiliations, a standard bibliometric approach to attribute institutional and national productivity.

By mapping publication outputs across countries and institutions, this analysis reveals the global structure of research engagement, highlights dominant contributors, and provides insight into the concentration of academic activity. Specifically, it identifies the most productive and most cited countries, as well as the institutions with the highest publication counts. This information not only reflects the extent of international participation but also indicates research leadership and potential hubs for collaboration.

The findings are presented in two subsections: The first focuses on national-level output and impact; the second highlights institutional performance. Together contributing to a comprehensive understanding of the knowledge production landscape in this domain.

3.2.1. Most Productive and Cited Countries

Figure 2 shows the document country/region distribution based on the corresponding author's information. The document distribution across 46 countries indicates a broad global interest in this research field. However, the significant concentration of publications in the USA (24.46%) and China (15.83%) suggests that these countries are the primary drivers of research output. Their dominance may be attributed to factors such as substantial research funding, institutional support, and a high number of active researchers in the field.



Note: MCP =Multi-Country Publications;
SCP =Single Country Publications

Figure 2. The top 10 corresponding author's country

Despite the wide geographical distribution, the research appears to be largely conducted within national boundaries, as evidenced by the predominance of Single-Country Publications (SCP). The relatively low number of Multi-Country Publications (MCP) suggests that international collaboration remains limited. Among the countries with MCPs, China leads with 8, followed by Canada (6), the USA and Korea (3 each), and Brazil (2). This pattern implies that while some cross-border cooperation exists, it is not a common practice in this domain.

The lack of extensive international collaboration could stem from various factors, including differing research priorities, funding limitations for cross-border projects, language barriers, or institutional policies favoring national research efforts.

3.2.2. Most Productive Affiliations

Figure 3 shows the top ten development literature institutions. Specifically, University of North Carolina at Chapel Hill (16) published the most literature on related topics, followed by Purdue University (13) and University of North Carolina (12). Overall, the vast majority of the top ten are concentrated in North America (7/10).

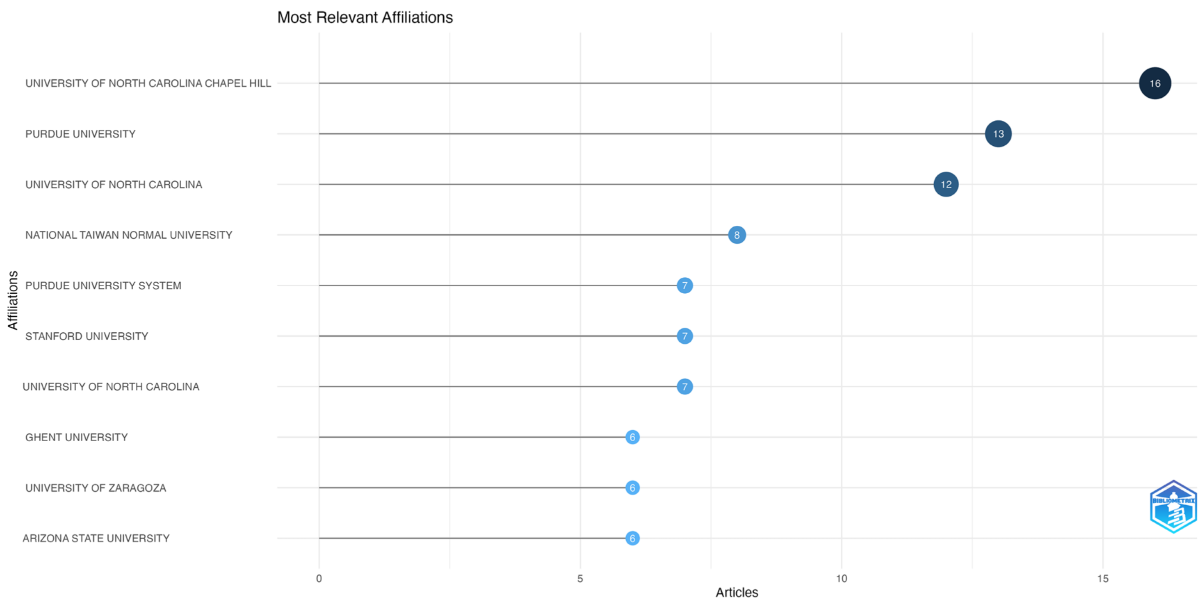


Figure 3. The top 10 corresponding author's institutions

3.3. Document Analysis

To uncover the intellectual structure and thematic evolution of the selected literature, this section conducts a document-level analysis of the 276 publications. Drawing on bibliometric techniques implemented via the bibliometric package, three dimensions are explored: Citation impact, keyword distribution, and topical trends.

First, the most globally cited documents are identified to reveal the seminal works that have exerted significant influence on subsequent research. These core publications often define theoretical foundations or methodological approaches within the field.

Second, a word cloud visualization is generated based on keyword frequency, offering an accessible representation of dominant research themes.

This qualitative mapping helps capture the conceptual focus of the literature and points to recurring areas of scholarly interest.

Finally, trend topic analysis is applied to examine the temporal dynamics of keyword usage. This method highlights the emergence, persistence, or decline of specific research themes over time, thereby indicating shifts in scholarly attention and potential future directions. Together, these analyses provide a comprehensive view of the intellectual content, influential contributions, and thematic developments shaping the field.

3.3.1. Most Global Cited Document of 276 Literature

The number of document citations can analyse the most important documents on this topic. The top five cited documents are selected from Table 4. According to [25] it is evident that the article has the highest impact in terms of total citations (1549) and average annual citations (73.76), indicating its strong influence in the academic community. As [26] also demonstrate significant academic reach with 529 citations and an average yearly citation rate of 37.79. [27], [28], [29] have comparatively lower citations, which could be due to their recency, niche focus, or limited reach. Since citations accumulate over time, the more recent publications [28], [29] may still gain wider recognition. However, the relatively low citation counts for [27] compared to [26] may imply a lesser impact or a more specialized audience. Additionally, the citation trajectory could indicate trends in academic interest. If [25] work continues to receive citations at a high annual rate, it suggests sustained relevance. Meanwhile, newer publications have the potential to grow in influence depending on how frequently they are cited in the coming years.

Table 4. The top 5 document citation of 276 publications

Title	TC	TC-Y	NTC	Source
Engineering Design Thinking, Teaching, and Learning	1549	73.76	1.00	[25]
What Is Design Thinking and Why Is It Important?	529	37.79	1.00	[26]
Design thinking: A creative approach to educational problems of practice	135	15	3.81	[27]
Theoretical foundations of design thinking – A constructivism learning approach to design thinking	103	17.17	5.63	[28]
A qualitative review of the design thinking framework in health professions education	90	12.86	6.43	[29]

Note: TC=Total Citations; TC-Y=Total Citations per Year; NTC=Normalized Total Citations

3.3.2. Word Cloud Map Analysis of 276 Literature

In bibliometric analysis, frequently occurring words are crucial for understanding academic publications' topics, trends, and focus areas. Figure 4 shows the most common "keyword plus" terms. "Education" (32) was the most common term, followed by "student" (22), "innovation" (20), "science" (17) and "framework" (14). The terms can be roughly divided into three categories: The core concepts are "education" and "student". "Innovation" and "framework" may be related to methods, strategies, or models. "Science" may refer to a specific field of study or the application of educational principles to scientific disciplines, or it may reflect a broader focus on Science, Technology, Engineering, and Mathematics (STEM) education.

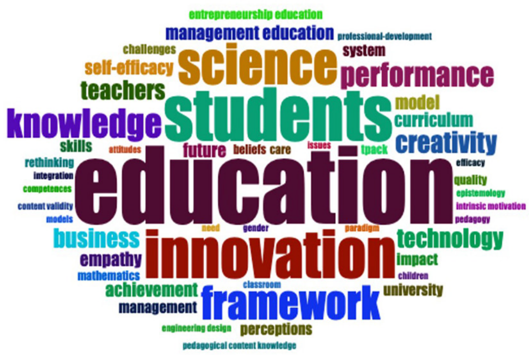


Figure 4. Word cloud map of 276 publications

3.3.3. Trend Topics Analysis of 276 Literature

Figure 5 visually illustrates the temporal trends of various academic topics from 2017 to 2023, with the size of each bubble representing the frequency of the term within the dataset.

The analysis reveals changes in academic focus, with some terms showing significant growth while others maintaining a stable level of relevance or declining over time.

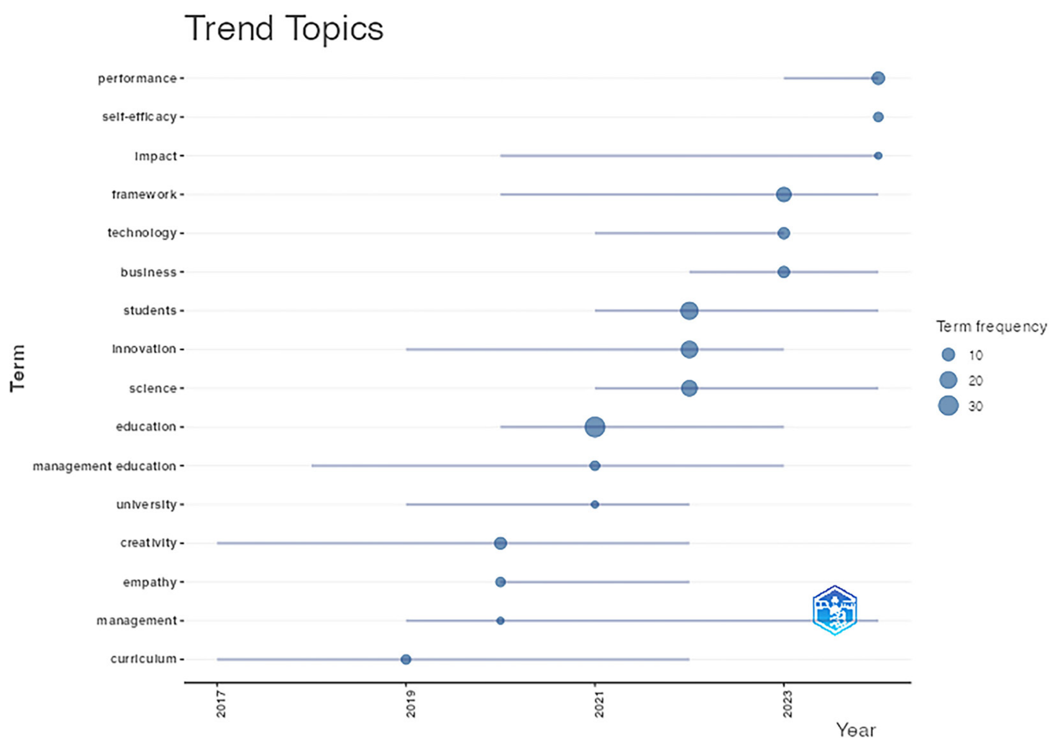


Figure 5. The trend topics of 276 publications

"Education" and "innovation" show a clear upward trajectory, especially after 2020, indicating an increasing emphasis on these areas in academic discussions. The prominence of education has been particularly evident in recent years, reaching a clear peak around 2021-2023. Similarly, the terms "innovation" and "student" show a similar upward trend, highlighting the growing interest of researchers in focusing more on student-centered learning and exploring new methods, technologies, and creative problem-solving in education. The term "science" shows moderate fluctuations throughout the timeline, with clear peaks around 2019 and 2021. This may indicate a cyclical shift in research interest or a cyclical focus on science-related topics within the broader field of education. "Management education" also shows a steady increase in frequency, especially after 2020, indicating that integrating design thinking into management education has attracted more academic attention. The terms "empathy", "creativity", and "curriculum" increased significantly in frequency from 2021 onwards.

This shift reflects a growing recognition of the need to incorporate core elements of design thinking, creative skills, and flexible curriculum design into education.

The increasing popularity of these terms may indicate a move towards a broader, more comprehensive approach to education. Similarly, while still important, "technology" declined slightly after 2021, suggesting that its prominence in education research may stabilize.

In contrast, "performance" and "self-efficacy" have gradually declined in frequency, especially after 2020. This suggests that while these topics remain relevant, academics may have shifted their focus from individual achievement indicators and psychological constructs to more systematic and innovative educational approaches. In summary, it demonstrates a dynamic shift in academic focus from traditional terms ("performance" and "self-efficacy") to emerging topics ("innovation", "empathy", and "creativity"), reflecting broader changes in educational priorities and methodologies. The continued rise of "education" and "innovation" demonstrates an enduring commitment to reform and transformation in education systems worldwide.

3.4. Structure Analysis

Structure analysis seeks to reveal the underlying organization of scientific knowledge by examining relationships among authors, documents, and concepts. It enables researchers to identify intellectual foundations, collaborative networks, and emerging thematic patterns through quantitative mapping techniques. These mappings serve as visual and analytical tools for understanding the evolution and dynamics of scholarly fields.

Drawing on data from the 276 publications and utilizing the bibliometric package, this section conducts four levels of structural analysis: social, intellectual, conceptual, and thematic.

Each offers a distinct perspective on how knowledge is produced, disseminated, and organized.

Social structure is examined through collaboration networks among authors and countries, reflecting patterns of scholarly cooperation. Intellectual structure is explored via co-citation analysis, identifying influential authors and foundational works that shape the field's theoretical core. Conceptual structure is investigated through keyword co-occurrence analysis, mapping the main themes and research clusters present in the literature. Thematic evolution captures the development of research topics over time, highlighting how intellectual priorities have shifted. Factorial analysis further interprets these structures through multivariate techniques, offering dimensional insights into the field's complexity.

Together, these approaches provide a comprehensive map of the scientific landscape, revealing both stable foundations and areas of innovation [30].

3.4.1. Social Structure Collaboration Network

The social structure shows the relationships between research entities, including authors or institutions. The most common form of social structure is a co-author network. It is used to discover established and influential groups of authors and related institutions in any research field [31]. Academic collaboration plays a crucial role in advancing global research efforts. The frequency of co-authored publications between countries indicates strong research partnerships and shared scientific interests.

There are 33 collaboration networks in total, but in this study, the provided dataset outlines the top 10 countries regarding research collaboration frequency (Table 5).

Table 5. The top 10 countries for publications by frequency of collaboration

From	To	Frequency
USA	CANADA	5
USA	KOREA	4
BELGIUM	ECUADOR	3
CHINA	AUSTRALIA	3
CHINA	JAPAN	2
CHINA	UNITED KINGDOM	2
EGYPT	SAUDI ARABIA	2
USA	CHINA	2
USA	JAPAN	2
AUSTRALIA	JAPAN	1

The USA is a collaborating country in five of the ten recorded instances. The USA has the highest collaboration frequency with Canada (5), followed by Korea (4), China (2), and Japan (2). Then, China established multiple research collaborations with Australia (3), Japan (2), and the United Kingdom (2). Notably, European and Middle Eastern collaborations (Belgium and Ecuador) exhibit a collaboration frequency 3, highlighting a notable academic connection between these regions. Egypt and Saudi Arabia, with a frequency of 2. Finally, Australia collaborates significantly with China (3) and Japan (1), indicating its research ties with Asia.

The data suggests that North America (USA and Canada) continues to dominate academic collaboration networks. China's increasing partnerships with Western countries and regional neighbors signify its commitment to international research engagement. Additionally, emerging collaborations between Belgium-Ecuador and Egypt-Saudi Arabia indicate diversification in global academic cooperation.

3.4.2. Intellectual Structure Co-Citation Analysis

A social network is a group of objects with a specific relationship between them. In a social network, nodes are people, and the connections between nodes represent a relationship between people [32]. Figure 6 is a social network composed of red and blue clusters. The most influential ones in these two clusters are [8] and [26], respectively.

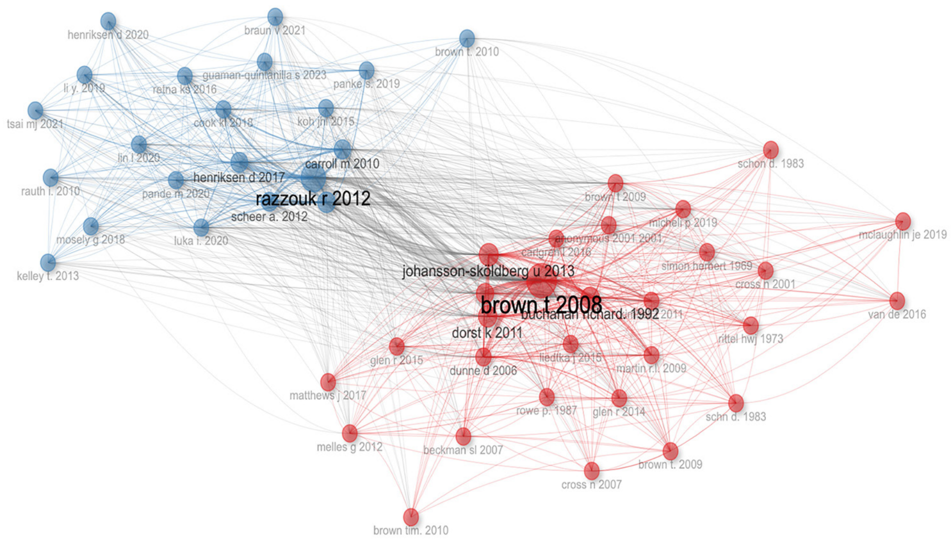


Figure 6. The co-citation network of 276 publications

Specifically, Figure 6 provides a detailed breakdown of the two main thematic clusters in the field, with five of the most cited articles in each theme. The first theme concerns the fundamental principles and core elements of design thinking.

Of the five articles, three explore the nature of design thinking, focusing on its theoretical foundations, methodology, and key components that define the approach. The remaining two articles focus more on the intersection of design thinking with engineering and management, emphasizing its practical applications in these fields (Table 6).

Table 6. Co-citation analysis of 276 Publications (red cluster)

Title	Source
Engineering Design Thinking, Teaching, and Learning	[25]
The core of 'design thinking' and its application	[33]
Design Thinking: Past, Present and Possible Futures	[34]
Wicked Problems in Design Thinking	[35]
Design Thinking and How It Will Change Management Education: An Interview and Discussion	[36]

In contrast, the second theme shifts attention to the practical applications of design thinking in various fields, as shown in Table 7. Three items specifically focus on the integration of design thinking in education.

Notably, both [37] and [38] emphasized design thinking pedagogy, highlighting its increasingly important role in shaping teaching practices and curricula.

Table 7. Co-citation analysis of 276 publications (blue cluster)

Title	Source
Design thinking: A creative approach to educational problems of practice	[27]
Design Thinking Pedagogy: The Educational Design Ladder.	[37]
Destination, Imagination and the Fires Within: Design Thinking in a Middle School Classroom	[39]
Transforming Constructivist Learning into Action: Design Thinking in Education	[40]
Design Thinking in Pedagogy	[38]

3.4.3. Conceptual Structure Co-occurrence Analysis

The conceptual structure is designed to target significant themes and trends. Co-occurrence networks are a method of analyzing text that enables the graphical visualization of underlying relationships [41]. In this part, the bibliometric package and Walktrap algorithm are the main tools to construct and analyze various graphs.

In this co-occurrence network, each node represents a keyword. The larger the node, the higher the frequency of keyword occurrence.

The distance between keywords can reflect the relationship between them. The shorter the distance between two nodes, the stronger the correlation between the two keywords [42]. As shown in Figure 7, after uploading a list of synonyms, such as STEM and STEM education, the keywords are divided into 5 clusters with 46 nodes. Each network node represents a keyword or research topic, and its size is proportional to its degree.

In the red cluster, keywords surrounding "design thinking" include "marker education", "STEM education", "teacher education", etc. The second cluster is blue based on "creativity", including "design education", "problem-solving", and "empathy", etc., and the green cluster includes "design think" and "project-based learning" (dt and pbl). The purple cluster is "education". The last is "engineering education".

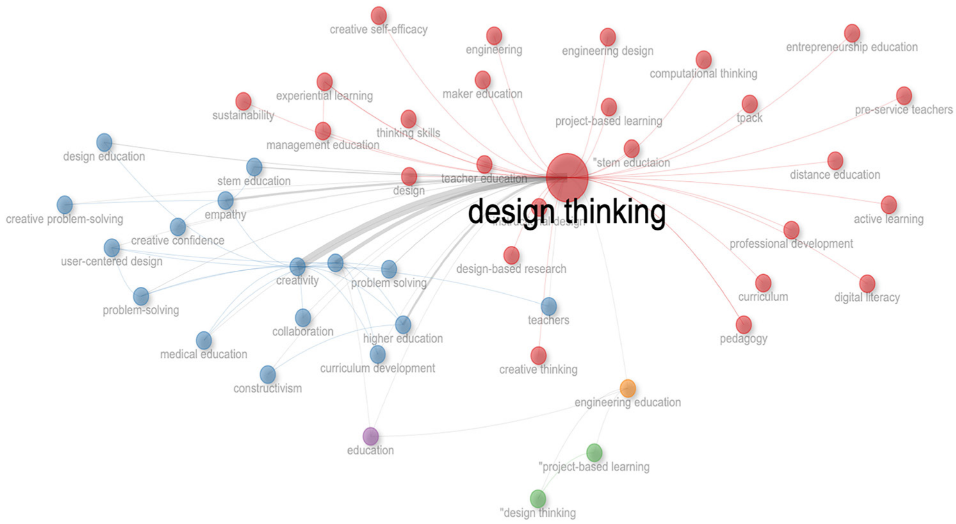


Figure 7. The co-occurrence network of 276 publications

3.4.4. Thematic Evolution

This part illustrates the thematic evolution of research across four distinct time slices, reflecting the field's shifting priorities and conceptual directions (Figure 8).

In the first period (2005–2015), the dominant theme was "education," categorized as a basic theme, indicating its foundational role in the research landscape (Figure 9).

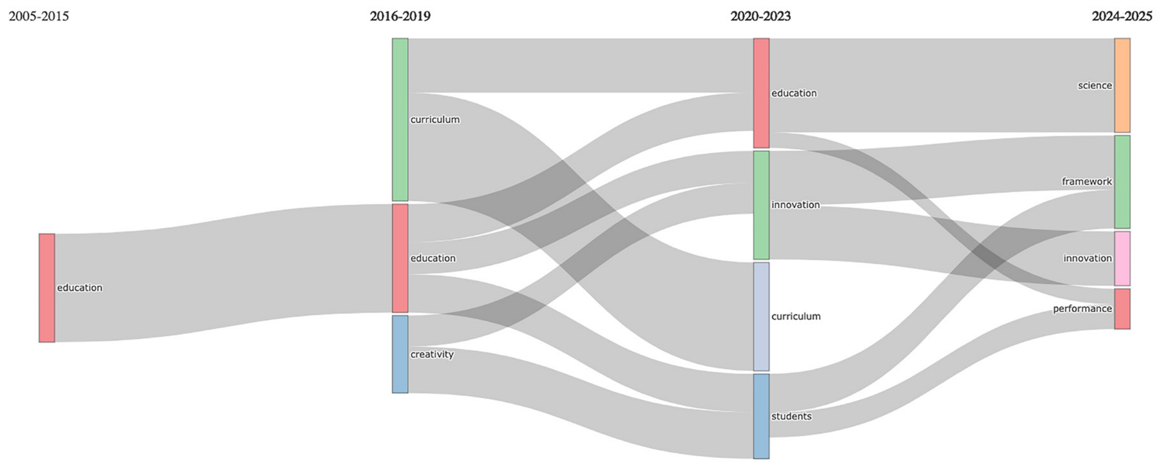


Figure 8. The thematic evolution of 276 publications

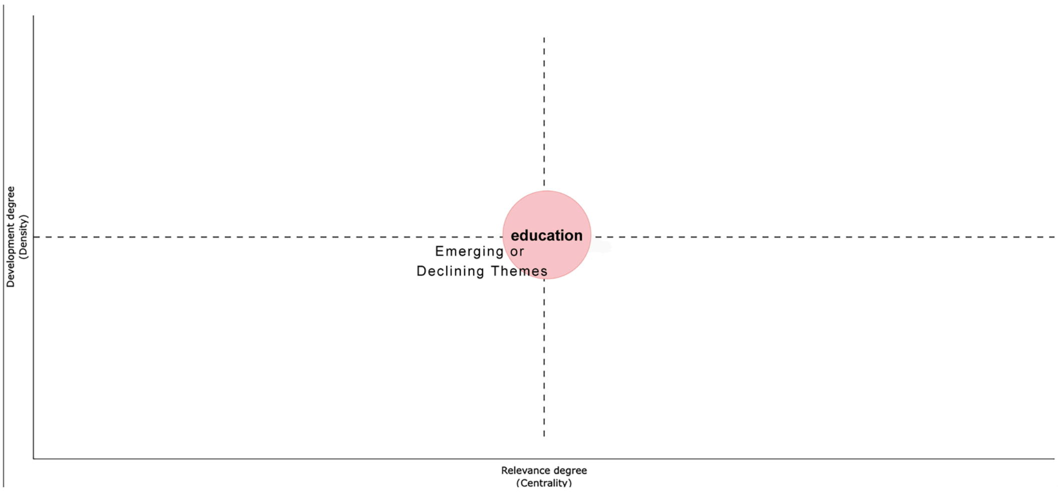


Figure 9. The thematic evolution of 276 publications (2005-2015)

During this time, studies predominantly focus on broad educational theories, pedagogical approaches, and the structural aspects of learning. In the second period (2016–2019), "education" remains a central theme, but there is a noticeable diversification of research topics.

"Curriculum" and "creativity" emerge as niche themes, reflecting an increasing interest in curriculum design, teaching methods innovation, and creativity's role in education (Figure 10).

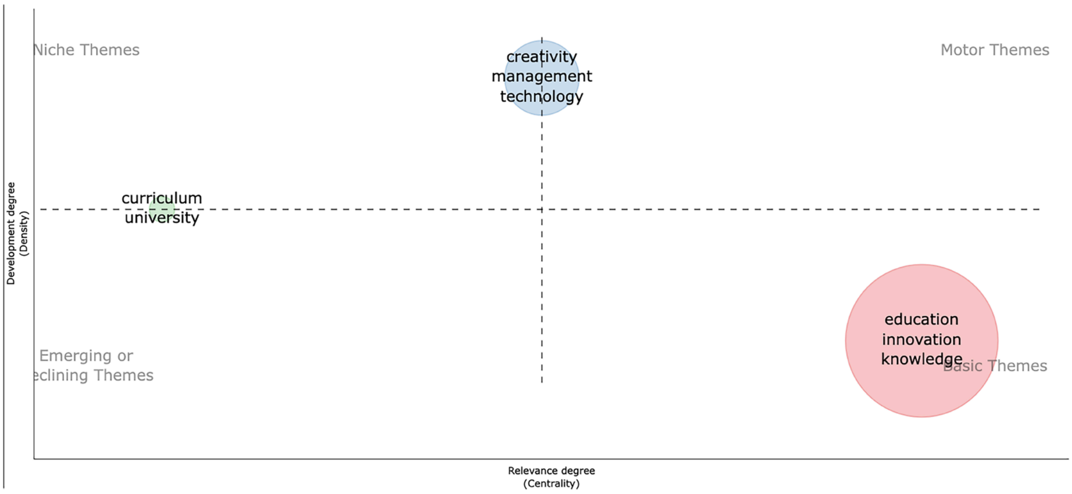


Figure 10. The thematic evolution of 276 publications (2016-2019)

The research landscape undergoes significant transformation during the third period (2020–2023). While "education", "science", and "achievement" remain core themes, they begin to integrate with "innovation", "business", and "technology". This intersection suggests a shift towards applied and outcome-based research, where the focus expands beyond theoretical discussions to practical implementations and measurable results (Figure 11).

The thematic landscape becomes more diverse and specialized in the most recent time slice (2024–2025). "Performance", "students", and "self-efficacy" emerge as dominant motor themes, indicating a strong research focus on student-centered outcomes, motivation, and psychological determinants of learning. This reflects a paradigm shift toward understanding individual learning experiences, personalized education strategies, and factors contributing to academic success.

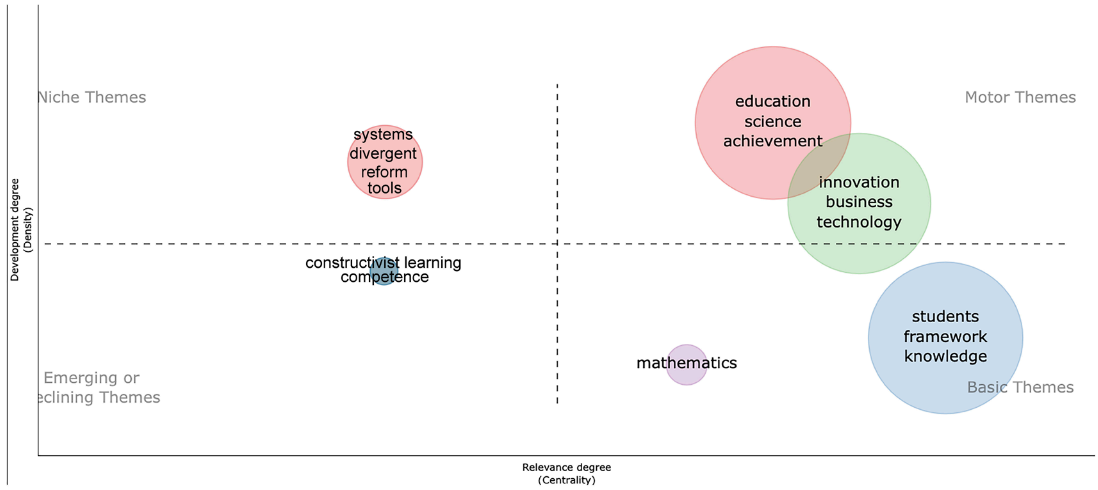


Figure 11. The thematic evolution of 276 publications (2020-2023)

"Framework", "business", and "future" represent another cluster of motor themes, suggesting an emphasis on structuring education through strategic models, economic considerations, and forward-thinking research. Next, "innovation" and "self-determination theory" appear as niche themes, meaning they are highly specialized but not yet widely integrated across the field. Similarly, "entrepreneurship education" and "barriers" remain relevant but are not dominant themes, indicating ongoing challenges and discussions surrounding the integration of entrepreneurship within education.

The presence of "barriers" suggests that researchers continue to investigate obstacles to implementing innovative educational strategies, whether related to institutional constraints or policy limitations. This stage significantly departs from theoretical educational research, emphasizing real-world impact, student outcomes, and institutional evolution (Figure 12).

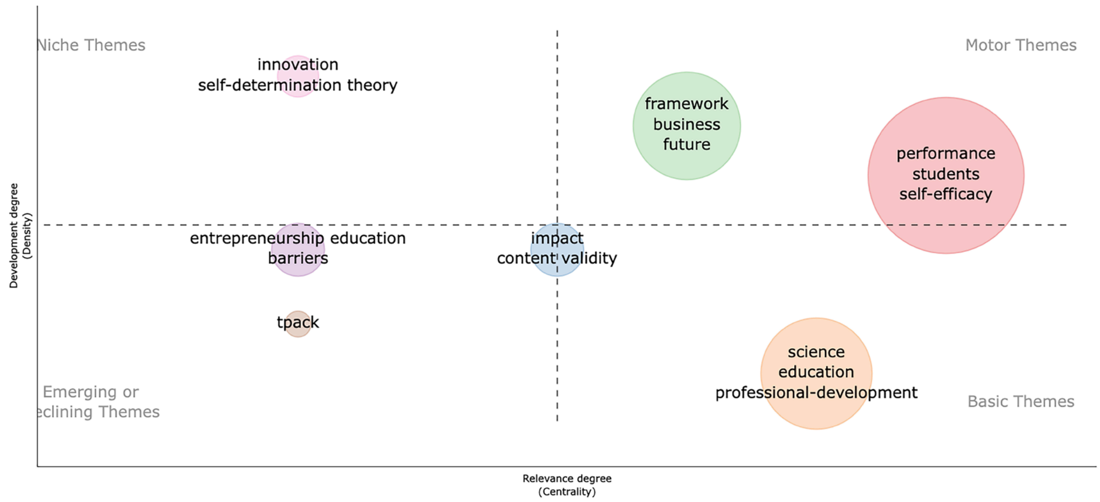


Figure 12. The thematic evolution of 276 publications (2024-2025)

Overall, the evolution of themes demonstrates a clear progression from general education topics to specialized and applied research areas.

The transition from broad pedagogical discussions to technology-driven, business-oriented, and student-centered approaches highlights the increasing importance of measurable learning outcomes, entrepreneurial competencies, and educational innovations.

3.4.5. Factorial Analysis

Correspondence Analysis (CA) and Multiple Correspondence Analysis (MCA) are statistical techniques used to analyze categorical data in a multidimensional space. These methods help understand relationships between categories, visualize latent structures and identify key trends in complex datasets [43], [44].

Factor weight analysis identifies the relative contribution of each variable to the extracted dimensions, helping to determine key drivers of the spatial distribution in the CA and MCA plots.

Figure 13 reveals that “competence,” “creativity”, and “entrepreneurial education” are the primary contributors to Dimension 1, reflecting a shift toward competency-based education.

In contrast, “epistemology”, “children”, and “management” load in the opposite direction, suggesting an emphasis on theoretical perspectives and early education models. Dimension 2 differentiates systemic educational concerns—such as “curriculum”, “effectiveness”, and “policy”—from innovation- and entrepreneurship-driven learning (Figure 13). Factor Weight Analysis in CA confirms a clear divergence between traditional educational theory and modern, skills-based, innovative education models.

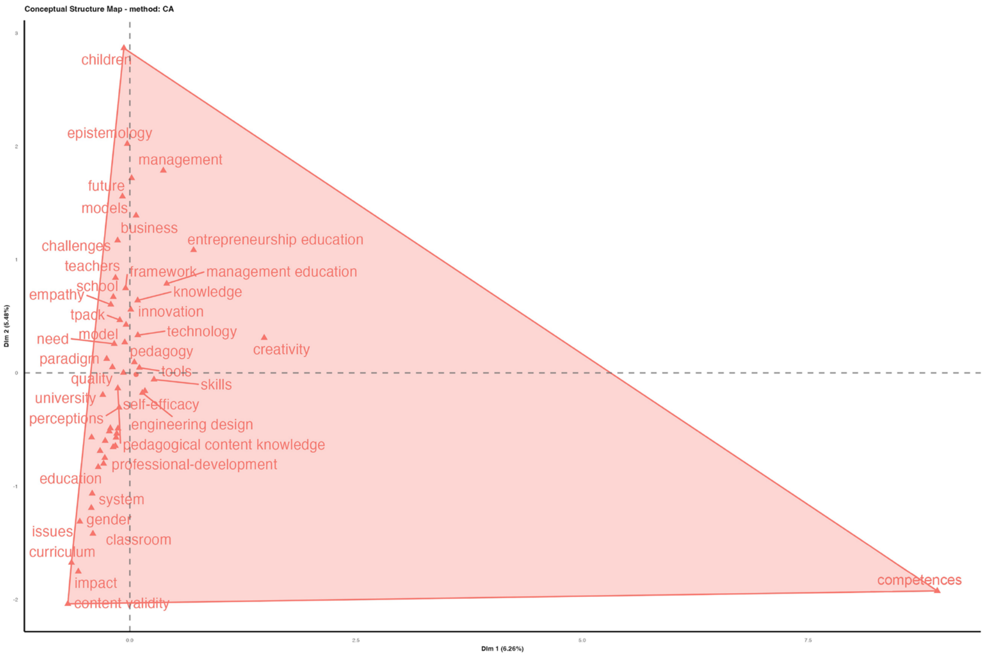


Figure 13. Correspondence analysis of 276 publications

Figure 14 highlights “pedagogical content knowledge” and “professional development” as dominant contributors to Dimension 1, reinforcing their pivotal role in teacher training and instructional practices. In contrast, “epistemology” and “curriculum” contribute negatively to Dimension 1, underscoring their association with theoretical frameworks and policy considerations.

“Self-determination theory” and “intrinsic motivation” heavily influence Dimension 2, emphasizing their relevance to student learning psychology. Notably, “technology” and “self-efficacy” load significantly on both dimensions, suggesting a dual impact on instructional practices and student motivation. Factor weight analysis in MCA reveals a clear contrast between psychological learning theories and teaching policy reforms.

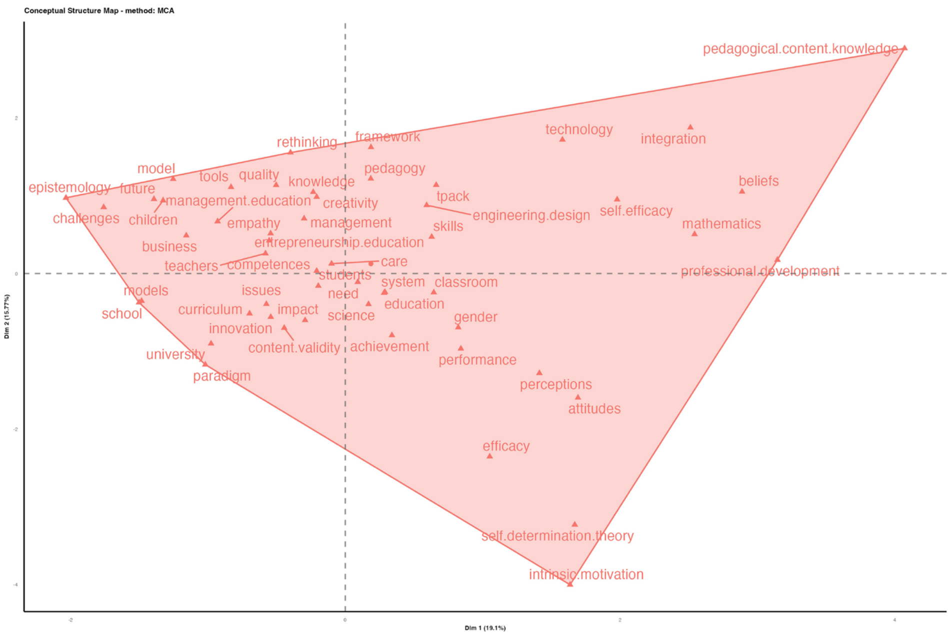


Figure 14. Multiple correspondence analysis of 276 publications

4. Discussion

RQ1: What are the main publication trends and leading contributors in Design Thinking research in education?

This study conducted a descriptive analysis of 276 articles indexed by WOS. From 2005 to 2015, the number of scientific research studies published each year was limited. However, in 2013, the increase was prolonged, and people's interest was early, but the increase was isolated. Academic results have increased significantly since 2016. During the past three years (2021-2024), the publication rate has accelerated, and the publication volume in 2024 is 1.5 times that in 2023. In addition, the amount of research expected in 2025 will be very promising and firmly established as a core research field in education. The publishers that include most of the research on design thinking are Springer Nature, Elsevier and Taylor & Francis. Furthermore, Thinking Skills and Creativity and the International Journal of Technology and Design Education are the journals with the most articles. These publications have a higher frequency of citations, underscoring their central role in shaping the discourse in the field.

The most prolific institutions in design thinking research include the University of North Carolina at Chapel Hill, Purdue University, and the University of North Carolina. In addition, the United States and China dominate the research output.

Despite contributions from 46 countries, the research landscape remains concentrated within countries, as evidenced by the prevalence of SCPs.

The low prevalence of cross-border research may be attributed to funding limitations for international projects, different national research priorities and institutional policies, and language and logistical barriers that hinder collaboration. Given the global significance of design thinking in education, future research should prioritize cross-border collaboration to promote methodological diversity and knowledge exchange.

Citation analysis of the most influential design thinking publications revealed a hierarchical influence structure. Dym maintained the highest academic influence, indicating continued fundamental relevance [25]. As [26] showed strong but relatively low impact. Analysis of keyword frequencies reveals shifts in educational focus. “Education” and “innovation” show sustained growth, peaking in 2021-2023. “Student-centered learning” reflects a growing emphasis on active learning approaches.

“Empathy”, “creativity”, and “curriculum” show significant growth after 2021, highlighting a shift toward holistic, flexible learning frameworks. The rise of these words research signals a paradigm shift toward student engagement and experiential learning.

RQ2: How do co-citation and collaboration networks shape the field’s intellectual and social structure?

Collaboration patterns indicate that North America (the United States and Canada) continues to dominate the global academic network. At the same time, China has expanded its international research engagement, establishing multiple collaborations with Australia, Japan, and the United Kingdom. In addition, emerging collaborations—such as those between Belgium and Ecuador and Egypt and Saudi Arabia—highlight the diversification of global research collaborations.

Social network analysis presents visualizations identifying two main thematic clusters in the field. The most influential works in these clusters are [8] and [26] which serve as core knowledge pillars in their respective fields. Detailed analysis of these clusters reveals two main research themes: Basic principles and core elements of design thinking. Interdisciplinary application of design thinking. These findings highlight the interplay between theoretical advances and practical applications in design thinking research. While basic research continues to define the conceptual boundaries of the field, an increasing number of publications explore its impact on education, engineering, and management, reflecting the discipline's growing interdisciplinary relevance.

RQ3: What are the key themes and emerging trends in DT applications in education?

The co-occurrence network analysis identifies five thematic clusters: (1) Design Thinking (e.g., STEM education, teacher education), (2) Creativity (e.g., design education, problem-solving), (3) Project-Based Learning, (4) General Education, and (5) Engineering Education. These clusters demonstrate how research has diversified beyond foundational principles, including applied methodologies and interdisciplinary integration.

Thematic evolution (2005–2025) highlights a shift from broad educational theories to applied, student-centered, and innovation-driven research.

Initially, research centered on pedagogical frameworks (2005–2015).

This expanded into specialized themes such as curriculum design and creativity (2016–2019). More recently, studies have integrated business, technology, and measurable student outcomes (2020–2023), culminating in an increasing focus on self-efficacy, motivation, and entrepreneurship (2024–2025).

This trajectory indicates a growing emphasis on practical educational applications and institutional reform.

Factorial analysis distinguishes between traditional theoretical frameworks and competency-based, innovative education models. Key influences include creativity, technology, and professional development, reinforcing a paradigm shift toward applied, skills-based education.

These findings suggest that design thinking research is evolving towards a multidisciplinary and impact-driven approach. The increasing prominence of entrepreneurial education, self-determination theory, and technology-enhanced learning reflects a broader shift towards competency-based and experiential learning models. This aligns with global trends emphasizing student-centered pedagogy, interdisciplinary collaboration, and industry-academic partnerships.

However, challenges remain. Despite the diversification of themes, barriers to implementation—such as institutional resistance, funding constraints, and policy limitations—persist.

The lack of extensive international collaboration, as seen in the limited MCP, suggests that research remains primarily nationally concentrated, potentially restricting knowledge transfer and global best practices.

5. Conclusion

This study offers a comprehensive bibliometric analysis of Design Thinking DT research in education between 2005 and 2025, addressing three core research questions. Through descriptive statistics, social network analysis, thematic mapping, and co-citation analysis, the study maps the intellectual landscape, knowledge structures, and thematic developments in the field.

Overall, the findings reveal that DT has become an increasingly central topic in educational research, especially in the last decade. The rising number of publications and citations indicates a growing scholarly interest, driven by the recognition of DT's potential to foster creativity, empathy, problem-solving, and innovation across disciplines.

Thematic clusters such as creativity, project-based learning, and student-centered pedagogy demonstrate that DT is no longer confined to design-related subjects but is increasingly integrated into general education, teacher training, STEM, and engineering education.

The expansion of research topics—from curriculum design to entrepreneurial learning—shows a shift from theoretical exploration to applied, competency-based educational reform.

Despite these developments, the research landscape remains geographically imbalanced. While the United States and China dominate output, multi-country collaboration remains low. The prevalence of single-country publications suggests that DT research is often shaped by national educational agendas and policy frameworks. The current structure risks limiting opportunities for cross-cultural learning and methodological pluralism.

In addition, this study has several methodological limitations that should be acknowledged. The analysis relied exclusively on literature indexed in the WOS, which, while reputable, may not fully capture relevant studies published in other databases such as Scopus, ERIC, or regional repositories. As a result, the comprehensiveness of the dataset may be limited. Moreover, the use of keyword co-occurrence and citation-based clustering—though effective in identifying dominant themes—may overlook emerging, underrepresented, or region-specific research areas, particularly those published in non-English languages.

These limitations suggest the need for more inclusive, multilingual, and cross-platform bibliometric analyses in the future.

Building on the insights gained, future research should be expanded in several directions. First, more comparative international studies are needed to understand how DT is interpreted, adapted, and institutionalized across diverse cultural and educational systems. These studies may uncover both best practices and context-specific barriers. Second, longitudinal and outcome-based research is crucial to assess the long-term impact of DT on student learning outcomes, creativity, teacher development, and institutional transformation. Third, further investigation is required to ensure equity and inclusivity in DT applications—particularly in under-resourced schools, non-Western contexts, or marginalized communities—thereby supporting the democratization of educational innovation.

Fourth, the integration of emerging technologies (e.g., Artificial Intelligence, Virtual Reality, Augmented Reality) with DT practices remains underexplored and should be examined for both its potential and its limitations.

Finally, scholars should study policy-level enablers and institutional support mechanisms, which are critical to the successful adoption and scaling of DT in formal education systems.

In conclusion, this study not only maps the evolution of DT in educational research but also highlights its growing impact and interdisciplinary relevance. However, for the field to progress meaningfully, future research must adopt a more globally engaged, methodologically diverse, and equity-oriented agenda. By doing so, design thinking can realize its full potential as a transformative paradigm in 21st-century education.

References:

[1]. Jaskyte, K., & Liedtka, J. (2022). Design thinking for innovation: Practices and intermediate outcomes. *Nonprofit Management and Leadership*, *32*(4), 555-575.

[2]. Bender-Salazar, R. (2023). Design thinking as an effective method for problem-setting and needfinding for entrepreneurial teams addressing wicked problems. *Journal of Innovation and Entrepreneurship*, *12*(1), 24.

[3]. Kim, H. J., Yi, P., & Ko, B. W. (2023). Deepening students' experiences with problem identification and definition in an empathetic approach: lessons from a university design-thinking program. *Journal of Applied Research in Higher Education*, *15*(3), 852-865.

[4]. Simeon, M. I., Samsudin, M. A., & Yakob, N. (2022). Effect of design thinking approach on students' achievement in some selected physics concepts in the context of STEM learning. *International Journal of Technology and Design Education*, *32*(1), 185-212.

[5]. Cross, N. (2023). Design thinking: What just happened?. *Design Studies*, *86*, 101187.

[6]. Jiang, C., & Pang, Y. (2023). Enhancing design thinking in engineering students with project-based learning. *Computer Applications in Engineering Education*, *31*(4), 814-830.

[7]. von Thienen, J. P., Weinstein, T. J., & Meinel, C. (2023). Creative metacognition in design thinking: exploring theories, educational practices, and their implications for measurement. *Frontiers in psychology*, *14*, 1157001.

[8]. Brown, T. (2008). Design thinking. *Harvard business review*, *86*(6), 84.

[9]. Liedtka, J. (2014). Innovative ways companies are using design thinking. *Strategy & Leadership*, *42*(2), 40-45.

[10]. IDEO. (2019). *Design thinking defined.* Designthinking.ideo. Retrieved from: https://designthinking.ideo.com/ [accessed: 10 February 2025][

[11]. Mukherjee, D., et al. (2022). Guidelines for advancing theory and practice through bibliometric research. *Journal of business research*, *148*, 101-115.

[12]. Öztürk, O., Kocaman, R., & Kanbach, D. K. (2024). How to design bibliometric research: an overview and a framework proposal. *Review of managerial science*, *18*(11), 3333-3361.

[13]. Bajwa, I. A., et al. (2022). Past, Present and Future of FinTech Research: A Bibliometric Analysis. *SAGE Open*, *12*(4).

[14]. Donthu, N., et al. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of business research*, *133*, 285-296.

[15]. Song, Y., et al. (2023). The top 100 most cited articles in anaphylaxis: a bibliometric analysis. *Clinical and Experimental Medicine*, *23*(5), 1783-1799.

[16]. Mougenot, B., & Doussoulin, J. P. (2022). Conceptual evolution of the bioeconomy: a bibliometric analysis. *Environment, Development and Sustainability*, *24*(1), 1031-1047.

[17]. Aria, M., & Cuccurullo, C. (2017). bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of informetrics*, *11*(4), 959-975.

[18]. Büyükkıdık, S. (2022). A bibliometric analysis: A tutorial for the bibliometrix package in R using IRT literature. *Journal of Measurement and Evaluation in Education and Psychology*, *13*(3), 164-193.

[19]. Moral-Muñoz, J. A., Herrera-Viedma, E., Santisteban-Espejo, A., & Cobo, M. J. (2020). Software tools for conducting bibliometric analysis in science: An up-to-date review. *El Profesional de la Información*, *29*(1), 1-20.

[20]. Clarivate. (n.d.). *Journal Citation Reports 2025 statistics*. Clarivate. Retrieved from: https://clarivate.com/academia-government/scientific-and-academic-research/research-funding-analytics/journal-citation-reports/infographic/ [accessed: 05 March 2025]

[21]. Pranckutė, R. (2021). Web of Science (WoS) and Scopus: The titans of bibliographic information in today's academic world. *Publications*, *9*(1), 12.

[22]. Almeida, L., & Vieira, E. (2023). Technical analysis, fundamental analysis, and Ichimoku dynamics: A bibliometric analysis. *Risks*, *11*(8), 142.

[23]. Rowley, J., et al. (2022). Factors influencing researchers' journal selection decisions. *Journal of Information Science*, *48*(3), 321-335.

[24]. Ahmad, T., et al. (2022). Global research mapping of psycho-oncology between 1980 and 2021: a bibliometric analysis. *Frontiers in Psychology*, *13*, 947669.
[25]. Dym, C. L., Agogino, A. M., Eris, O., Frey, D. D., & Leifer, L. J. (2005). Engineering design thinking, teaching, and learning. *Journal of engineering education*, *94*(1), 103-120.
[26]. Razzouk, R., & Shute, V. (2012). What is design thinking and why is it important?. *Review of educational research*, *82*(3), 330-348.
[27]. Henriksen, D., Richardson, C., & Mehta, R. (2017). Design thinking: A creative approach to educational problems of practice. *Thinking skills and Creativity*, *26*, 140-153.
[28]. Pande, M., & Bharathi, S. V. (2020). Theoretical foundations of design thinking–A constructivism learning approach to design thinking. *Thinking Skills and Creativity*, *36*, 100637.
[29]. McLaughlin, J. E., et al. (2019). A qualitative review of the design thinking framework in health professions education. *BMC medical education*, *19*(1), 98.
[30]. Pessin, V. Z., Yamane, L. H., & Siman, R. R. (2022). Smart bibliometrics: an integrated method of science mapping and bibliometric analysis. *Scientometrics*, *127*(6), 3695-3718.
[31]. Gutiérrez-Salcedo, M., et al. (2018). Some bibliometric procedures for analyzing and evaluating research fields. *Applied intelligence*, *48*(5), 1275-1287.
[32]. Serrat, O. (2017). Social network analysis. *Knowledge solutions: Tools, methods, and approaches to drive organizational performance*, 39-43. Springer.
[33]. Dorst, K. (2011). The core of 'design thinking'and its application. *Design studies*, *32*(6), 521-532.
[34]. Johansson-Sköldberg, U., Woodilla, J., & Çetinkaya, M. (2013). Design thinking: Past, present and possible futures. *Creativity and innovation management*, *22*(2), 121-146.
[35]. Buchanan, R. (1992). Wicked problems in design thinking. *Design issues*, *8*(2), 5-21.
[36]. Dunne, D., & Martin, R. (2006). Design thinking and how it will change management education: An interview and discussion. *Academy of management learning & education*, *5*(4), 512-523.
[37]. Wrigley, C., & Straker, K. (2017). Design thinking pedagogy: The educational design ladder. *Innovations in education and teaching international*, *54*(4), 374-385.
[38]. Luka, I. (2014). Design thinking in pedagogy. *The Journal of Education, Culture, and Society*, *5*(2), 63-74.
[39]. Goldman, S., et al. (2010). Destination, Imagination and the Fires Within: Design Thinking in a Middle School Classroom. *International Journal of Art & Design Education*, *29*(1), 37-53.
[40]. Scheer, A., Noweski, C., & Meinel, C. (2012). Transforming constructivist learning into action: Design thinking in education. *Design and Technology Education*, *17*(3), 8-19.
[41]. Lamboglia, R., et al. (2021). Exploring the relationship between audit and technology. A bibliometric analysis. *Meditari Accountancy Research*, *29*(5), 1233-1260.
[42]. Narong, D. K., & Hallinger, P. (2023). A keyword co-occurrence analysis of research on service learning: Conceptual foci and emerging research trends. *Education Sciences*, *13*(4), 339.
[43]. Iman, B., et al. (2023). Mapping research trends with factorial analysis in organizational politics. *Sage Open*, *13*(4).
[44]. Lara-Rodríguez, J. S., Rojas-Contreras, C., & Duque Oliva, E. J. (2019). Discovering emerging research topics for brand personality: A bibliometric analysis. *Australasian Marketing Journal*, *27*(4), 261-272.