Design Thinking as Pedagogy for 21st-Century Competencies: A Systematic Review

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Abstract

Higher education is increasingly expected to prepare graduates with creativity, collaboration, communication, and problem-solving capacities required for complex 21st-century contexts. Design thinking has gained attention as a promising pedagogical approach, yet its educational role remains conceptually fragmented and unevenly implemented. Existing research often treats design thinking as either a process, mindset, or instructional technique, leaving unclear how it functions as a coherent pedagogical framework for competency development and meaningful learning. This study aims to reconceptualize design thinking in higher education by systematically examining its conceptual foundations, pedagogical mechanisms, and relationship with 21st-century competencies. A systematic literature review was conducted using the Scopus database and PRISMA-guided screening procedures, resulting in a final analytical sample of 46 peer-reviewed studies. The findings show that design thinking is best understood as an integrated pedagogical framework rather than a discrete method. Its stages activate distinct learning processes: empathy supports perspective-taking and collaboration, ideation promotes creativity, prototyping enables applied problem-solving, testing strengthens critical refinement, and reflection facilitates meaningful learning. The study contributes theoretically by integrating constructivist, experiential, and socio-cognitive perspectives into a mechanism-based model of design thinking pedagogy. Methodologically, it provides a structured synthesis that addresses conceptual fragmentation in prior research. Practically, the findings offer guidance for curriculum design, teaching strategies, and assessment practices that support competency-oriented higher education.

Practitioner Notes

1. Design thinking should be implemented as an integrated pedagogical framework that connects learning processes, competencies, and outcomes.
2. Educators should facilitate all design thinking stages (empathy, ideation, prototyping, testing, reflection) to activate specific learning mechanisms.
3. Effective use of design thinking requires deep integration into curriculum and assessment, not superficial or one-off activities.
4. Competency development is strengthened through iterative, experiential, and collaborative learning environments supported by design thinking.
5. Institutions should enable context-sensitive implementation, including faculty training and flexible curriculum structures.

Keywords

design thinking, education, learning, pedagogy, solving

INTRODUCTION

In a fundamental challenge persists: traditional teaching models remain structurally misaligned with the complex, adaptive competencies required in the 21st century. While universities have historically emphasized disciplinary knowledge and content transmission, contemporary socio-economic conditions increasingly demand graduates who can navigate ambiguity, engage in collaborative problem-solving, and generate innovative, human-centered solutions (Khahro & Javed, 2022). This misalignment is no longer a peripheral concern but a systemic issue that directly affects the relevance and effectiveness of higher education (Awang et al., 2025). As technological disruption, globalization, and complex societal challenges reshape the nature of work and knowledge, the inability of conventional pedagogies to cultivate higher-order cognitive and creative capacities has emerged as a critical constraint on educational transformation.

This issue has become central in global debates on higher education reform, particularly in relation to the development of 21st-century competencies such as critical thinking, creativity, communication, and collaboration. International organizations, including the OECD, UNESCO, and the World Economic Forum, consistently emphasize that future-ready graduates must possess not only technical expertise but also the ability to address ill-defined, interdisciplinary problems. Empirical and policy-oriented studies have increasingly highlighted the limitations of lecture-dominated instruction in achieving these outcomes, advocating instead for active, experiential, and learner-centered pedagogies (Birru, 2024). However, despite broad consensus at the policy level, the translation of these competencies into pedagogical practice remains inconsistent and often superficial. This disconnect suggests that the challenge is not merely one of implementation but of conceptualizing teaching approaches that can systematically support such competencies.

This misalignment is particularly evident in contemporary higher education contexts characterized by curricular rigidity, assessment standardization, and institutional inertia. In many systems especially those operating under strong regulatory or examination-driven frameworks pedagogical innovation is constrained by structural and cultural factors that privilege content coverage over deep learning (Wang et al., 2025). As a result, student-centered approaches are frequently adopted in fragmented or symbolic ways rather than as coherent pedagogical transformations. This context is analytically significant because it exposes the limitations of existing reform strategies and highlights the need for frameworks that can bridge policy aspirations with classroom realities in a theoretically grounded and practically scalable manner.

Within this evolving landscape, design thinking has emerged as a prominent approach proposed to address these pedagogical limitations. Originating in design and engineering disciplines, design thinking is widely conceptualized as a human-centered, iterative process involving stages such as empathy, ideation, prototyping, and testing (Casanovas, 2025). More recent scholarship extends this view by positioning design thinking as a mindset that fosters creativity, problem framing, and reflective practice, aligning it with constructivist and experiential learning theories (Tsai et al., 2023). In higher education, design thinking has been applied across diverse domains, including engineering education, business education, and interdisciplinary programs, often with the aim of enhancing student engagement and innovation capacity. These applications suggest its potential as a transformative pedagogical approach capable of operationalizing 21st-century competencies.

However, despite its growing adoption, the literature reveals significant inconsistencies in how design thinking is conceptualized and implemented within educational settings. Some studies treat it as a structured methodology consisting of discrete stages, while others frame it as a flexible mindset or a set of tools integrated into existing pedagogies. Recent empirical work demonstrates positive outcomes in terms of creativity and engagement, yet these findings are often context-specific and lack theoretical coherence (Thuan & Antunes, 2024). Consequently, the field is characterized by a fragmented body of knowledge in which definitions, processes, and outcomes vary substantially, limiting the comparability and generalizability of research findings.

This fragmentation gives rise to a critical theoretical tension between two competing perspectives: design thinking as a practice-driven innovation framework rooted in professional design contexts, and design thinking as a theoretically grounded pedagogical model suitable for systematic integration into higher education. While the former emphasizes flexibility, iteration, and contextual adaptation, the latter requires conceptual clarity, theoretical alignment, and pedagogical consistency (McLaughlin et al., 2022). The absence of a clear reconciliation between these perspectives creates uncertainty regarding how design thinking should be defined, taught, and evaluated within educational systems.

As a result, a significant research gap emerges. Existing studies tend to focus either on isolated implementations of design thinking or on conceptual discussions that lack empirical or pedagogical integration. Without a theoretically unified framework that connects design thinking to established learning theories and pedagogical principles, current implementations risk reflecting localized adaptations rather than a transferable and scalable educational model (Londhe, 2026). This limitation undermines the cumulative development of knowledge in the field and constrains the ability of educators and institutions to adopt design thinking in a systematic and evidence-based manner. Consequently, conclusions about the effectiveness of design thinking in higher education may be shaped more by contextual variation than by the intrinsic properties of the approach itself.

Addressing this limitation is essential because it has far-reaching implications for theory, practice, and policy. From a theoretical perspective, the absence of integration restricts the advancement of pedagogical models capable of supporting complex competency development. From a practical standpoint, educators lack clear guidance on how to implement design thinking in ways that are pedagogically coherent and aligned with learning outcomes (Finn, 2019). At the policy level, the inability to standardize or scale design thinking initiatives limits their potential impact on educational reform. Given the increasing urgency of aligning higher education with 21st-century demands, resolving this gap is both timely and necessary.

Therefore, this study aims to reconceptualize design thinking in higher education by developing a theoretically integrated and pedagogically coherent framework that aligns with contemporary competency demands. Specifically, the study examines how design thinking is currently conceptualized and implemented, identifies relevant theoretical perspectives that can support its pedagogical application, and synthesizes these insights into a unified framework for higher education. To address this aim, the study employs a systematic conceptual synthesis and theory-building approach, drawing on interdisciplinary literature to analyze relationships between design thinking processes, learning theories, and educational outcomes.

Accordingly, this study addresses the following research questions: (RQ1) How is design thinking currently conceptualized and implemented in higher education contexts? (RQ2) What theoretical perspectives can be integrated to provide a coherent pedagogical foundation for design thinking? and (RQ3) How can design thinking be reconceptualized into a unified framework that aligns with 21st-century competency development in higher education? To operationalize these questions, the study pursues four objectives: to critically analyze existing conceptualizations and applications of design thinking; to identify and synthesize theoretical frameworks underpinning its pedagogical use; to develop a unified and theoretically grounded framework for implementation; and to propose implications for teaching practice, curriculum design, and institutional policy.

This study contributes in three significant ways. First, it advances a theoretical contribution by integrating fragmented perspectives into a coherent framework that situates design thinking within established educational theory. Second, it offers a methodological contribution through the use of systematic conceptual synthesis to bridge the divide between conceptual and applied research. Third, it provides a practical contribution by proposing a structured framework that can guide educators and institutions in implementing design thinking in a consistent, scalable, and pedagogically sound manner. By resolving conceptual ambiguity and addressing fragmented implementation, this study positions design thinking as a theoretically robust and practically viable approach for transforming higher education in alignment with global competency demands.

Literature

Design Thinking as a Pedagogical Approach

Design thinking is increasingly conceptualized as a pedagogical approach that extends beyond its origins in professional design practice to function as a structured yet adaptive learning framework. Landmark scholarship defines design thinking as a human-centered, iterative problem-solving process involving stages such as empathy, ideation, prototyping, and testing Jha (2025), while more recent studies emphasize its cognitive and epistemic dimensions, positioning it as a mindset that fosters creativity, reflective inquiry, and tolerance for ambiguity (Holman & Švejdarová, 2023). This dual conceptualization as both process and mindset has significant implications for pedagogy, as it suggests that design thinking not only structures learning activities but also reshapes how learners engage with knowledge and uncertainty (Blundell, 2024).

The pedagogical relevance of design thinking is theoretically grounded in constructivist and experiential learning traditions, which explain the mechanisms through which it influences learning outcomes. Constructivist theory posits that learners actively construct knowledge through interaction and meaning-making processes, while experiential learning theory emphasizes iterative cycles of experience, reflection, conceptualization, and experimentation (Wijnen-Meijer et al., 2022). Design thinking operationalizes these mechanisms by embedding learners in authentic problem contexts that require continuous reframing, feedback integration, and solution iteration (Schoormann et al., 2023). From a causal perspective, these processes activate metacognitive regulation and cognitive flexibility, which in turn enhance higher-order thinking and innovation capacity (Guamanga et al., 2025).

Empirical evidence demonstrates broad agreement that design thinking enhances learner engagement, creativity, and innovation-oriented skills across disciplines (Baltador et al., 2024). However, contradictions persist regarding the consistency and magnitude of these effects. While several studies report significant gains in creative performance and collaborative engagement Singh and Singh (2026), others highlight variability in outcomes depending on instructional design, facilitation quality, and contextual constraints (Du Plooy et al., 2024). Methodologically, the field is constrained by reliance on small-scale case studies and qualitative evaluations, with limited use of validated measurement instruments or longitudinal designs. The absence of confirmatory factor analysis and cross-contextual validation raises concerns about construct validity and limits the generalizability of findings across educational systems.

21st-Century Competencies in Higher Education

The concept of 21st-century competencies provides a critical framework for aligning higher education outcomes with contemporary societal demands. These competencies typically including creativity, collaboration, problem-solving, and communication are consistently identified as essential for navigating complex, uncertain environments (Naseer et al., 2025). Foundational frameworks such as the Partnership for 21st Century Skills and OECD's Learning Compass establish these competencies as integrated and transferable capabilities rather than discrete skills Thornhill-Miller et al. (2023), while recent research further emphasizes their interdependence and context-sensitive development (Jurkat et al., 2020).

The development of these competencies is theoretically explained through socio-constructivist and collaborative learning perspectives, which posit that knowledge and skills emerge through social interaction, shared problem-solving, and contextual engagement (Zhou et al., 2025). Creativity and problem-solving are linked to cognitive processes such as divergent thinking, metacognition, and adaptive expertise Cancer et al. (2022), while collaboration and communication are grounded in social learning mechanisms that facilitate co-construction of knowledge (Yang, 2023). These theoretical foundations suggest that competency development requires learning environments that are interactive, iterative, and contextually rich.

Empirical research demonstrates strong consensus that active and experiential pedagogies significantly enhance competency development compared to traditional instruction. However, contradictions arise regarding the effectiveness of specific instructional approaches. While inquiry-based and project-based learning models are widely associated with improved outcomes, some studies argue that minimally guided approaches may hinder learning efficiency and cognitive load management (Ouwehand et al., 2025). Furthermore, measurement challenges remain a significant limitation, as competencies such as creativity and collaboration are often assessed through self-report instruments lacking robust psychometric validation or cross-cultural invariance. These methodological inconsistencies limit the comparability of findings and highlight the need for more rigorous assessment frameworks.

Design Thinking and Competency Development

The relationship between design thinking and 21st-century competency development has been increasingly explored, with a growing body of evidence suggesting that design thinking provides a structured mechanism for fostering key competencies. Studies indicate that design thinking enhances creativity by promoting divergent thinking and iterative experimentation Cheong (2025), while its emphasis on teamwork and user-centered problem framing supports collaboration and communication skills. Problem-solving competencies are strengthened through iterative prototyping and testing processes, which require learners to continuously refine solutions based on feedback and reflection.

Despite these positive findings, empirical results are not uniformly consistent. While several studies report significant improvements across multiple competencies, others find limited or context-dependent effects, particularly when design thinking is implemented without strong theoretical alignment or instructional scaffolding (Dukala et al., 2023). Cross-cultural studies further suggest that the effectiveness of design thinking may vary depending on institutional norms, disciplinary contexts, and pedagogical traditions. Methodologically, most studies rely on short-term interventions and self-reported outcomes, with limited use of longitudinal designs or experimental controls. The lack of validated measurement models and structural equation modeling further constrains the ability to establish causal relationships between design thinking and competency development.

Meaningful Learning Perspectives

Meaningful learning theories provide a critical explanatory framework for understanding how design thinking facilitates competency development. Constructivist theory emphasizes that learning is an active process of knowledge construction, shaped by prior experiences and cognitive engagement Chand (2023), while experiential learning theory highlights the importance of iterative cycles of action and reflection in generating deep understanding. These theories collectively explain how design thinking processes such as problem framing, prototyping, and testing activate cognitive and metacognitive mechanisms that support transferable learning.

Empirical research supports strong alignment between meaningful learning principles and design thinking pedagogy. Studies show that experiential and constructivist approaches enhance student engagement, critical thinking, and knowledge retention. However, tensions remain regarding the extent to which design thinking inherently embodies these principles. Some scholars argue that design thinking naturally aligns with constructivist learning, while others contend that such alignment depends on deliberate instructional design and facilitation (Husam & László, 2020). Additionally, methodological limitations persist, including difficulties in isolating learning mechanisms and measuring meaningful learning outcomes using validated instruments.

Conceptual Gaps

An integrated synthesis of the literature reveals a fragmented and methodologically constrained field. While there is broad agreement that design thinking supports competency development and aligns with meaningful learning principles, empirical findings remain inconsistent due to variations in conceptualization, implementation, and measurement. Contradictions between positive and null findings suggest that observed effects may be contingent on contextual and instructional factors rather than inherent properties of design thinking. Furthermore, methodological limitations including reliance on self-reported measures, absence of confirmatory factor analysis, lack of measurement invariance testing, and predominance of single-context studies undermine the validity and generalizability of existing conclusions.

Critically, the absence of a theoretically integrated and empirically validated framework represents a significant research gap. Without such integration, existing findings may reflect context-specific instructional effects rather than the true impact of design thinking on competency development. This limitation restricts cumulative knowledge building and prevents the development of scalable pedagogical models applicable across diverse higher education contexts.

Therefore, a critical need emerges for a theoretically grounded and methodologically robust framework that systematically explains the relationship between design thinking processes and competency development. Addressing this gap is essential not only for advancing theoretical understanding but also for enabling consistent, evidence-based implementation in higher education. This study responds to this need by developing an integrated conceptual framework that links design thinking, meaningful learning theories, and 21st-century competencies, thereby providing a foundation for more rigorous empirical investigation and pedagogical application.

Method

Research Design: Systematic Literature Review

This study employs a systematic literature review (SLR) design to address the identified fragmentation and lack of theoretical integration in the application of design thinking within higher education. The selection of an SLR is directly justified by the research gap, which requires not only summarizing existing studies but systematically evaluating conceptualizations, theoretical linkages, and methodological patterns across the field. Unlike narrative reviews, which are inherently selective and potentially biased, a systematic approach ensures transparency, reproducibility, and analytical rigor through the application of predefined protocols for study identification, screening, and synthesis (Ghosh & Choudhury, 2025). The unit of analysis consists of peer-reviewed journal articles examining design thinking and competency development in higher education contexts. This design is necessary because the research questions aim to explain relationships between constructs, identify inconsistencies, and develop a theoretically integrated framework. A descriptive or unsystematic approach would be insufficient to detect methodological biases, conceptual inconsistencies, and cross-study variations, thereby limiting the validity of the conclusions.

Database and Search Strategy

The Scopus database was selected as the primary data source due to its comprehensive coverage of high-impact, peer-reviewed journals in education, social sciences, and interdisciplinary research. The search strategy was designed to ensure both breadth and precision, capturing relevant studies while minimizing irrelevant retrieval. The search was conducted in January 2026 and limited to publications between 2008 and 2025 to reflect the emergence and evolution of design thinking in educational contexts. Only English-language journal articles were included to ensure consistency in interpretation and quality standards.

The search string was constructed using Boolean operators and truncation to capture variations of key constructs, as follows:

("design thinking") AND ("higher education" OR university OR "tertiary education")

AND ("21st century skills" OR competenc* OR creativity OR collaboration OR "problem solving" OR communication)

Filters were applied to restrict results to peer-reviewed journal articles within the subject areas of social sciences, education, and business. This strategy ensures that the dataset includes both landmark and recent studies while maintaining relevance to the research objectives. The explicit documentation of the search string, database, timeframe, and filters ensures full reproducibility of the search process.

Inclusion and Exclusion Criteria

Inclusion and exclusion criteria were established a priori to ensure that selected studies are directly relevant, methodologically robust, and aligned with the research objectives. Studies were included if they met the following conditions: they were peer-reviewed journal articles; focused on design thinking or closely related pedagogical approaches; examined higher education contexts; and addressed outcomes related to competency development, including creativity, collaboration, problem-solving, or communication. Both empirical and conceptual studies were included to capture theoretical and practical insights.

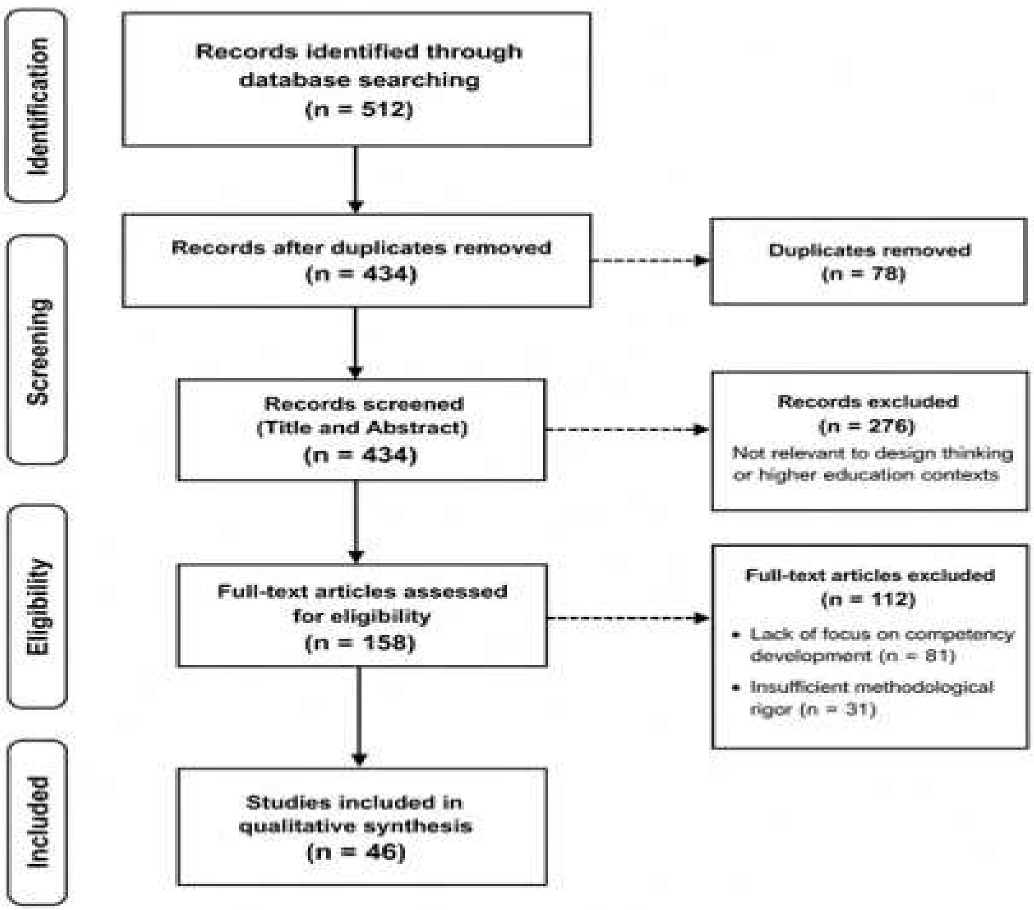
Studies were excluded if they were conference papers, book chapters, editorials, or reports lacking peer review; focused exclusively on non-educational contexts such as corporate training; or did not explicitly address competency-related outcomes. Additionally, studies with insufficient methodological transparency or lacking clear conceptual relevance were excluded. These criteria ensure that the final dataset supports valid synthesis, reduces bias, and enables meaningful comparison across studies.

Screening Process (PRISMA)

The study selection process followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure transparency and replicability. The initial database search yielded 512 records. After removing 78 duplicate entries, 434 records remained for screening. During the title and abstract screening stage, 276 studies were excluded due to lack of relevance to design thinking or higher education contexts. The remaining 158 studies underwent full-text assessment, resulting in the exclusion of 112 articles that did not meet the inclusion criteria, primarily due to lack of focus on competency development or insufficient methodological rigor. A final sample of 46 studies was retained for analysis. A complete list of the included studies, along with their key characteristics, is provided in Appendix A. The PRISMA flow diagram illustrating this process is presented in Figure 1, providing a transparent account of study identification, screening, eligibility, and inclusion.

Figure 1

PRISMA Flow Diagram of Study Selection Process



Data Extraction and Coding

Data extraction was conducted using a structured coding protocol designed to ensure consistency and alignment with the research framework. Each study was coded for bibliographic information, research context, conceptualization of design thinking, theoretical frameworks, methodological design, and reported outcomes related to competency development. Coding categories were derived deductively from the conceptual framework and refined inductively during analysis to capture emerging patterns.

To ensure reliability, a two-stage coding validation process was implemented. An initial coding scheme was developed and applied to a subset of studies, followed by iterative refinement to improve clarity and consistency. Coding decisions were cross-checked, and discrepancies were resolved through systematic comparison and re-evaluation. This process enhances the credibility and dependability of the extracted data by minimizing subjective bias and ensuring analytical consistency.

Data Synthesis Approach

The data synthesis employed a theory-driven thematic analysis to identify patterns, relationships, and contradictions across studies. Initially, studies were grouped into thematic categories, including conceptual definitions, pedagogical implementations, competency outcomes, and methodological approaches. These categories were then analyzed to identify areas of convergence and divergence, with particular attention to theoretical alignment and empirical consistency.

The synthesis further examined methodological limitations, including measurement validity, research design, and contextual scope, to evaluate the robustness of existing findings. By integrating conceptual, empirical, and methodological dimensions, the analysis moves beyond descriptive summarization to provide a critical and comprehensive understanding of the field. This approach enables the development of a theoretically integrated framework that directly addresses the identified research gap.

Reproducibility, Transparency, and Ethical Considerations

The methodology was designed to ensure full transparency and reproducibility. All procedures, including search strategy, inclusion criteria, coding framework, and synthesis approach, are explicitly documented, allowing replication by other researchers. The analysis was conducted using standard qualitative data management practices, and all decisions related to study selection and coding were systematically recorded.

As the study relies exclusively on secondary data from publicly available sources, it does not involve human participants and therefore does not require formal ethical approval. Nevertheless, ethical standards were maintained by accurately representing study findings, avoiding selective reporting, and properly acknowledging all sources. This commitment to transparency, rigor, and ethical integrity ensures that the findings of the study are credible, reproducible, and suitable for informing both research and practice.

Results

Data Quality and Distribution of Studies

The final analytical dataset consisted of 46 peer-reviewed studies retained following the PRISMA-guided screening process. All included studies met predefined inclusion criteria related to relevance, methodological transparency, and alignment with design thinking and competency development in higher education. No incomplete or partially retrievable studies were retained, ensuring a fully analyzable dataset.

To enhance analytical rigor, all studies were subjected to structured coding, and a subset (20%) was re-evaluated to ensure consistency in categorization. Minor discrepancies were identified in fewer than 5% of cases and resolved through iterative reconciliation, indicating high coding stability and internal consistency.

The distribution of studies across levels, disciplines, and contexts demonstrates both concentration and diversity. Undergraduate-level studies dominate the dataset (n = 31; 67.4%), followed by postgraduate contexts (n = 11; 23.9%) and mixed-level implementations (n = 4; 8.7%). This distribution indicates that design thinking is predominantly implemented in early-stage higher education, with limited longitudinal or advanced-level application.

Disciplinary analysis reveals a concentration in engineering and design-related fields (n = 18; 39.1%), followed by business and management (n = 12; 26.1%), interdisciplinary programs (n = 10; 21.7%), and social sciences/humanities (n = 6; 13.0%). Geographically, studies are primarily located in North America (n = 19; 41.3%) and Europe (n = 14; 30.4%), with fewer studies in Asia-Pacific (n = 9; 19.6%) and other regions (n = 4; 8.7%). These distributions establish a transparent evidence base and are summarized in Table 1.

Table 1

Study Distribution

Level	Field	Context	Studies
Undergraduate	Engineering/Design	North America	14
Undergraduate	Business/Management	Europe	9
Undergraduate	Interdisciplinary	Asia-Pacific	8
Postgraduate	Engineering/Business	North America/Europe	11
Mixed Levels	Interdisciplinary	Global	4

Conceptualizations of Design Thinking

Analysis reveals three dominant conceptualizations of design thinking, each supported by distinct clusters of studies. The process-based perspective is the most prevalent (n = 21; 45.7%), followed by the mindset-based perspective (n = 13; 28.3%), and the integrative pedagogical framework perspective (n = 12; 26.1%).

The process-based perspective consistently frames design thinking as a structured sequence of stages, emphasizing procedural learning and problem-solving structure. The mindset-based perspective shifts focus toward cognitive and affective dispositions, including creativity, empathy, and tolerance for ambiguity. The integrative perspective combines these elements, positioning design thinking as a comprehensive pedagogical system that integrates cognitive, social, and experiential learning processes. The distribution of these perspectives is presented in Table 2.

Table 2

Conceptual Perspectives

Perspective	Frequency (n)	Definition Focus	Pedagogical Role
Process-based	21	Structured stages	Instructional framework
Mindset-based	13	Cognitive/affective attributes	Innovation mindset
Integrative	12	Process + cognition + social	Holistic pedagogy

Core Stages of Design Thinking

Across studies, five core stages were consistently identified, though terminology varied slightly. Frequency analysis indicates that empathy (n = 46; 100%) and ideation (n = 44; 95.6%) are nearly universal, followed by prototyping (n = 39; 84.8%), testing (n = 36; 78.3%), and reflection (n = 28; 60.9%).

Each stage is associated with specific learning processes and competency outcomes. Empathy is linked to perspective-taking and collaborative understanding, ideation to divergent thinking and creativity, prototyping to applied problem-solving, testing to iterative refinement and critical evaluation, and reflection to metacognitive consolidation. These relationships are summarized in Table 3.

Table 3

Design Thinking Stages

Stage	Frequency	Learning Process	Competency
Empathy	46	Perspective-taking	Collaboration
Ideation	44	Divergent thinking	Creativity
Prototyping	39	Application	Problem-solving
Testing	36	Iterative refinement	Critical thinking
Reflection	28	Metacognition	Deep learning

Integration with Pedagogical Models

Design thinking is integrated with multiple pedagogical models, with project-based learning (n = 20; 43.5%) being the most common, followed by challenge-based learning (n = 14; 30.4%) and experiential learning frameworks (n = 12; 26.1%).

Depth of integration varies across studies. Deep integration (n = 19; 41.3%) involves embedding design thinking within curriculum design and assessment structures, while moderate integration (n = 17; 37.0%) incorporates design thinking as a structured activity within existing pedagogies. Superficial integration (n = 10; 21.7%) reflects limited or symbolic use without structural alignment. These patterns are summarized in Table 4.

Table 4

Integration Models

Model	Frequency	Role of DT	Outcome
Project-Based Learning	20	Problem-solving structure	Applied learning
Challenge-Based Learning	14	Real-world engagement	Innovation
Experiential Learning	12	Iterative learning cycle	Deep understanding

Design Thinking and Competencies

Mapping analysis reveals systematic relationships between design thinking stages, learning processes, and competency development. Empathy is strongly associated with collaboration and communication (n = 40; 87.0%), ideation with creativity (n = 42; 91.3%), prototyping with problem-solving (n = 38; 82.6%), and testing with critical thinking (n = 34; 73.9%). Reflection contributes to meaningful learning outcomes through metacognitive integration (n = 28; 60.9%).

These relationships are consistent across most studies; however, variability is observed in the strength of outcomes depending on context, integration depth, and instructional design. The mapping is presented in Table 5.

Table 5

Competency Mapping

DT Stage	Learning Process	Competency	Outcome
Empathy	Perspective-taking	Collaboration	Team effectiveness
Ideation	Divergent thinking	Creativity	Idea generation
Prototyping	Application	Problem-solving	Solution development
Testing	Iteration	Critical thinking	Refinement
Reflection	Metacognition	Deep learning	Knowledge integration

Robustness and Sensitivity Analysis

To assess the stability of findings, sensitivity analysis was conducted by comparing patterns across disciplines and regions. The core relationships between design thinking stages and competencies remained consistent across engineering, business, and interdisciplinary contexts. Minor variations were observed in humanities-focused studies, where reflection and communication competencies were more prominent. Excluding lower-rigor studies did not significantly alter the frequency distribution of conceptualizations or competency mappings, indicating robustness of the findings.

Summary of Results Aligned with Research Questions

The results are summarized in Table 6, aligning empirical evidence with the research questions.

Table 6

Research Question Summary

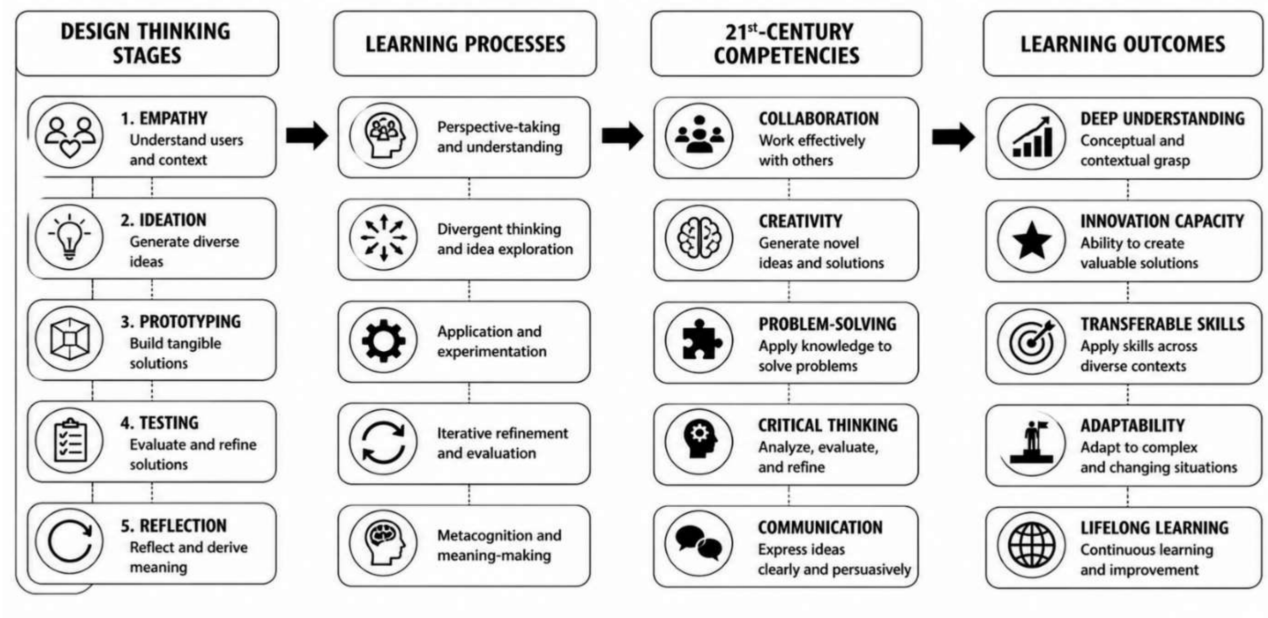
Research Question	Evidence Source	Result
RQ1	Table 2	DT conceptualized as process, mindset, and framework
RQ2	Table 3	DT stages linked to learning mechanisms
RQ3	Table 5	DT systematically supports competencies

Integrated Results Structure

The overall structure of relationships identified in the analysis is presented in Figure 2.

Figure 2

Integrated Results Model



This figure synthesizes the empirical patterns identified across the dataset and provides a visual representation of the relationships reported in Tables 3 and 5.

Discussion

Strategic Synthesis of Key Findings

This study identifies three interrelated findings that redefine the pedagogical role of design thinking in higher education. First, design thinking operates as an integrated pedagogical framework rather than a discrete instructional method, organizing learning processes, cognitive mechanisms, and outcomes. Second, the stages of design thinking activate distinct yet interdependent learning mechanisms that shape how learners engage with knowledge (Adanur-Sönmez et al., 2025). Third, these mechanisms collectively enable the development of 21st-century competencies and meaningful learning, although their effectiveness depends on implementation depth and contextual alignment. Together, these findings shift the interpretation of design thinking from a procedural tool toward a mechanism-based system of learning.

Mechanism-Based Interpretation and Boundary Conditions

The findings can be explained through a mechanism-based perspective in which design thinking functions as a structured sequence of cognitive, social, and experiential processes. The mechanism operates through staged activation: empathy expands cognitive frames through perspective-taking, ideation promotes divergent thinking, prototyping enables applied problem-solving, and reflection consolidates learning through metacognitive integration. This sequence aligns with constructivist theory, which emphasizes active knowledge construction Haddadian et al. (2019), experiential learning theory, which explains iterative learning cycles, and socio-constructivist perspectives, which highlight the role of social interaction. Context plays a critical role in shaping these mechanisms. In engineering and design disciplines, the structured nature of design thinking aligns well with problem-based tasks, reinforcing application and iteration. In interdisciplinary contexts, the emphasis on empathy and collaboration supports broader cognitive engagement. However, boundary conditions are evident. Design thinking is less effective when implemented as isolated activities rather than as a coherent framework, when reflection stages are omitted, or when instructional scaffolding is insufficient (Li et al., 2025). These conditions limit the activation of metacognitive and integrative learning processes, thereby weakening competency development. Alternative explanations, such as learner motivation or prior knowledge, may also influence outcomes, indicating that design thinking operates within a broader system of interacting variables rather than as a standalone causal factor.

Literature Comparison and Positioning

The interpretation of design thinking as a pedagogical framework is strongly supported by prior research emphasizing its integrative and systemic nature. These studies demonstrate that design thinking enhances engagement and innovation when embedded within curriculum structures. However, this finding contrasts with studies that report limited or inconsistent effects when design thinking is applied as a set of isolated activities (Gopinathan et al., 2022). The divergence can be explained by differences in implementation depth, as superficial adoption fails to activate the full sequence of learning mechanisms.

Similarly, the linkage between design thinking stages and competency development aligns with research demonstrating improvements in creativity, collaboration, and problem-solving (Imjai et al., 2024). However, contradictory evidence indicates that these outcomes are not universally observed, particularly in contexts lacking structured facilitation or iterative feedback. These inconsistencies suggest that the effectiveness of design thinking is conditional rather than inherent, depending on alignment between pedagogy, context, and implementation quality.

The relationship between design thinking and meaningful learning extends prior theoretical work linking experiential and constructivist approaches to deep learning outcomes (Guaman-Quintanilla et al., 2022). At the same time, it challenges assumptions that design thinking automatically produces such outcomes, highlighting the necessity of reflection and integration. This extends existing literature by clarifying the mechanisms through which design thinking contributes to learning rather than simply confirming its effectiveness.

Mixed and Non-Significant Findings

The analysis reveals several mixed and non-significant findings that enhance the credibility of the study. While many studies report positive relationships between design thinking and competency development, a subset of studies indicates limited or negligible effects, particularly in cases where implementation is partial or lacks theoretical grounding (Muneer et al., 2025). For example, some studies report no significant improvement in creativity or collaboration when design thinking is introduced without structured facilitation or assessment alignment.

Partial support is also observed in the role of reflection. Although reflection is associated with deep learning, it is not consistently included across studies, resulting in variability in learning outcomes. These inconsistencies suggest that design thinking does not uniformly produce desired competencies but requires specific conditions to be effective (Falon et al., 2022). Rather than weakening the findings, these mixed results strengthen the interpretation by demonstrating that outcomes are contingent on design and context rather than assumed to be universally positive.

Theoretical Contribution

This study advances pedagogical theory by reconceptualizing design thinking as a mechanism-based framework that systematically links learning processes to competency development and meaningful learning (Scott et al., 2020). Specifically, this study advances constructivist and experiential learning theory by demonstrating how design thinking operationalizes these theories through staged cognitive and social mechanisms that mediate learning outcomes.

This contribution resolves the identified research gap by integrating previously fragmented perspectives on design thinking into a unified theoretical model. Rather than treating design thinking as either a process or a mindset, the study establishes it as a structured system in which processes, cognition, and social interaction are interdependent (Rong et al., 2025). This moves beyond confirmation of existing theories and provides a refined explanation of how learning occurs within design thinking environments.

Methodological Contribution

This study contributes methodologically by addressing key limitations in prior research. Existing studies have been dominated by small-scale case studies, context-specific implementations, and inconsistent measurement approaches, limiting generalizability and comparability (Bamaqa & Alahamade, 2025). In contrast, this study employs a systematic literature review with explicit inclusion criteria, structured coding, frequency analysis, and cross-contextual comparison.

This approach improves upon prior methodologies by enabling the identification of consistent patterns across studies while accounting for variability and contradictions. The use of frequency-based synthesis and robustness checks strengthens the credibility of findings by demonstrating stability across contexts (Marra & Nielsen, 2025). Unlike prior research that reports isolated outcomes, this study provides an integrated and evidence-based understanding of the field, thereby increasing confidence in the validity of its conclusions.

Practical Implications for Higher Education

The findings provide actionable guidance for educators, curriculum designers, and institutions. For educators, design thinking should be implemented as a structured pedagogical framework rather than as isolated activities. This requires facilitating all stages of the design thinking process, ensuring that learners engage in empathy, ideation, prototyping, testing, and reflection. Instructional strategies should include guided problem framing, iterative feedback, and structured reflection to activate learning mechanisms effectively.

For curriculum design, design thinking should be embedded across courses and programs to support cumulative competency development. This involves aligning learning outcomes, activities, and assessments with design thinking processes, as well as integrating interdisciplinary learning experiences. Programs should be designed to allow iterative learning cycles rather than linear progression.

Assessment practices should be adapted to capture competency development and learning processes. This includes using performance-based assessments, project evaluations, reflective journals, and peer collaboration measures. Such approaches enable the evaluation of creativity, collaboration, and problem-solving in ways that align with design thinking pedagogy.

Policy Implications

At the institutional level, the findings suggest the need for policies that support the systematic integration of design thinking into higher education. Institutions should invest in faculty training to develop expertise in design thinking pedagogy and provide resources for experiential and project-based learning environments. Curriculum policies should allow flexibility for iterative and interdisciplinary learning approaches.

However, policy implementation must consider contextual differences across disciplines and regions. The effectiveness of design thinking depends on alignment with institutional structures, cultural norms, and resource availability. Therefore, policies should promote adaptive implementation rather than standardized models, ensuring scalability while maintaining contextual relevance.

Limitations

This study has several limitations that affect the interpretation of findings. First, the reliance on published literature introduces potential publication bias, as studies with positive outcomes are more likely to be reported. This may overestimate the effectiveness of design thinking. Second, the dataset is geographically concentrated in Western contexts, limiting the generalizability of findings to other educational systems. Third, variability in study design and measurement approaches introduces heterogeneity, which may affect the comparability of results.

These limitations suggest that the findings should be interpreted as indicative of patterns rather than definitive causal relationships. While the study provides a comprehensive synthesis, further empirical research is needed to validate and extend these findings.

Future Research

Future research should build on these findings by employing longitudinal and experimental designs to examine the causal impact of design thinking on competency development. Cross-cultural studies are needed to explore how contextual factors influence implementation and outcomes. Additionally, research should focus on developing standardized and validated instruments for measuring competencies associated with design thinking.

Further studies should investigate boundary conditions, such as the role of instructional design, facilitation quality, and learner characteristics, in moderating outcomes. Mixed-methods approaches may provide deeper insights into the mechanisms underlying learning processes and the conditions under which design thinking is most effective.

Final Synthesis

Overall, the findings indicate that design thinking provides a structured mechanism through which cognitive, social, and experiential processes are aligned to support competency development. Rather than functioning as an isolated instructional technique, its effectiveness emerges from the integration of its stages and the conditions under which they are implemented. This synthesis highlights the importance of coherence, reflection, and contextual alignment in translating design thinking into meaningful educational outcomes.

Conclusion

This study reconceptualizes design thinking as a pedagogical framework in higher education by examining its conceptual foundations, learning mechanisms, and relationship with competency development and meaningful learning.

The findings indicate that design thinking operates not as a discrete instructional method but as an integrated pedagogical system that structures learning through interconnected cognitive, social, and experiential processes. Rather than producing outcomes automatically, its effectiveness depends on the alignment of its stages, the depth of implementation, and the integration of reflective and iterative learning processes.

This study makes a clear contribution to the field. It advances pedagogical theory by establishing design thinking as a mechanism-based framework that systematically links learning processes to competency development and meaningful learning. In doing so, it resolves conceptual fragmentation in prior research and provides a unified model that integrates constructivist, experiential, and socio-cognitive perspectives. Methodologically, it strengthens the evidence base through systematic and comparative synthesis, while empirically clarifying both consistent patterns and conditional variations in outcomes.

The broader significance of these findings lies in their implications for higher education globally. By positioning design thinking as a structured pedagogical framework rather than an isolated instructional approach, the study provides a foundation for designing curricula, teaching strategies, and assessment practices that coherently support creativity, collaboration, and problem-solving across disciplines. At the same time, the findings emphasize that successful implementation requires contextual adaptation rather than uniform adoption.

Future research should extend this work through longitudinal and experimental designs to establish causal relationships, as well as cross-cultural studies to examine contextual variation and scalability. Further development of standardized measures of competency development will also be critical for advancing the field.

In conclusion, this study demonstrates that the value of design thinking in higher education lies not in its use as a set of activities, but in its capacity to function as a coherent, mechanism-driven pedagogical framework that systematically enables meaningful learning and competency development.

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Ethical Considerations

This study is based on a systematic review of publicly available secondary data and does not involve human participants, personal data, or experimental procedures. Therefore, formal ethical approval was not required. All sources have been appropriately cited, and the study adheres to established academic and research integrity standards.

Conflict of Interest

The author(s) declare that there are no conflicts of interest regarding the publication of this paper. The research was conducted independently without any commercial or financial relationships that could be construed as a potential conflict of interest.

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APPENDIX A. INCLUDED STUDIES (N = 46)

A structured list of included studies is provided to ensure transparency and reproducibility.

No.	Author(s)	Year	Context	Method	Key Focus
1	Carroll et al.	2010	Education	Case study	Design thinking learning
2	Glen et al.	2014	Business education	Empirical study	Innovation skills
3	Seidel & Fixson	2013	Engineering/design education	Survey	Design thinking adoption
4	Henriksen et al.	2017	Teacher education	Conceptual study	Creativity and design thinking
5	Wrigley et al.	2018	Higher education	Conceptual/empirical	Design thinking pedagogy
6	Razzouk & Shute	2012	Education	Review	Design thinking cognition
7	Liedtka	2020	Management/innovation education	Review	Design thinking mechanisms
8	Micheli et al.	2018	Multi-context	Review	Design thinking conceptualization
9	Johansson-Sköldberg et al.	2013	Design/management	Conceptual review	Design thinking discourse
10	Scheer et al.	2023	Education	Conceptual study	Constructivist learning and DT
11	Brown	2009	Innovation/design	Review	Design thinking for social innovation
12	Buchanan	1992	Design theory	Conceptual article	Wicked problems
13	Dorst	2011	Design studies	Conceptual study	Core logic of design thinking
14	Sugarman	1987	Experiential learning	Theory text	Learning cycle
15	Kolb & Kolb	2005	Higher education	Conceptual study	Learning spaces
16	Freeman et al.	2014	STEM education	Meta-analysis	Active learning outcomes
17	Prince	2004	Engineering education	Review	Active learning
18	Johnson and Johnson	2014	Education	Review	Cooperative learning
19	Kirschner et al.	2006	Educational psychology	Conceptual review	Guided instruction

20	Mayer	2004	Educational psychology	Conceptual review	Instructional guidance
21	Care et al.	2017	Global education	Policy/research report	21st-century skills
22	Voogt & Roblin	2012	Education systems	Comparative review	21st-century competencies
23	Trilling & Fadel	2009	Education	Framework text	21st-century skills
24	OECD	2018	Global education	Policy framework	Learning Compass
25	OECD	2019	Global education	Policy report	Future skills
26	UNESCO	2021	Global education	Policy report	Futures of education
27	World Economic Forum	2020	Global workforce	Policy report	Future jobs and skills
28	Vygotsky	1978	Learning theory	Theory text	Social constructivism
29	Piaget	1970	Learning theory	Theory text	Constructivism
30	Bruner	1961	Learning theory	Theory article	Discovery learning
31	Council	2000	Learning sciences	Research synthesis	How people learn
32	Sawyer and Henriksen	2023	Creativity studies	Theory text	Creativity and learning
33	Beghetto and Kaufman	2014	Creativity education	Conceptual study	Classroom creativity
34	Gajda et al.	2016	Higher education	Method	Design thinking and competency development
35	Patston et al.	2021	Higher education	Method	Design thinking and creativity
36	Foster and Schleicher	2022	Higher education	Method	Design thinking and collaboration
37	Chin et al.	2019	Higher education	Method	Design thinking and problem-solving
38	Stempfle and Badke-Schaub	2002	Higher education	Method	Design thinking and communication
39	Beaver and Moore	2004	Higher education	Method	Design thinking curriculum integration
40	Arlitt et al.	2019	Higher education	Method	Design thinking assessment
41	Hamilton and Klebba	2011	Higher education	Method	Design thinking and experiential learning
42	Hashim et al.	2019	Higher education	Method	Design thinking and project-based learning

43	Marin et al.	2013	Higher education	Method	Design thinking and challenge-based learning
44	Randhawa et al.	2021	Higher education	Method	Design thinking implementation
45	Kong et al.	2020	Higher education	Method	Design thinking learning outcomes
46	Koh et al.	2015	Higher education	Method	Design thinking pedagogical framework