INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN PROGRESSIVE EDUCATION & DEVELOPMENT

OPEN ACCESS JOURNAL

Vol 14, Issue 4, (2025) E-ISSN: 2226-6348

Design Thinking Interventions in Student Creative Performance: A Thematic Review

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DOI Link: http://dx.doi.org/10.6007/IJARPED/v14-i4/26742

Published Online: 26 October 2025

Abstract

In recent years, there has been growing emphasis on students' creativity and problem-solving abilities. Academic development and societal demands have demonstrated increasing requirements for students' innovative capabilities. Design thinking, often regarded as a user-centered iterative innovation methodology, holds significant potential for enhancing students' creative performance. This paper systematically reviews 35 publications from 2020 to 2025, employing thematic analysis to examine the current state and developmental trends of design thinking's impact on student creative performance. It focuses on four core themes: the educational application of design thinking, the visualization of creative processes, interdisciplinary and multi-group collaboration, and the institutionalization of creative literacy. Findings indicate that design thinking not only stimulates students' innovative thinking and collaborative abilities through structured processes, driving the institutionalization of creative literacy within educational systems, but also integrates multidisciplinary knowledge and diverse group resources. By leveraging visualization tools, it enhances the integrity of the creative process. This research aims to provide a systematic theoretical framework for applying design thinking in educational settings, offering significant reference value for teaching practices and policy development while laying the groundwork for future in-depth studies on design thinking and creative performance.

Keywords: Design Thinking;, Creative Expression, Innovation Capability, Interdisciplinary Education, Institutionalization of Creative Literacy, Thematic Analysis

Introduction

With the strengthening of 21st-century core competencies and reforms in educational environments, creative expression has been widely recognized as a key capability enabling individuals to tackle complex challenges and powerfully drive sustainable social development. Coupled with the acceleration of Industry 4.0 and digital transformation, the United Nations Sustainable Development Goals explicitly incorporate creative literacy into core educational objectives, further highlighting the necessity for students to confront uncertain problems through innovative abilities. Design thinking, as a human-centered innovation methodology, holds significant potential in cultivating creative expression. Widely applied in educational settings, it serves as a vital bridge connecting pedagogical practice with the development of creative literacy. However, despite the growing recognition of creativity's importance, genuine

opportunities to enhance students' creative expression remain scarce. Existing research and practice still exhibit core gaps that require resolution, directly impacting the maximization of design thinking intervention effectiveness and underscoring the necessity of this review study: First, research contexts remain fragmented. Most existing studies focus on single disciplines or isolated educational settings, making it difficult for educators to adapt design thinking methods to different subject characteristics and preventing the formation of cross-disciplinary, reusable practice frameworks. Second, creative expression lacks a unified assessment logic. Most studies examine only singular dimensions of creative expression—such as cognitive-level thinking fluency[10] or behavioral-level prototype quality.

Furthermore, significant variations in assessment tools across studies make it difficult to compare the impact of design thinking interventions on creative expression across different contexts and to comprehensively measure improvements in students' creative literacy.Meanwhile, significant variations in assessment tools across different studies make it difficult to compare the impact of design thinking on creative performance across different contexts. This also prevents a comprehensive evaluation of improvements in students' creative literacy. Finally, analyses of implementation barriers remain fragmented. Design thinking still faces numerous obstacles in practical teaching: teachers' vague understanding of design thinking and schools' lack of systematic resource support, creating a gap between theory and practice and hindering the transformation of design thinking theory into routine teaching practices. Therefore, this thematic review aims to systematically integrate existing research gaps, deeply explore the current application status and practical effects of design thinking interventions, and provide theoretical support and practical pathways for effectively cultivating creative literacy in educational settings.

Literature Review and Research Objectives

Design Thinking

Design thinking originated as a methodology employed by designers to engage in design practice. It is a user-centered, iterative approach to creative problem-solving that has since evolved into a versatile tool applicable across disciplines. At its core, it is a “way of thinking that combines analysis and creation.” Unlike traditional logical analysis, it prioritizes understanding users' deeper needs through emotional insights and emphasizes a “human-centered” perspective when solving problems. The five-stage model framework proposed by Stanford University's D.school includes: empathy, definition, ideation, prototyping, and testing. Each stage exhibits nonlinear, cyclical iterative characteristics. It integrates knowledge from design, social sciences, engineering, and business. Brown, founder of IEDO, implemented a model balancing “user needs, technical feasibility, and commercial value” through team collaboration, prototype-driven approaches, and continuous feedback. Tramonti et al. (2023)proposed that design thinking focuses not only on solution outputs but also on cultivating creativity, empathy, and metacognitive awareness through the thinking process. Thus, the design thinking methodology serves as an effective tool for addressing complex, ambiguous “wicked problems” (Rittel & Webber, 1992).

Design thinking has been widely adopted in education to cultivate and enhance students' innovative capabilities and holistic development. It has gradually shifted from theoretical exploration to interdisciplinary practice. Firstly, as a universal methodology, design thinking has been extensively integrated into multidisciplinary curricula such as STEM, art and design,

and social work. In STEM education, the “empathy-prototype” process is employed to solve real-world problems. For instance, in packaging design courses, students are guided to balance product visual design with consumer needs, thereby enhancing their creative self-efficacy; when confronting environmental sustainability challenges, it helps students integrate scientific, technological, and engineering knowledge[4]; in educational robotics courses, it serves as an auxiliary tool to enhance students' ability to solve multidisciplinary problems; and in social work education, it cultivates students' sensitivity to social needs through “human-centered” program design.

Secondly, design thinking significantly enhances students' creative expression and comprehensive competencies through process-oriented practice. During the “association” phase, techniques such as brainstorming and SCAMPER are employed to boost the fluency and originality of ideas; while the “prototype-testing” iteration reinforces the feasibility of creative concepts, cultivating skills such as empathy, collaboration, and critical thinking, with particularly positive effects on expanding the thinking of educationally disadvantaged students; iterative feedback enhances students' ability to monitor their own thought processes, stimulating intrinsic motivation for continuous innovation.

Finally, design thinking propels education from universal knowledge transmission toward practice-based inquiry. By leveraging real-world challenges like sustainability issues and community needs as drivers, it guides students to “learn by doing” through the five stages of design thinking. For instance, Stanford University students developed low-cost lighting solutions using design thinking, integrating knowledge application with creative implementation; Teachers transition from “knowledge authorities” to “facilitators,” promoting student autonomy through supportive guidance—such as interview techniques and prototyping instruction—and ongoing feedback.

Creative Expression

Creative expression refers to the process or outcome of materializing creative ideas through artistic and innovative techniques, emphasizing sensory impact—such as visual and auditory effects—and emotional resonance. Operationally, it can be defined as a dynamic process wherein individuals or groups generate tangible outputs through the interplay of skills, cognitive processes, and environmental influences (Plucker, 2004). Such outputs are characterized by originality and practicality within specific social contexts. They encompass diverse forms of expression—including art, music, writing, and innovative problem-solving—and hold the potential to enhance individuals' emotional, cognitive, and social functioning.

In the field of education, creative expression represents the comprehensive manifestation of students' creative achievements and capabilities across cognitive, behavioral, and affective dimensions. Specifically, it encompasses the following aspects: Cognitively, it involves the fluency, flexibility, and originality of creative thinking[10]; Behaviorally, it encompasses innovative practical abilities, such as the quality of prototyping and the completeness of problem-solving; At the affective level, it encompasses creative self-efficacy and immersion in creative activities. Its core characteristic is the “integration of novelty and practicality,” emphasizing both unconventional thinking outputs and alignment with real-world needs. This aligns closely with the core logic of design thinking: “human-centered and iterative optimization.”

The Role of Design Thinking in Students' Creative Expression Process

Design thinking promotes students' creative expression in multiple dimensions through structured processes, interdisciplinary integration, and the reshaping of thinking patterns.

First, activate creative output through a structured process. The five-stage design thinking process—"empathize, define, ideate, prototype, test"—provides an actionable framework for creative expression, driving ideas from abstract concepts to tangible outcomes. Thomason(2023) notes that design thinking's steps align closely with engineering design processes. When applied as a problem-solving method in classrooms, the "empathize" phase helps students transcend self-centered perspectives, identify latent user needs, and broaden creative directions—systematically fostering creativity, critical thinking, and collaboration. The "ideate" phase employs techniques like brainstorming to stimulate idea flow and originality. while the iterative "Prototype and Test" process drives continuous refinement of ideas, enhancing their feasibility. Kuo(2021) further contrasts this with traditional linear problem-solving models, emphasizing that design thinking—as a "human-centered innovation process"—breaks mental patterns, guiding students to produce more innovative product and service solutions that directly elevate the quality of creative output.

Second, expanding creative dimensions through interdisciplinary integration. The cross-disciplinary nature of design thinking provides students with diverse perspectives for creative expression. Particularly when integrated with other disciplines or methodologies, it significantly broadens the breadth and depth of creativity. Siew's research(2025) indicates that integrating social science issues with design thinking plays a crucial role in cultivating creative thinking among rural students in the field of entrepreneurship. This integration encourages students to synthesize scientific knowledge with user needs when analyzing complex social problems, generating solutions that combine social value with innovation. King(2024) also notes that combining design thinking with art education provides non-art majors with a vehicle for creative expression, enhancing their performance in innovation and strategic design while addressing gaps in interdisciplinary creative training within higher education.

Furthermore, enhancing creative literacy through a shift in mindset. The core value of design thinking lies not only in the process itself but also in the "innovative mindset" it cultivates. This mindset profoundly impacts students' long-term creative performance. Macagno found that as a process-oriented mindset, design thinking significantly alters how students approach problem-solving. Particularly when confronting complex issues like sustainability, students become more inclined to adopt flexible, iterative approaches. This mindset shift directly enhances their capacity to creatively tackle challenges. Patel (2024)links design thinking to the "4C meta-skills"—creativity, critical thinking, collaboration, and communication—arguing that by cultivating these core competencies, design thinking provides foundational support for students' creative performance, enabling them to consistently generate innovative outcomes across diverse contexts.

Finally, enhance the relevance of creativity through personalized adaptation. The flexibility of design thinking allows it to adapt to different student characteristics and educational contexts, thereby more precisely stimulating individual creative potential. Fu(2024) proposes that educators can tailor design thinking by screening and integrating methodologies through focus group discussions, removing inapplicable approaches, and

merging similar strategies based on institutional preferences and student characteristics. This customization ensures design thinking aligns with students' cognitive styles and creative starting points, avoiding the limitations of a one-size-fits-all model and ultimately enhancing the precision and effectiveness of creative expression.

In summary, as the field of education continues to evolve, the role of design thinking in fostering students' creative expression has grown increasingly significant. A growing number of researchers are focusing on addressing the enhancement of student creativity within the framework of design thinking. However, existing research on this topic remains limited, making it difficult to discern current overall trends and future research directions. Therefore, it is necessary to conduct a thematic evaluation of the literature discussing design thinking education from 2020 to 2025 through the following research question: What are the current trends in the literature from 2020 to 2025 regarding the impact of design thinking on students' creative performance?

Research Objectives

This paper reviews relevant literature on design thinking education from 2020 to June 2025, focusing on the characteristics of design thinking education to clarify the current state of research and the interrelationship between design thinking and students' creative performance. The findings aim to provide theoretical and practical guidance for effectively enhancing students' creative performance in design thinking education, laying the foundation for future research on design thinking and creative performance.

Part One introduces the role of design in students' creative expression processes and further poses the research questions. Part Two outlines the methodology, data collection, and analysis procedures employed in this study. Part Three employs directed and qualitative analysis methods based on 35 selected literature sources, focusing on four key themes: (1) the application of design thinking education, (2) the visualization of creative processes, (3) interdisciplinary and multi-group approaches, and (4) the institutionalization of creative literacy. Part IV derives a framework for the role of design thinking in implementing student creative expression. The final section presents the conclusions of this research.

Materials and Methods

This study employs the thematic analysis method proposed by Zairul (2020) to conduct a systematic analysis of the literature review, utilizing the thematic analysis software ATLAS.ti 9 as an auxiliary tool. Clark and Braun (2013) note that thematic analysis involves interpreting literature to identify patterns and construct themes. Consequently, this study's qualitative process analysis first identifies patterns within the literature to inductively derive themes, aiming to gain a deeper understanding of current research hotspots and development trends in the field of design thinking education. By analyzing and interpreting the findings, the research provides constructive suggestions for future studies in design thinking education.

The purpose of this review is to analyze and interpret the current literature on design thinking interventions affecting student creative performance. However, the topics of design thinking and creative performance have only gained attention in recent years, with limited research available on this subject. To address this, this study employs a thematic capture method to extract key data relevant to the research questions. The identified themes

represent a patterned reflection or underlying meaning that reflects a certain degree of concentration within the data. This study is dedicated to analyzing and interpreting the research findings, and to establishing criteria for future literature screening based on grounded theory research examining the impact of design thinking on creative performance. The selection criteria include: (1) publications from 2020 to 2025, (2) keywords “design thinking” or “design thinking education,” (3) studies linking design thinking to creative performance or creativity, and (4) all literature must be in English. The research process primarily involves formulating research questions, selecting and retrieving data sources, purifying data, and extracting, analyzing, and synthesizing themes. This is achieved through data visualization, result exposition, interpretation, and completion of the study.

A scoping search was conducted in June 2025, with appropriate search keywords identified through the Web of Science and SCOPUS databases. Initial literature search criteria included subject domains: design thinking and creative expression, education, and student populations. These parameters later became the formal inclusion criteria for selected studies. A systematic approach was adopted to maximize the breadth and depth of search results. English search terms: “design thinking” AND “education” AND “Creative Expression” OR ‘creativity’ OR “innovation”. Results were filtered after deduplication via Mendeley. The final dataset was uploaded to ATLAS.Ti9, where each article was categorized by author, volume and issue number, journal, publisher, and publication year for further analysis (Table 1 and Figure 1).

Table 1
Search String

Database	Search Strings	Results
Web of Science	TITLE: (design thinking) OR (“Creative Expression”) and “education” and English (Language) and Articles OR Editorial Materials OR Review Articles (Document Types) and ingenuity or design thinking method or study or Art or innovation (Web of Science Category) Timespan: 2020–2025.06	445 results
SCOPUS	TITLE-ABS-KEY (Design Thinking) OR TITLE-ABS-KEY (“Creative Expression”) AND TITLE–ABS–KEY (Design Thinking AND Creative Expression) AND LANGUAGE (English)) AND PUBYEAR > 2020 AND LIMIT-TO (DOCTYPE, “ARchiver”) AND LIMIT-TO (SUBJAREA,“EDUCATION”) OR LIMIT-TO (SUBJAREA, “ARTS”)	633 results
Mendeley	“design thinking”and "creative expression" AND DOCUMENT TYPE: Article YEAR: [2020 TO 2025.06]	494 results

An extensive database search was first conducted, yielding a total of 1,078 articles: 445 from Web of Science and 633 from Scopus. After removing 584 duplicate publications, 494 articles remained for further evaluation. These were subsequently screened based on titles, abstracts, and keywords to determine relevance, eliminating numerous unrelated studies. The chart indicates that 390 reports were excluded from detailed review for various reasons: 184 focused on arts, humanities, engineering, computer science, psychology, business economics, etc., and 206 addressed topics not directly related to education. Among the retrieved literature, only 104 underwent full-text review to assess eligibility—a critical step in

determining research relevance to the study question. Ultimately, 69 full-text articles were excluded based on specific criteria: 12 were non-English language documents, and 57 did not address outcomes relevant to higher education. This study conducted a full-text eligibility screening of all literature, categorizing them as included, uncertain, or excluded, ultimately selecting 35 articles for further analysis, as illustrated in Figure 1.

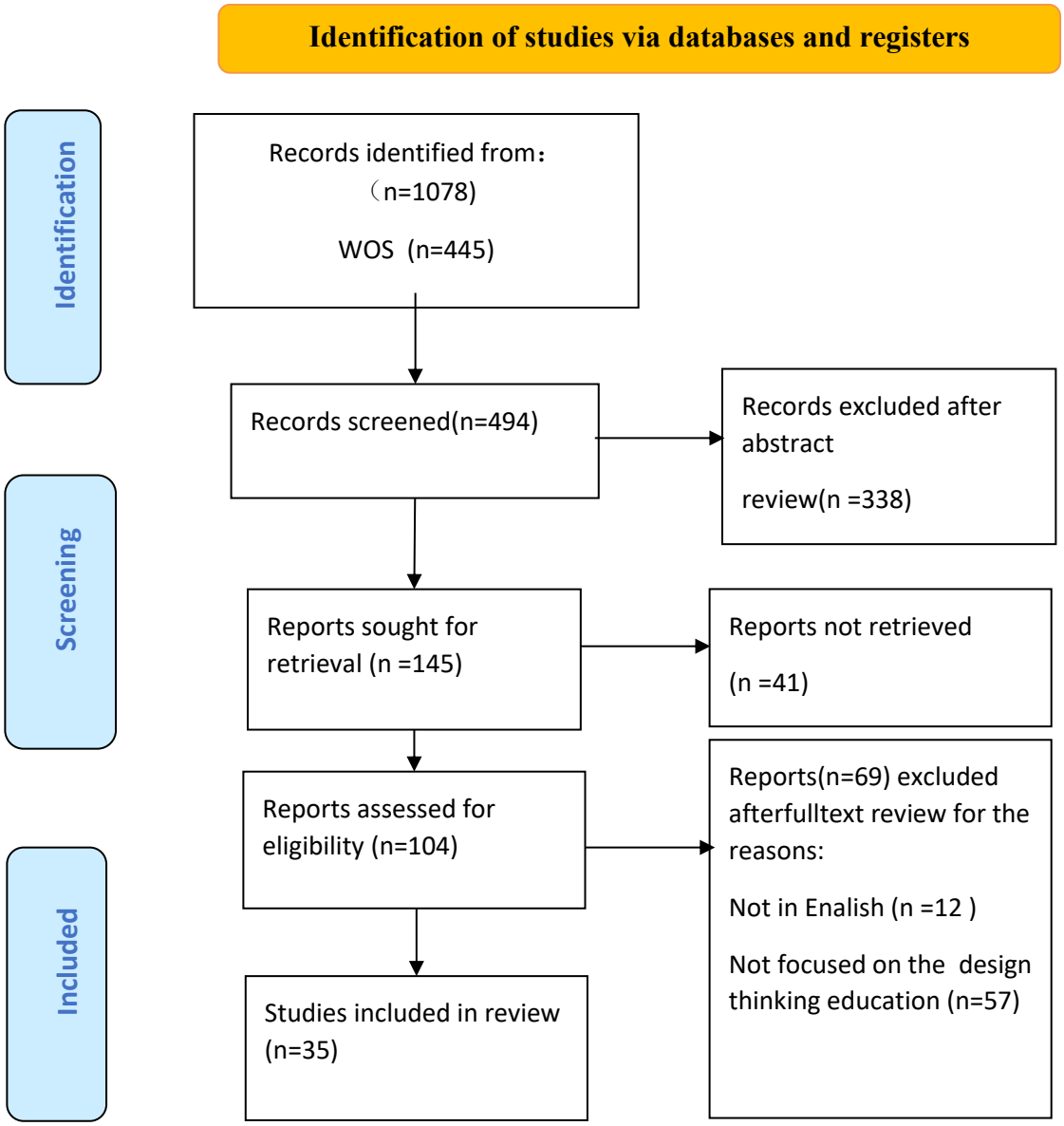

Figure 1. Inclusion and Exclusion Process in the Theme Synthesis.

The article was then evaluated using quantitative and qualitative analytical methods. The quantitative section analyzed the research findings from a mathematical perspective to derive corresponding data. Concurrently, the qualitative section extracted codes, identified themes, and developed a conceptual framework.

Result

This section presents key findings from the systematic review. Selected articles were evaluated through quantitative and qualitative analysis to address the research questions.

Quantitative Findings

By analyzing word frequency, publication year, research location, publication source, and subject matter, we can to some extent reflect research trends related to design thinking interventions on student creative performance. First, the quantitative section generated the following word cloud (Figure 1) based on analysis of source literature. As shown in Figure 1, the most frequently appearing words in the word cloud are “Design Thinking,” “Education,” “Learning,” “Creativity,” and “Students,” indicating their high occurrence in the articles. As previously stated, this study focuses on design thinking interventions affecting student creative performance. The word cloud reveals key terms within this theme:“Design”was mentioned 4,707 times, followed by“Thinking”(3,789 times) and ‘Students’ (2,733 times), while “Learning”“Education,” and “Creativity” appeared 1,856, 1,734, and 1,001 times respectively.

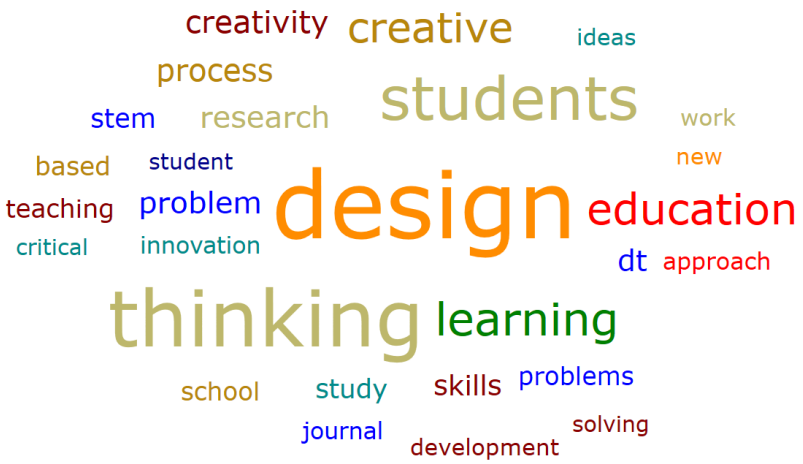

Figure 2. Word cloud generated from 35 articles

As shown in Figure 3, the annual distribution of 35 articles reviewed between 2020 and June 2025 reveals initial fluctuations, with two studies beginning in 2020. Publication numbers remained low until a significant increase in 2023 (9 articles), followed by a sustained upward trend starting in 2023, highlighting heightened academic attention. This trend peaked in 2024 with 11 articles, indicating substantially heightened research interest in the relationship between design thinking and student creative performance. Early 2025 data shows two publications, reflecting sustained academic engagement with the topic. Figure 3 demonstrates the growing emphasis on design thinking research within higher education settings.

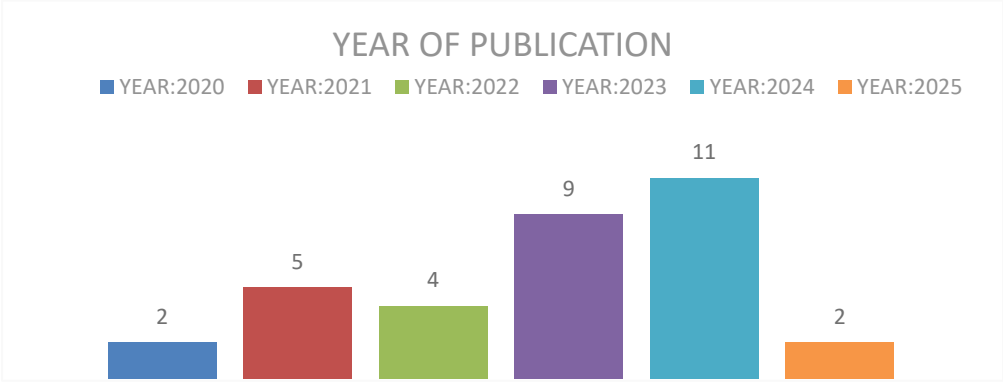

Figure 3. Publication Year.

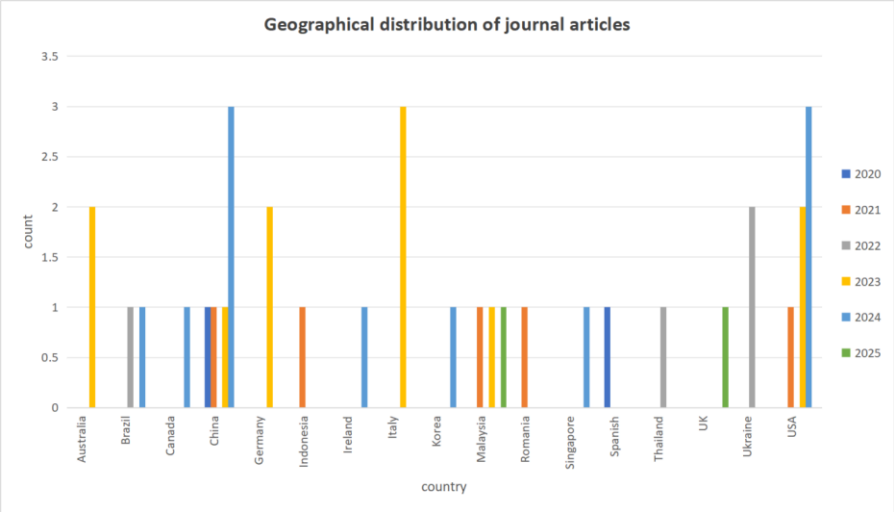

Figure 4. Publication Years and Number of Papers by Country.

Additionally, Figure 4 summarizes country-specific contributions, revealing China and the United States as the primary contributors with six publications each, highlighting their dominant role in advancing this research field. Contributions from Australia, Brazil, Canada, Germany, Indonesia, Ireland, Italy, South Korea, Malaysia, Romania, Singapore, Spain, Thailand, the United Kingdom, and Ukraine were smaller, ranging from one to three publications each. The review indicates that quantitative research designs predominate among the analyzed studies. Twelve included articles employed quantitative methods, ten utilized qualitative approaches, six adopted mixed-methods research, and the remainder employed case study methodologies, collecting data through observation and interviews. Table 2 outlines selected thematic trends and patterns in the publications. Twelve coding attributes were renamed and consolidated into four themes: Design Thinking Applications in Education, Visualization of Creative Processes, Interdisciplinary and Multi-Stakeholder Approaches, and Institutionalization of Creative Literacy. These themes will be analyzed in detail in the subsequent qualitative section. Many studies in the selected articles focus on the application of design thinking in education. The themes of Creative Process Visualization and Interdisciplinary and Multi-Group Collaboration have seen growth in the past two years, while the Institutionalization of Creative Literacy also represents a significant research focus.

Table 2
Summary of Topics and Years.

	Application Of Design Thinking Education	Institutionalization Of Creativity Literacy	Interdisciplinary and Multi-group	The Creative Process is Manifested	Total
2020	1	0	0	1	2
2021	1	1	1	2	5
2022	2	0	1	1	4
2023	4	2	3	2	11
2024	4	4	1	2	11
2025	0	0	2	0	2
Total	12	7	8	8	35

Table 3
Summary of Topics and Authors

	Application Of Design Thinking Education	Institutionalization Of Creativity Literacy	Interdisciplinary and Multi-group	The Creative Process is Manifested
Fu (2024)	√			
Tramonti (2023)	√			
Siew (2025)			√	
Lin (2024)				√
Sluijs (2024)		√		
Yang (2020)	√			
Castro (2024)	√			
Wren (2025)			√	
Vignoli (2023)	√			
Choi (2024)	√			
McLaughlin (2023)		√		
Liu (2024)			√	
Von Thienen (2023)				√
Sonia Martin (2023)			√	
Baltador(2021)	√			
Kuo (2021)			√	
Novo (2023)	√			
Schmidberger (2023)	√			
Sobieraj (2024)	√			
Noh (2021)				√
Liudmyla (2022)	√			
Garcia (2022)	√			
Ladachart (2022)			√	
Macagno (2024)		√		
King (2024)		√		
Meina (2021)		√		
Patel (2024)		√		
Seevaratnam (2023)		√		
Kozik (2022)				√
Chen (2023)				√
Pratomo (2021)				√
Latorre-Cosculluela (2020)				√
Dorland (2024)				√
Thomason (2023)			√	
Arifin (2023)			√	

Analysis of published materials indicates that educational journals are the preferred choice for researchers in design thinking and creative performance. As shown in Table 4, Frontiers in Education and Journal of Baltic Science Education are popular selections among design thinking researchers. Searching solely with keywords like “design thinking” or “creative performance” yields thousands of articles. However, adding “education” to the search string significantly reduces results. These articles are more concentrated, indicating the topic remains fresh and warrants further exploration in the future.

Table 4
Summary of Journals and Years

THEMES	2020	2021	2022	2023	2024	2025
Acta Scientiarum - Education			1			
Advances in Transdisciplinary Engineering		1				
American Journal of Pharmaceutical Education					1	
Cogent Education					1	
E3S Web of Conferences		1				
Education Sciences				1		
Eduweb			1			
Frontiers in Education				1	2	
FRONTIERS IN PSYCHOLOGY				1		
Higher Education Quarterly					1	
International Conference on Higher Education Advances				1		
International Journal of Evaluation and Research in Education		1				
International Journal of Innovation in Science and Mathematics Education			1			
International Journal of Instruction		1				
JOURNAL OF BALTIC SCIENCE EDUCATION				1		1
Journal of Chemical Education					1	
Journal of Curriculum and Teaching			1			
Knowledge Management and E-Learning				1		
MATEC Web of Conferences		1				
PLOS ONE					1	
RESEARCH PAPERS IN EDUCATION						1
Revista Brasileira de Educação Médica					1	
Revista Electrónica de Investigación Educativa	1					
STUDIES IN HIGHER EDUCATION				1		
SUSTAINABILITY				1		
Sustainability (Switzerland)	1				1	
The Canadian Journal for the Scholarship of Teaching and Learning					1	
THINKING SKILLS AND CREATIVITY					1	
Book				1		
Cogent					1	
Elsevier					1	

In summary, this section examines research trends on design thinking and student creative performance through quantitative findings, providing preliminary evidence of design thinking's positive impact on enhancing student creativity. Although these studies cover diverse aspects, students exposed to design thinking interventions demonstrate distinct differences in problem-solving tasks compared to traditional teaching groups. Few studies explicitly address the relationship between design thinking and creative performance. Wren et al. quantitatively found that integrating design thinking into STEM curricula significantly improved students' scores in creative thinking fluency and flexibility. However, the absence of a systematic DT teaching effectiveness evaluation framework makes it challenging to quantify its impact on enhancing students' core competencies—such as collaboration and innovation [6]. Consequently, research on design thinking and student creative performance remains in a phase of rapid development, with potential for expansion in research depth, geographical coverage, and methodological integration.

Quantitative Results

This section presents a qualitative analysis, explaining the themes derived from reviewing relevant articles to address the research questions. First, themes and directions concerning the impact of design thinking interventions on students' creative performance were coded. Subsequently, these codes were synthesized and inductively grouped to reflect the theoretical and conceptual frameworks underlying the researchers' thinking and investigative process. Four major themes were ultimately identified: (1) Design Thinking Educational Applications, (2) Making the Creative Process Explicit, (3) Interdisciplinary and Multi-group Collaboration, (4) Institutionalization of Creative Literacy. These themes are not mutually exclusive and may overlap across articles, meaning some articles may address multiple themes simultaneously. Each theme is discussed in depth below, drawing on findings beyond the reviewed articles as necessary to answer the research questions and develop a conceptual framework for design thinking interventions in student creative performance (Figure 5).

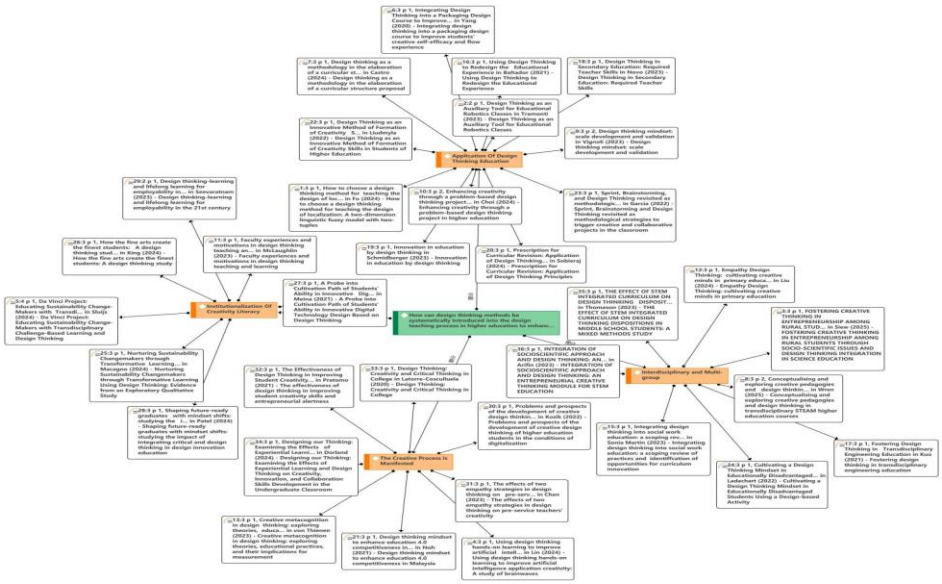

Figure 5. Overall Network.

Application Of Design Thinking Education

Design thinking, as a user-centered, iterative, and interdisciplinary methodology, exhibits multi-scenario and multi-dimensional practical characteristics in educational applications. Its core lies in activating students' creative thinking, collaborative abilities, and problem-solving competencies through structured processes, while simultaneously enhancing the adaptability and innovation of educational systems. The five-stage framework proposed by Stanford University's D.school is widely recognized. It emphasizes a closed-loop process—from deep understanding of user needs, precise problem definition, divergent solution generation, tangible prototyping, to user feedback iteration—to achieve end-to-end innovation from problem exploration to solution implementation. This methodology aligns profoundly with educational objectives: On one hand, its "human-centered" nature resonates with education's emphasis on student agency. Liudmyla(2022) notes that design thinking, through its four core principles—collaboration, participation, anthropological perspective, and experimental spirit—transforms students from passive recipients into active knowledge constructors. On the other hand, its iterative process provides a structured pathway for tackling complex problems, particularly suited for cultivating creative thinking and collaboration skills. This aligns with Novo's assertion that "design thinking is an exemplary active learning method."

However, the iterative and practical nature of the design thinking application process places high demands on resources such as time, tools, and workspaces, presenting a significant barrier to its widespread adoption. Tramonti et al. (2023)observed in secondary school robotics courses that, due to the limited time available for after-school activities, students struggled to independently complete the design and 3D printing of complex components. This reliance on teachers' advance preparation restricted the depth of student-driven innovation. Schmidberger emphasized that effective implementation of design thinking during the teacher-guided, iterative feedback phase requires ample time allocation. Insufficient resources—such as limited class hours or lack of flexible workspaces—can prevent the full realization of the "empathy-prototype-test" cycle. Furthermore, design thinking often relies on specific tools, where the technical proficiency of both students and teachers may become a bottleneck . Tramonti et al.(2023) mention that students' unfamiliarity with tools like 3D design and programming increases learning burdens. Certain technical operations require additional foundational knowledge, necessitating task simplification in practice and limiting creative complexity. Yang(2020) observed in packaging design courses that the "prototyping" requirement of design thinking may be difficult to achieve due to students' insufficient manual or digital skills, hindering the transition from concept to tangible form. While design thinking emphasizes process orientation, existing educational assessment systems face challenges in both quantitative and qualitative evaluation of its outcomes. Despite these limitations, the importance of applying design thinking in education remains undeniable (Figure 6).

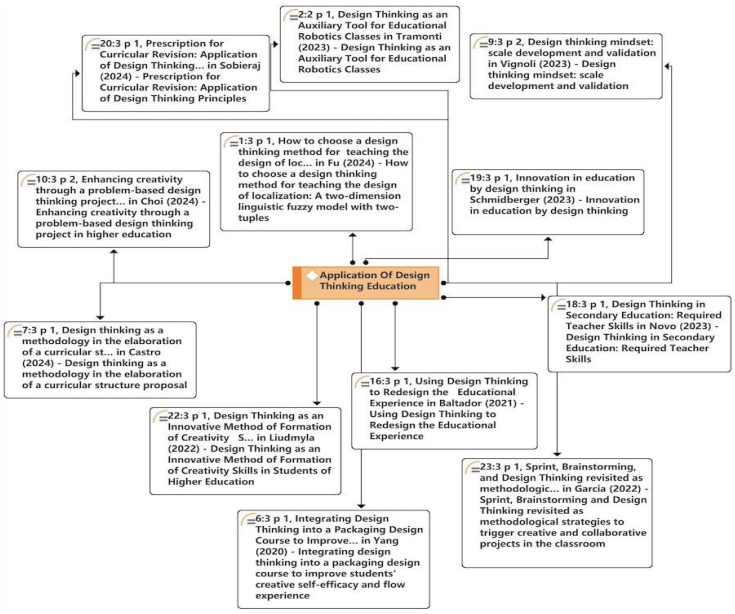

Figure 6. Thematic Network of Design Thinking Education Applications.

The Creative Process is Manifested

The creative process becomes visible when structured workflow design, tool application, and metacognitive reflection transform the entire chain—from the latent generation of inspiration and vague ideas to the explicit iteration of refined proposals and optimized prototypes—into a traceable, analyzable, and collaborative form. Its core lies in dismantling the “black box” nature of the creative process. By defining stage boundaries, documenting key milestones, and integrating feedback, the logic of idea generation, developmental trajectory, and optimization rationale become explicit knowledge.

From a theoretical perspective, the iterative and user-centered nature of design thinking provides a natural framework for making the creative process explicit. Stanford University's five-stage model breaks down the creative process into actionable steps, while David Kolb's experiential learning theory emphasizes the cycle of “experience, reflection, abstraction, and application” to help learners transform tacit knowledge into explicit knowledge. Furthermore, Von Thienen(2023) notes that monitoring and regulating the creative process through creative metacognitive theory—such as reflecting on strategy effectiveness—relies on explicit documentation of the process, providing cognitive science evidence for the necessity of explicit representation .

From a practical perspective, the multi-stage model of design thinking provides a foundational framework for visualization. During the empathy and definition phases, tools such as user interview transcripts, observation notes, and empathy maps help visualize the understanding of user needs. For instance, when comparing empathy strategies through interviews versus observation, Chen(2023) found that interviews—by documenting users' verbal expressions and inquiring about learning difficulties and challenges—clarify problem definitions, reducing blind spots in subsequent creative exploration. During ideation and prototyping, tools like brainstorming sticky notes, creative sketches, and prototype iteration logs make divergent thinking and tangible attempts explicit. Lin's (2024)research on AI

application ideation confirmed that hands-on learning design thinking (HLDT) makes the optimization trajectory traceable by visualizing outcomes across “discover, define, ideate, implement, refine” phases. Particularly in the “refine” phase, prototyping modification logs directly enhance the novelty and feasibility of creative products. During testing and iteration, tools like user feedback logs and solution comparison analyses make the alignment between ideas and user needs explicit. Von Thienen(2023) notes that “creative metacognition”—reflection on the creative process—relies on explicit analysis of test results. By comparing user evaluation distributions across different prototypes, designers can clarify directions for refining ideas .

Pratomo's(2021) vocational school case demonstrates that through the practical application of the five stages of design thinking, students can systematically grasp the logic of transforming abstract ideas into concrete forms, significantly enhancing their creativity and entrepreneurial awareness. This demonstrates that making implicit creative skills—such as empathy and prototyping techniques—explicit enables them to be taught and learned, providing educators with a basis for assessment and guidance. On one hand, Latorre-Cosculluela et al. (2020)found that teams could more efficiently integrate diverse perspectives and develop consensus-based solutions by documenting discussions during the “empathy, define, ideate” phases. Dorland(2024) further notes that design thinking tools like sticky notes and mind maps transform individual ideas into collectively visible outcomes, enhancing team collaboration efficiency. This enables members from diverse backgrounds—such as engineers and artists—to rapidly grasp each other's thinking through shared sketches. Conversely, von Thienen(2023) argues that creative metacognition relies on analyzing visible outputs at each stage. For instance, comparing user evaluation distributions across prototypes allows quantifying the suitability of creative solutions. Furthermore, visualization makes the “trial-and-error” process in creativity traceable, helping identify inefficient strategies—such as overly divergent conceptual phases—and thereby reducing wasted effort. Thus, in education, visualization processes assist learners in mastering creative methodologies (Figure 7).

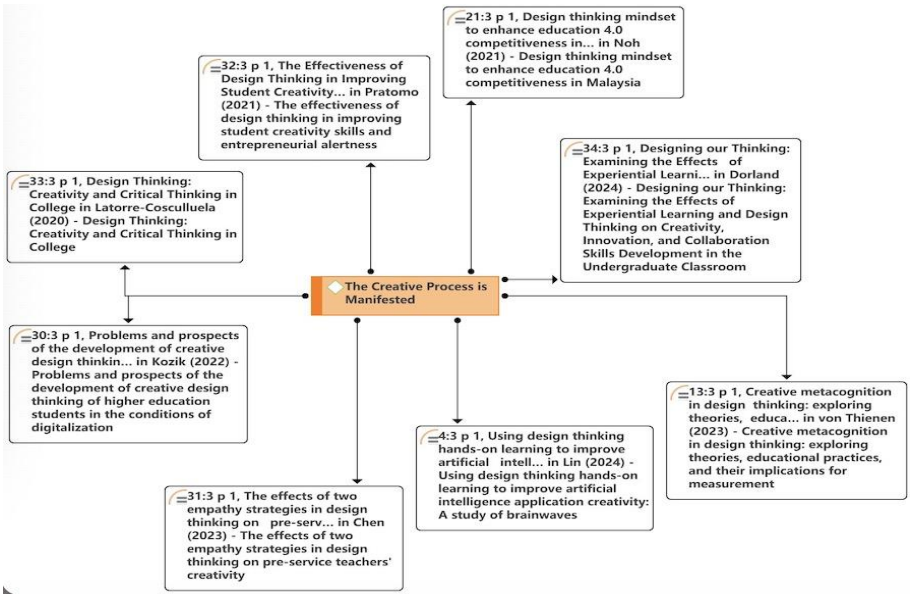

Figure 7. Visualization of the Creative Process Theme Network.

Interdisciplinary and Multi-group

Design thinking, as a methodology for tackling complex problems, relies heavily on the integration of interdisciplinary knowledge and the collaborative participation of multiple stakeholders. These elements form a dynamic interaction through knowledge complementarity, perspective convergence, and tool mediation, collectively driving the generation of innovative solutions.

First, interdisciplinary integration serves as the core strategy for design thinking to tackle "wicked problems". By synthesizing theories, methodologies, and tools from diverse disciplines, it achieves complementary knowledge and methodological innovation. The interdisciplinary nature of design thinking manifests in the systematic integration of knowledge across different fields. Kuo(2021) proposes that interdisciplinary engineering education must cultivate "T-shaped skills"—combining vertical professional depth with horizontal cross-domain collaboration—enabling design thinking to tackle complex challenges like digital manufacturing. In a sustainable development project case, integrating knowledge from environmental science (ecological impact assessment), engineering (technical feasibility), and sociology (community acceptance) yielded solutions balancing ecological, technical, and social values. Wren(2025) further demonstrated in STEAM education that interdisciplinary integration of arts and STEM more effectively addresses complex issues like climate change and urban well-being. Interdisciplinary teams achieve knowledge translation through shared tools like data visualization software, transforming abstract concepts into comprehensible concrete expressions. Siew(2025) integrates social issues assessment (SIA) with design thinking, blending agricultural technology, ethical evaluation, and business management knowledge in rural student entrepreneurship education. This approach transcends disciplinary boundaries to cultivate multidimensional problem-solving capabilities.

Interdisciplinary integration is not merely the accumulation of knowledge; it sparks methodological innovation. The "ideation phase" of design thinking relies on the collision of different disciplinary mindsets: the structured analysis of engineers, the qualitative research of sociologists, and the divergent imagination of artists collectively propel creativity beyond conventional frameworks. Arifin's "SIA-DT Module" integrates social science problem-definition methodologies with design thinking's iterative prototyping within STEM education. This enables students to precisely identify core issues while rapidly validating solutions, establishing a closed-loop innovation mechanism of "problem identification-solution generation-testing and optimization".

Secondly, multi-stakeholder collaboration embodies the human-centered essence of design thinking. By incorporating perspectives from participants with diverse backgrounds—such as learners, educators, users, and community members—it ensures solutions are both applicable and inclusive. Design thinking emphasizes the centrality of user needs, requiring multi-stakeholder involvement in identifying requirements and optimizing solutions. In medical school curriculum redesign, Castro(2024) leveraged student-faculty collaboration to clarify program requirements, resulting in solutions that met educational standards while aligning with learner realities. Sonia Martin(2023) noted that integrating design thinking with social work education requires involving groups with lived experience to ensure solutions address the genuine needs of vulnerable populations, avoiding "expert bias".

Effective multi-group collaboration relies on structured mechanisms. Ladachart's research on education for disadvantaged groups reveals that multi-group collaboration—involving students, teachers, community volunteers, and others—can compensate for the cognitive limitations of any single group. However, this requires scaffolding strategies and carefully designed collaborative rules to resolve conflicts of perspective and ensure each group's voice is heard. For instance, in rural education projects, integrating students' learning needs, teachers' pedagogical experience, and community resource conditions through collaboration enhances the practicality of design thinking solutions. Fu(2024) proposed in localized design education that selecting appropriate methods through focus group discussions balances the needs of teachers, students, and users. Thomason demonstrated in STEM courses that clear role division—such as "problem definer," "solution implementer," and "feedback tester"—enhances multi-group collaboration efficiency, facilitating smoother design thinking iterations.

Therefore, interdisciplinary integration provides the knowledge foundation for multi-group collaboration, while multi-group collaboration offers practical scenarios for implementing interdisciplinary knowledge. The two form synergy through tool mediation. For instance, interdisciplinary teams leverage multimedia tools—such as 3D modeling and virtual simulation technologies—to present prototype solutions to community users. This approach not only visualizes disciplinary knowledge but also optimizes solutions through user feedback. Thus, this synergy enables design thinking to address the knowledge demands of complex problems while ensuring the social adaptability of solutions, ultimately enhancing innovation effectiveness (Figure 8).

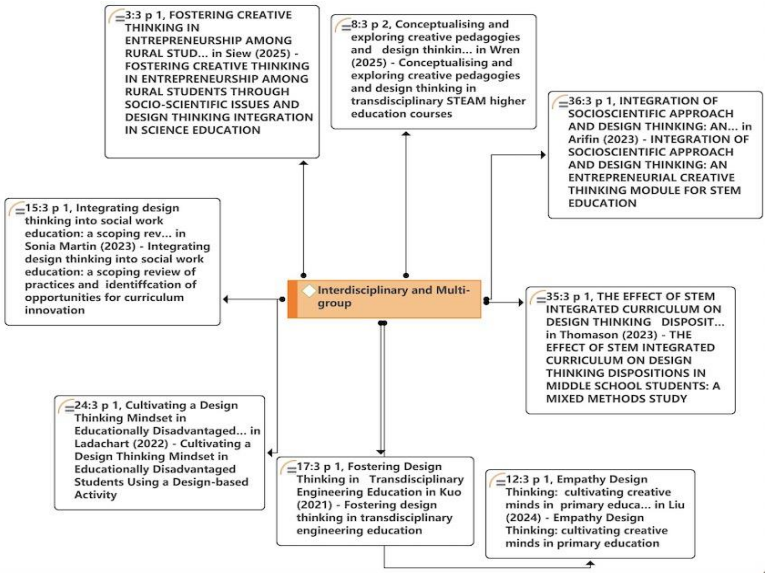

Figure 8. Interdisciplinary and Multi-Group Thematic Networks.

Institutionalization Of Creativity Literacy

Institutionalizing creative literacy involves integrating the cultivation of creative abilities—such as creative thinking, problem-solving, and collaborative innovation—into the formal institutional framework of the education system. Through systematic design encompassing policy guidance, curriculum integration, assessment mechanisms, and teacher training, the development of creative literacy becomes a sustainable and scalable educational

practice. As the core methodology for fostering creative literacy, design thinking's institutionalized path in education reflects the transformation of creative literacy from an "implicit practice" to an "explicit institution."

First, top-level policy design provides directional support for institutionalizing creative literacy. Noh(2021) notes that Malaysia's Education Blueprint (2013-2025) incorporates design thinking into its "Problem-Solving Thinking Development Model," explicitly listing creativity and innovation as core competencies for addressing Industry 4.0. By promoting DT integration into curricula through policy, it makes cultivating creative literacy a vital component of national educational objectives. Ehlers lists design thinking as one of the "17 Future Skills", further reinforcing the necessity of institutionalizing creative literacy from an industry demand perspective. This drives alignment between the education system and workplace requirements.

Such policies not only establish the critical importance of creative literacy but also ensure institutionalization through resource allocation (e.g., dedicated funds, pilot projects). For instance, in Italy's educational robotics program for secondary schools, Tramonti et al. (2023)leveraged EU educational policies supporting the integration of STEM with innovative methodologies. They incorporated design thinking elements—such as "prototype iteration" and "collaborative innovation"—into curriculum standards, making creative practice a compulsory component. This exemplifies grassroots institutionalization driven by policy guidance.

Secondly, the curriculum serves as the core vehicle for institutionalizing creative literacy. By integrating design thinking into the curricular structures of different educational stages and disciplines, creative cultivation becomes a routine practice. Novo's research(2023) in secondary education confirms that when design thinking is systematically incorporated into the curriculum as an"exemplary active learning method,"it enables the cultivation of collaborative and divergent thinking—key components of creative literacy—through the fixed process of "empathy, define, ideate, prototype, test," thereby permeating classroom instruction. For instance, in science courses, students apply design thinking to solve environmental problems through waste sorting schemes. Creative practice thus transcends extracurricular activities to become an integral component of subject instruction.

Sobieraj(2024) restructured the pharmacy curriculum through the "iterative process" of design thinking, incorporating creative problem-solving into required courses and making creative literacy one of the assessment metrics for students. Castro(2024) applied design thinking to gather student needs during medical school curriculum reform, integrating "user-centered creative design" into course planning mechanisms. This tied creative literacy development to course evaluation, establishing an institutionalized closed-loop system of "needs identification-curriculum adjustment-outcome feedback". In STEAM higher education, Wren(2025) proposed integrating design thinking through interdisciplinary curricula. This approach breaks the constraints of single disciplines, making creative literacy—including cross-domain collaboration and prototyping innovation—a core objective for cultivating multidisciplinary talent. Such courses ensure the continuity of creative literacy development through fixed credits and required modules. Vignoli's(2023) "Design Thinking Intermediate Scale" quantifies core dimensions of creative literacy—such as empathy, experimental spirit,

and creative confidence—providing standardized assessment tools. This transforms previously intangible creative abilities into measurable educational outcomes, laying the groundwork for institutionalized evaluation. In vocational school entrepreneurship education, Pratomo(2021) employs documentation of outcomes across design thinking stages, utilizing prototypes and user feedback to evaluate students' creative efficacy. This shifts assessment from a "results-oriented" approach to a comprehensive "process + results" dimension, better aligning with the developmental patterns of creative literacy.

Finally, institutionalizing creative literacy hinges on the systematic enhancement of teachers' capabilities. Novo(2023) emphasizes that secondary education must establish a "design thinking teacher training model." For instance, specialized training should equip educators with creative facilitation techniques during brainstorming sessions and prototype guidance, preventing creative instruction from becoming mere formality.Therefore, institutionalizing design thinking in education necessitates a complementary "teacher collaboration network." Through regular workshops and resource sharing, this network ensures the continuous refinement and dissemination of creative teaching methodologies(Figure 9).

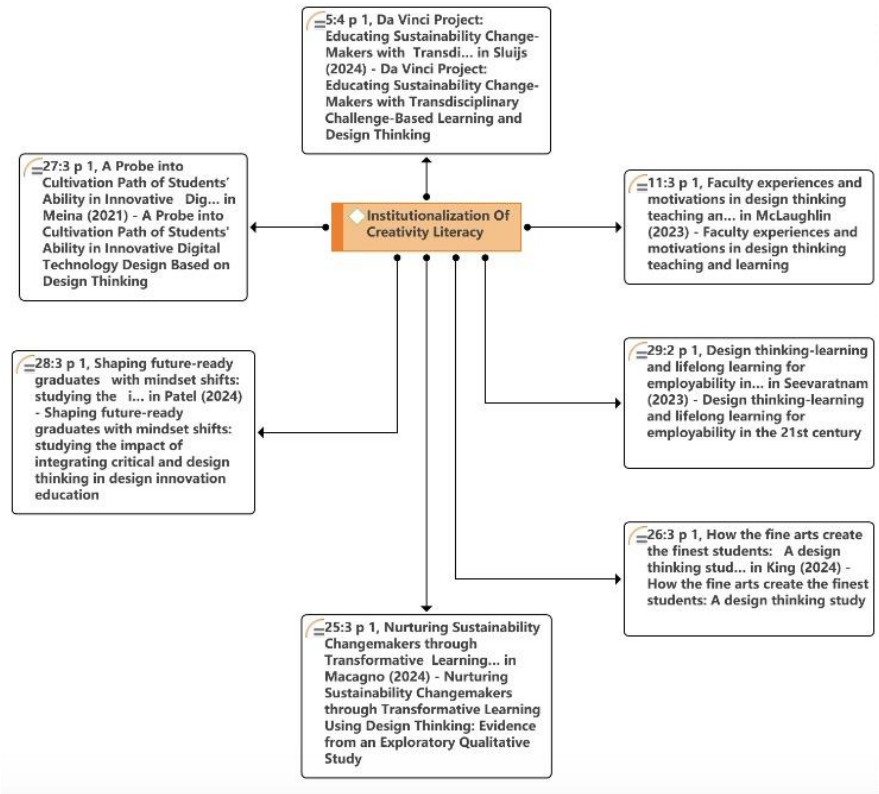

Figure 9. Thematic Network for Institutionalizing Creative Literacy.

Conceptual Framework for Intervening in Students' Creative Expression

Following the analysis and review of these articles, a conceptual framework was developed to inform further research. Figure 10 illustrates the four primary research areas for enhancing student creative performance through design thinking interventions. This framework delineates the concepts and underlying logic associated with design thinking education implementation, institutionalization of creative literacy, interdisciplinary and multi-

stakeholder collaboration, and the visualization of creative processes. This framework embodies the institutionalization of creative literacy as a foundation for establishing policies, curricula, and assessments that ensure the implementation of design thinking and the cultivation of student creativity, fostering long-term sustainability. The application of design thinking education serves as a practical pathway, guiding students through a five-stage process they help construct to stimulate innovative thinking and collaborative abilities. Within the design process framework, tools for making the creative process explicit enable students to clearly grasp and sensitively navigate each stage, promoting the explicit knowledge of tacit understanding and enhancing creative quality. Interdisciplinary and multi-stakeholder collaboration infuses multidisciplinary knowledge and diverse perspectives into the design thinking process, driving greater breadth, depth, and social awareness in student creative expression. This framework encourages active student participation, learning, and innovation within the system, ultimately fostering comprehensive creative outcomes and elevating innovation capabilities and literacy. The framework is proposed to assist researchers in further exploring relevant pathways, uncovering specific connections between these aspects, gaining deeper insights into students' creative expression abilities, and supporting educators or students in implementing learning strategies.

1. Design Thinking Education Application - Applying the five-stage design thinking process: empathize, define, ideate, prototype, test. This activates students' innovation capabilities and provides a structured path to innovation.
2. Creative Process Manifestation - Utilizing tools such as interview transcripts, mind maps, prototype logs, and user feedback to transform implicit creative processes into explicit ones, supporting diverse cognitive reflection.
3. Interdisciplinary and Multi-stakeholder Collaboration - Integrating knowledge across disciplines and diverse roles (students, teachers, users, communities) to achieve complementary expertise and optimize innovative solutions through collaboration.
4. Institutionalizing Creative Literacy - Embedding creative competency development into the education system through policy guidance, curriculum frameworks, assessment mechanisms, and teacher training to ensure sustainable advancement.

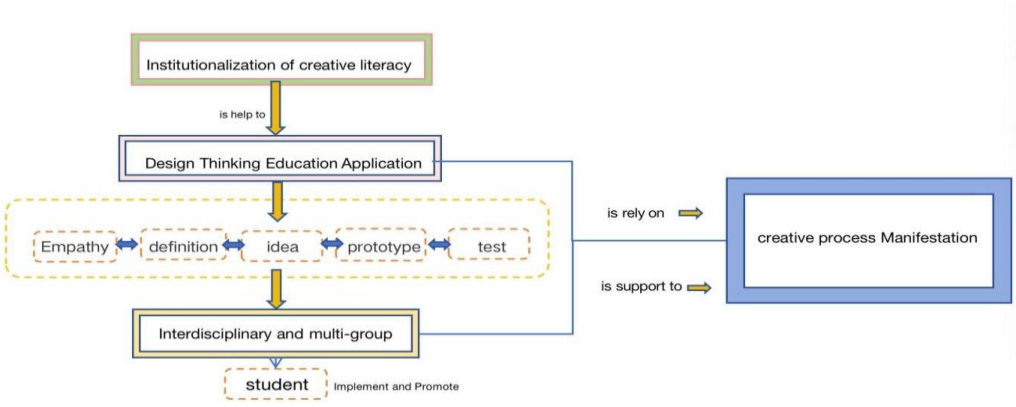

Figure 10. Conceptual Framework for Intervening in Students' Creative Expression.

Conclusion

This review conducted an in-depth study of 35 articles published between 2020 and 2025 concerning design thinking interventions and student creative performance, offering

significant theoretical insights. It comprehensively reveals the current state, development trends, and core mechanisms of design thinking in promoting student creative performance within education. The review elucidates how design thinking influences student creative performance across different dimensions. It highlights the multifaceted benefits of design thinking and underscores the necessity of cultivating it in educational settings. Findings further indicate that strengthening the institutionalization of creative literacy and promoting cross-disciplinary, multi-stakeholder participation can enhance students' creative performance, positively impacting their learning capabilities and creative potential. These discoveries underscore the pivotal role of design thinking in fostering student creativity and provide a framework for developing and implementing effective support strategies and interventions.

The theoretical contribution of this paper primarily lies in identifying trends within the current literature regarding how design thinking influences student creative performance in educational settings. It represents the first systematic synthesis of interdisciplinary research on design thinking interventions affecting student creative performance. By integrating case studies scattered across fields such as art and design, STEM, and medical education, the paper distills four major themes: the educational application of design thinking, the visualization of creative processes, interdisciplinary and multi-group approaches, and the institutionalization of creative literacy. This approach breaks the limitations of single-discipline research, forming a theoretical framework that spans multiple scenarios. Based on the interactive logic of these themes, a conceptual framework for intervening in student creative performance is established. This corrects the research flaw of focusing solely on single dimensions, providing a systematic explanation for the theoretical connection between design thinking and creative performance. The practical contribution lies in providing tiered solutions to implementation barriers: First, addressing resource and competency bottlenecks. For teacher competency gaps, explicitly enhancing five-stage facilitation techniques and interdisciplinary collaboration training enables educators to rapidly master design thinking pedagogy. Second, optimizing curriculum and assessment systems. At the institutional level, we recommend interdisciplinary modules paired with “process + outcome” assessments to address the current evaluation bias toward outcomes over processes. Finally, institutional safeguards are strengthened. To address the lack of institutionalized creative literacy frameworks, we propose integrating design thinking into regional education policies and resource allocations, establishing teacher collaboration networks, and promoting the translation of theory into routine teaching practices. This lays the groundwork for refining future assessment systems, cultivating teacher competencies, and advancing in-depth cross-cultural and multidisciplinary research, thereby driving the scalable and high-quality development of design thinking education.

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