



## DESIGN THINKING IN TEACHER EDUCATION: A SYSTEMATIC LITERATURE REVIEW

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### **Abstract:**

Design Thinking (DT) has emerged as a human-centered, iterative approach with the potential to transform teacher education by fostering creativity, reflective practice, and technology-enhanced pedagogy. Despite growing interest, empirical evidence regarding DT's impact on teacher learning and professional development remains fragmented and conceptually inconsistent. This systematic literature review synthesizes findings from 34 empirical studies published between 2018 and 2025, following PRISMA 2020 guidelines and employing JBI quality appraisal standards. The synthesis identifies three core mechanisms through which DT influences teacher learning: empathy-driven reframing of learner needs, adaptive expertise through iterative experimentation, and collaborative sense-making within professional communities. Findings indicate that DT enhances creative confidence, learner-centered mindsets, reflective practice, and digital pedagogy skills among both pre-service and in-service teachers. However, adoption is constrained by systemic barriers, including rigid curricula, limited institutional support, and cultural resistance to non-traditional pedagogies. Effective implementation strategies include DT-infused curriculum modules, faculty learning communities, hybrid project-based approaches, and DT-TPACK frameworks. This review contributes to the development of a multi-level conceptual model of DT in teacher education that integrates micro-level teacher learning mechanisms, meso-level program and institutional structures, and macro-level cultural and policy conditions. By connecting empirical evidence with theories of teacher professional learning, this synthesis deepens understanding of DT not only as a pedagogical approach but also as a driver of professional identity transformation. Implications for teacher educators, institutions, and policymakers are discussed, alongside directions for longitudinal, cross-cultural, and technology-integrated research in teacher education.

**Keywords:** design thinking; teacher education; creativity; reflective practice; professional development

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## 1. Introduction

Teacher education is undergoing a profound transformation in response to rapid technological advances, globalization, and the increasing complexity of learning environments. The need for teachers to adapt to these challenges has intensified interest in innovative pedagogical approaches that foster creativity, reflective practice, and learner-centered instruction. Among these, Design Thinking (DT)—a human-centered, iterative problem-solving methodology originating in engineering and business contexts (Brown, 2008; Plattner *et al.*, 2009)—has emerged as a promising framework for reimagining teacher education.

DT is characterized by iterative stages—empathize, define, ideate, prototype, and test—which encourage flexibility, creativity, and responsiveness to real-world problems (Brown, 2008). In teacher education, DT offers the potential to enhance pre-service and in-service teachers' pedagogical innovation, reflective thinking, and technological integration, while promoting an empathy-driven understanding of learners' needs (Bush *et al.*, 2022; Tseng *et al.*, 2019).

Despite growing interest, empirical evidence on DT in teacher education remains fragmented and conceptually inconsistent. This fragmentation is particularly problematic given two enduring issues in teacher education that Design Thinking is well positioned to address: the persistent theory–practice gap (Korthagen, 2017) and the difficulty of shifting teachers from transmission-oriented toward learner-centred pedagogies (Cochran-Smith, 2021). By examining DT through the lens of these systemic challenges, this review contributes not only to scholarship on pedagogical innovation but also to broader debates concerning how teacher preparation programs can respond to increasingly diverse and complex classroom environments. Prior reviews have often focused on K–12 student outcomes, general higher education applications, or descriptive accounts of DT practices (Guaman-Quintanilla *et al.*, 2018; Wrigley *et al.*, 2018), leaving a gap in a systematic, theory-driven understanding of how DT influences teacher learning, professional identity, and instructional practice. Moreover, conceptualizations of DT vary considerably, with some studies emphasizing it as a pedagogical methodology, others as a mindset, and still others as a curricular framework or programmatic strategy (Henriksen *et al.*, 2020; Park *et al.*, 2023). This conceptual diversity complicates synthesis and theory development.

Teacher education programs have historically prioritised technical rationality over adaptive expertise (Schön, 1983). Despite three decades of advocacy for learner-centred, reflective practice, initial teacher education remains largely organised around the transmission of established knowledge rather than preparation for uncertainty. It is no longer sufficient to add isolated innovation workshops to entrenched curricula. This review argues that Design Thinking offers not merely a new technique but a fundamental reorientation—and that the evidence now compels action.

The current review addresses these gaps by providing a PRISMA-guided systematic synthesis of empirical studies (2018–2025) examining the use of DT in teacher education. Specifically, it aims to identify pedagogical, cognitive, and professional

outcomes associated with DT integration; examine barriers and constraints affecting DT adoption in pre-service and in-service teacher programs; integrate and articulate strategies and models that support the long-term adoption of digital technologies and develop an integrated theoretical framework linking DT to teacher learning mechanisms, professional identity, and systemic conditions. By integrating rigorous methodological analysis with conceptual synthesis, this review goes beyond description to propose a multi-level model of DT in teacher education. This model addresses teacher learning processes (micro level), program structures (meso level), and cultural and policy contexts (macro level). This framework situates DT as a mechanism of professional growth, adaptive expertise, and pedagogical innovation, rather than merely a set of instructional techniques.

The findings of this review aim to inform teacher educators, professional development designers, and policymakers about the conditions and mechanisms that maximize DT's transformative potential, while also highlighting theoretical and methodological gaps for future research.

## 2. Methods

### 2.1 Review Design and Conceptual Orientation

This systematic review adopts a theory-driven, interpretive synthesis approach, combining principles from PRISMA 2020 guidelines (Page *et al.*, 2021), critical interpretive synthesis (Dixon-Woods *et al.*, 2006), and realist review logic (Pawson *et al.*, 2005). The review is designed not only to summarize empirical studies but also to develop a conceptual understanding of how Design Thinking (DT) functions as a mechanism for teacher learning and professional development. By integrating qualitative, quantitative, and mixed-method evidence, the review synthesizes outcomes across cognitive, affective, and institutional dimensions, highlighting both mechanisms and contextual constraints.

The review is guided by three overarching research questions:

1. **Outcomes:** What Pedagogical, Cognitive, and Professional Learning Outcomes Are Associated with the Integration of Dt in Teacher Education?
2. **Barriers:** What Institutional, Pedagogical, Technological, or Cultural Barriers Constrain Dt Adoption in Pre-service and In-service Teacher Education?
3. **Implementation Models:** Which Strategies or Models Support Sustainable Integration of Dt in Teacher Education Programs?

These questions align with the aim to produce a theoretically informed synthesis that identifies both mechanisms of teacher learning and contextual conditions influencing DT implementation.

### 2.2 Eligibility Criteria

Study eligibility was defined using the PICOS framework (Schardt *et al.*, 2007), see Table 1):

Exclusion criteria eliminated:

- Non-empirical, theoretical, or opinion papers

- Studies focusing solely on K–12 students without teacher components
- Interventions where DT was superficially mentioned without methodological detail
- Empirical studies failing minimum methodological quality thresholds

**Table 1: PICOS Criteria for Inclusion and Exclusion of Studies**

Component	Criteria
Population	Pre-service teachers, in-service teachers, and teacher educators in higher education or professional development contexts
Intervention	Programs, courses, workshops, or training explicitly incorporating DT (full or partial cycle: empathize, define, ideate, prototype, test)
Comparator	Not required; focus on exploratory and practice-based outcomes
Outcomes	Empirical evidence of teacher learning: creativity, mindset shifts, reflective practice, digital pedagogy, barriers, and implementation models
Study design	Qualitative, quantitative, and mixed-methods studies published in peer-reviewed journals or conference proceedings
Years	2018–2025
Languages	English or French

### 2.3 Data Sources and Search Strategy

A comprehensive search was conducted in the following databases: Scopus, Web of Science (Core Collection), ERIC, and Science Direct, covering 2018–2025. Manual searches of reference lists were also conducted to capture additional relevant studies.

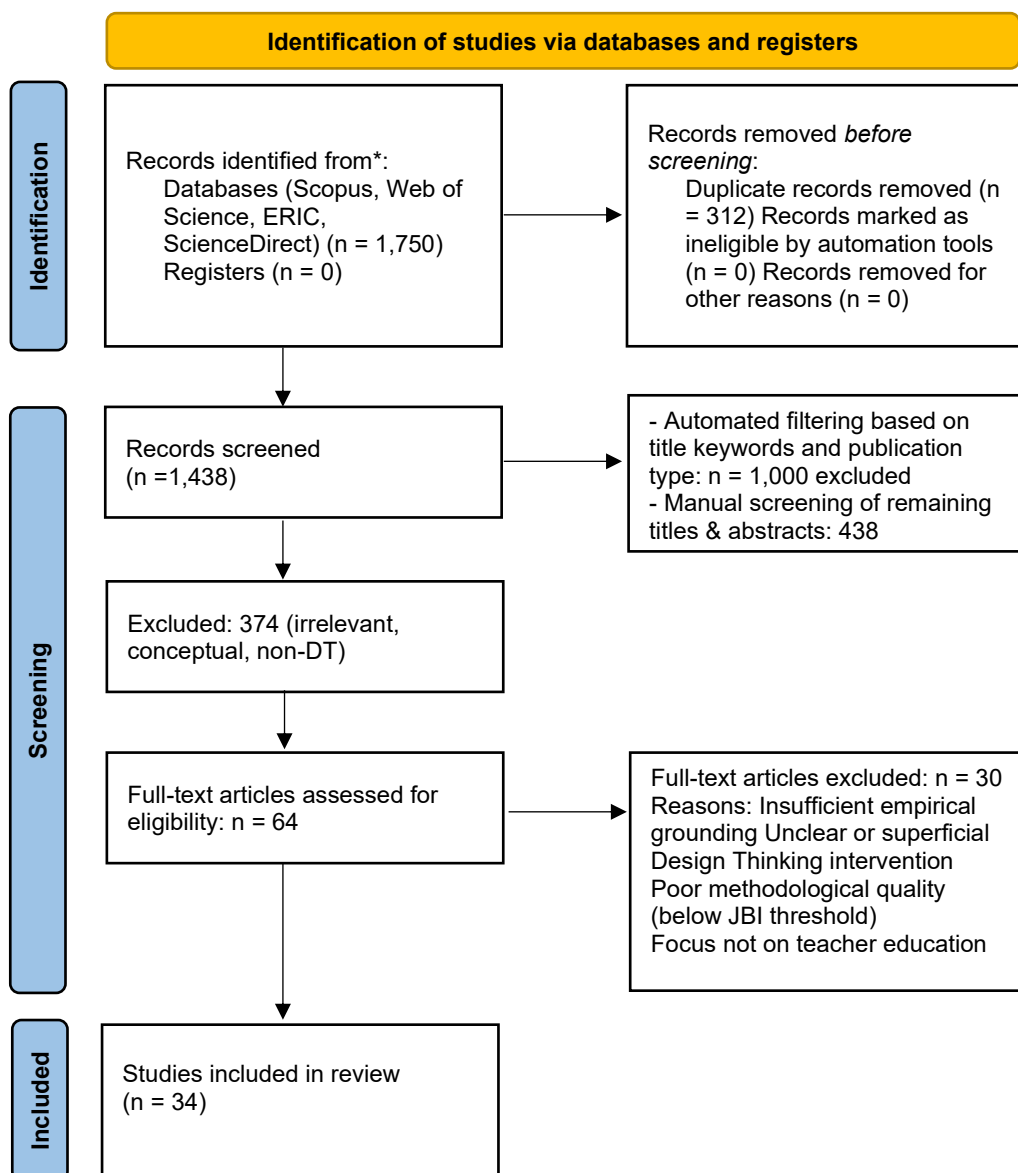
Search strings included combinations of: "Design Thinking" AND "teacher education" OR "Design Thinking" AND "teacher training") OR "Design Thinking" AND "pre-service teachers" OR "human-centered design" AND "teacher education".

Filters were applied to limit results to peer-reviewed articles in English or French. This search identified 1,750 records, which were subsequently screened following the PRISMA flow.

### 2.4 Study Selection

The study selection followed PRISMA 2020 recommendations (Page *et al.*, 2021), consisting of three stages, Identification, Screening, Eligibility, Ultimately, 34 studies were included in the final synthesis (see Figure 1).

**Figure 1: PRISMA Flow Diagram**



## 2.5 Data Extraction and Management

A structured data extraction protocol ensured consistency across studies.

Extracted data included:

- Author(s) and year,
- Country and context,
- Participant characteristics (pre-service vs. in-service),
- DT model employed (Stanford d.school, Double Diamond, hybrid),
- Study design and methodology,
- Data collection methods,
- Reported outcomes (creativity, reflective practice, mindset, technology integration),
- Barriers or enablers,
- Implementation models or strategies proposed,

- Methodological quality score (JBI).

This approach facilitated both thematic analysis and descriptive statistical synthesis.

## 2.6 Quality Appraisal

Studies were assessed using Joanna Briggs Institute (JBI) Critical Appraisal Tools appropriate to the study design (Aromataris *et al.*, 2015). The appraisal evaluated methodological rigor, transparency, and reliability. Out of 34 included studies:

- High quality (scores 8–10): 18 studies,
- Moderate quality (scores 6–7): 11 studies,
- Low quality (excluded): 5 studies,

Quality scores informed both the weighting in the synthesis and the identification of gaps in methodological robustness.

## 2.7 Synthesis Approach

A dual methodological strategy was selected for the synthesis of the research. Firstly, Reflexive Thematic Analysis was employed in accordance with the approach outlined by Braun and Clarke (2006). The process of analysis involved both inductive and deductive coding in order to identify meaningful patterns across the reported outcomes, barriers, and implementation strategies. These emergent themes underwent a process of iterative review and refinement, with the objective of ensuring that they accurately reflected the underlying mechanisms of teacher learning as captured within the studies. Secondly, a descriptive quantitative synthesis was conducted. This involved the systematic tabulation of the frequencies of the different design thinking models used, the types of participants involved, the geographic distribution of the studies, and the various outcomes measured. This numerical overview served to clarify broad trends within the literature and provided a foundational structure to support the integration of findings across a diverse set of study designs. Finally, findings were organized into a three-level conceptual model capturing micro-level learning processes, meso-level program and institutional structures, and macro-level cultural and policy conditions.

## 3. Results

This section synthesizes findings from the 34 empirical studies included in the review. The synthesis is organized into four interrelated domains: characteristics of DT interventions, teacher learning outcomes, barriers and constraints, and models for sustainable implementation. Across studies, the evidence reflects global diversity, methodological variation, and multiple levels of impact on teacher education.

### 3.1 Characteristics of Included Studies

As shown in Figures 2 to 5 and Tables 1, 2, 3 and 4, the reviewed studies demonstrate wide geographic and methodological diversity, with varied participant populations, DT frameworks, and degrees of implementation intensity.

**Figure 2:** Distribution of Participant Populations Across the Included Studies (N = 34)

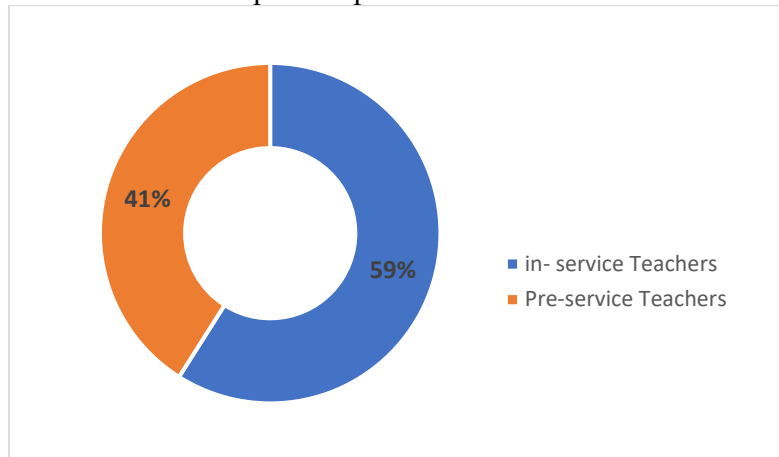
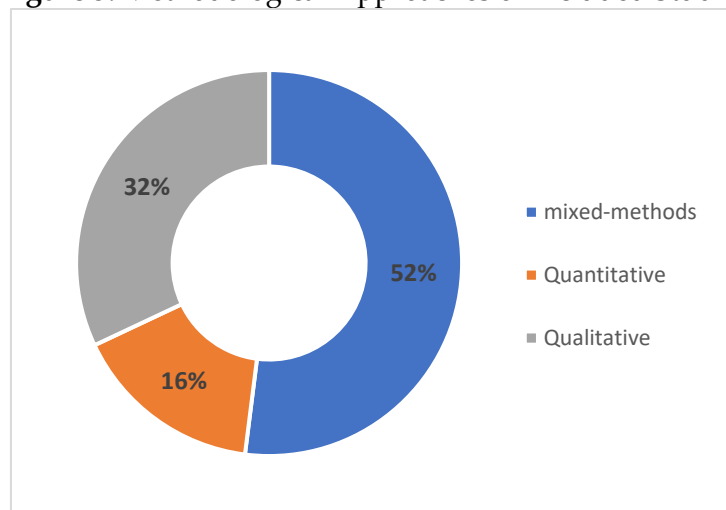


Figure 2 and Table 2 illustrate the composition of study participants, showing that 59% of studies focused on pre-service teachers and 41% on in-service teachers. The distribution highlights balanced attention to both initial teacher preparation and continuing professional development.

Figure 3 and Table 2 present the methodological diversity of the reviewed literature, with mixed-methods designs predominating (52%), followed by qualitative approaches (32%) and quantitative studies (16%). The prevalence of mixed-methods designs reflects the exploratory and practice-oriented nature of DT research in teacher education.

**Figure 3:** Methodological Approaches of Included Studies



**Table 2:** Distribution of Studies

Variable	Statistics
Time span	2018–2025
Countries represented	19
Pre-service teacher-focused	59%
In-service teacher-focused	41%
Mixed-methods	52%
Qualitative	32%

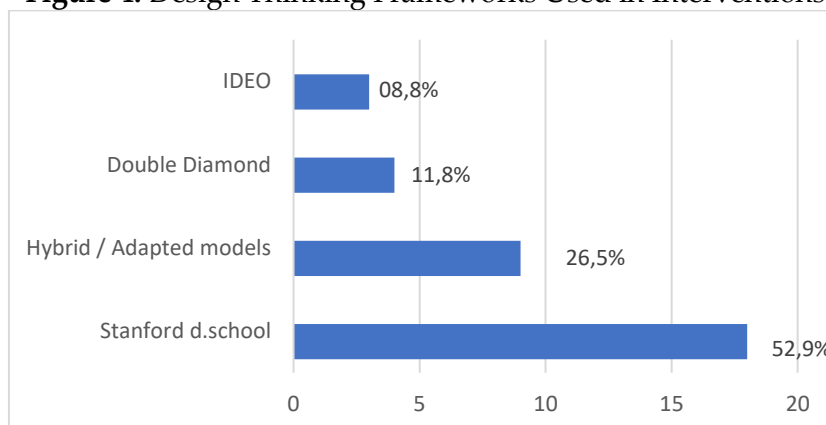
Quantitative	16%
Full DT cycle used	44%

Table 3 and Figure 4 compare the DT frameworks adopted across studies. The Stanford d.school model was most frequently used (18 studies), followed by hybrid or adapted models (9 studies), while the Double Diamond (4 studies) and IDEO approaches (3 studies) were less common. This variation indicates both conceptual plurality and contextual adaptation.

**Table 3:** Design Thinking frameworks: Frequency, definitions, and representative studies

DT Framework	n	%	Core Characteristics	Representative Studies
Stanford <a href="#">d.school</a>	18	52.9%	Five-stage model: Empathise, Define, Ideate, Prototype, Test	Arrington & Willox (2021); Baran & AlZoubi (2024); Blundell (2024)
Hybrid / Adapted Models	9	26.5%	DT integrated with TPACK, PBL, self-determination theory, or contextual modifications	Tseng <i>et al.</i> (2019); Wang <i>et al.</i> (2025); Avsec (2023)
Double Diamond	4	11.8%	Four-phase model: Discover, Define, Develop, Deliver	Schmidberger & Wippermann (2024); Bush <i>et al.</i> (2022)
IDEO	3	8.8%	Human-centred design; inspiration, ideation, implementation	Gleason & Jaramillo (2021); Garcia-Lopez <i>et al.</i> (2020)
<b>Total</b>	<b>34</b>	<b>100%</b>		

**Figure 4:** Design Thinking Frameworks Used in Interventions



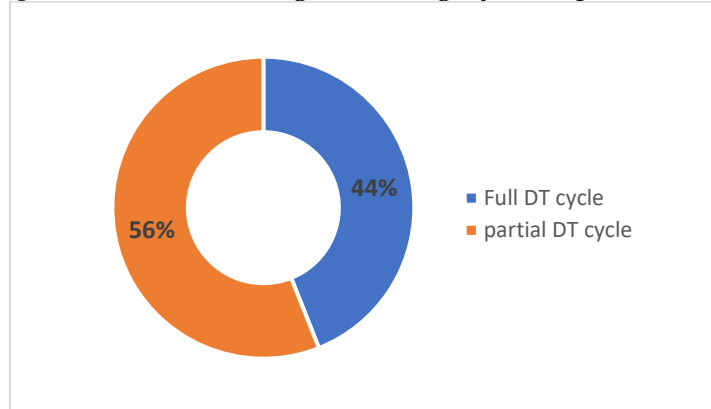
### 3.2 Conceptualisations of Design Thinking in the Reviewed Studies

Analysis of how DT was defined revealed four distinct conceptual orientations across the 34 studies. Eleven studies framed DT primarily as a pedagogical methodology—a structured sequence of activities to be taught and enacted. Nine studies emphasised DT as a mindset characterised by empathy, optimism, and tolerance for ambiguity. Seven studies operationalised DT as a curricular framework guiding program-level design, while a further seven adopted hybrid conceptualisations, integrating DT with TPACK, project-based learning, or self-determination theory. These orientations were not mutually exclusive; several studies invoked multiple framings. To manage this

heterogeneity in synthesis, studies were coded according to their dominant conceptual orientation, and cross-cutting themes were identified irrespective of framing. This approach enabled thematic integration while preserving conceptual distinctions where they influenced reported outcomes or implementation strategies.

Figure 5 shows that 44% of interventions implemented a full DT cycle, whereas 56% adopted partial cycles, often tailored to specific pedagogical objectives or institutional constraints.

**Figure 5:** Extent of Design Thinking Cycle Implementation



**Table 4:** Overview of Some Included Studies

Study	Country	Population	DT Framework	Design	Key Outcomes
Arrington & Willox (2021)	USA	In-service teachers	d.school	Mixed	Gains in DT knowledge & confidence
Avsec (2023)	Slovenia	Pre-service	Hybrid DT	Quantitative	Sustainable tech-enhanced pedagogy
Baran & AlZoubi (2024)	USA	Pre-service	d.school	Mixed	Mindset transformation
Blundell (2022)	Australia	In-service	Mixed models	Scoping /Mixed	Systemic perspectives on DT
Blundell (2024)	Australia	In-service	d.school	Qualitative	DT for digital tech integration
Bush <i>et al.</i> (2022)	USA	Pre-service & in-service	Empathy-driven DT	Mixed	Humanistic STEM & empathy
Calavia <i>et al.</i> (2023)	Spain	Pre-service	Mandatory DT	Quantitative	Certification improves adoption
Chiu <i>et al.</i> (2021)	Hong Kong	In-service STEM	Self-determination DT	Mixed	Pedagogical autonomy & motivation
Gleason & Jaramillo (2021)	USA/Ecuador	Pre-service	Global collaboration DT	Qualitative	Empowered collaborative learning

Schmidberger & Wippermann (2024)	Germany	University teachers	DT for ESD	Qualitative	Sustainability integration
Tseng <i>et al.</i> (2019)	Taiwan	Pre-service	DT-TPACK	Mixed	Digital pedagogy competence
Wang <i>et al.</i> (2025)	Thailand	Pre-service	Project-based DT	Quantitative	Creativity & openness to experience
Ye Wang (2023)	China	University faculty	DT Instructional Design	Mixed	Teachers' perceptions of DT

Data collection methods included interviews, reflective journals, surveys, classroom observations, pre-post tests, and performance assessments. Quality appraisal using the JBI tools classified 18 studies as high-quality, 11 as moderate-quality, and excluded 5 low-quality studies.

### 3.3 Teacher Learning Outcomes

#### 3.3.1 Creativity and Pedagogical Innovation

Across 21 studies, DT significantly enhanced teachers' creative confidence and capacity for instructional innovation (Arrington & Willox, 2021; Baran & AlZoubi, 2024; Wang *et al.*, 2025). Pre-service teachers reported greater flexibility in lesson design and the ability to explore multiple problem-solving pathways, while in-service teachers emphasized DT's role in disrupting habitual instructional routines (Blundell, 2022; Blundell, 2024). DT promoted iterative thinking, risk-taking, and imaginative integration of materials and technologies.

#### 3.3.2 Mindset Transformation and Empathy

Twenty-four studies highlighted DT's role in fostering learner-centered mindsets, empathy, and reflective practice (Bush *et al.*, 2022; Gleason & Jaramillo, 2021; Chiu *et al.*, 2021). Through engagement in the empathize phase, teachers developed a deeper and more understanding of learners' needs, drawing on observation, interviews, and prototyping activities. DT further encouraged perseverance, tolerance for ambiguity, and openness to experimentation—particularly among pre-service teachers—echoing Henriksen *et al.*'s (2020) and Schön's (1983) conceptualizations of reflective and adaptive professional practice.

#### 3.3.3 Technology Integration and Digital Pedagogy

Sixteen studies demonstrated that DT supports meaningful integration of digital tools (Blundell, 2024; Tseng *et al.*, 2019; Gleason & Jaramillo, 2021). DT interventions enabled teachers to embed digital technologies within authentic, problem-focused learning cycles rather than as add-ons. Several studies incorporated emerging technologies, including AI-enhanced tools and learning analytics, showing that DT provided a human-centered framework for ethical and pedagogically sound technology adoption (Dimitriadis *et al.*, 2021; Topali *et al.*, 2024).

### 3.4 Barriers and Constraints to DT Implementation

More than half of the studies (20/34) reported substantial institutional, cultural, and structural barriers (Calavia *et al.*, 2023; Razali *et al.*, 2022; Retna, 2019):

- **Structural barriers:** rigid curricula, limited time for prototyping, lack of administrative support.
- **Cultural barriers:** teacher-centered traditions, resistance to ambiguity, and reluctance to depart from exam-oriented systems.
- **Resource barriers:** insufficient access to materials, digital tools, or design spaces.

These barriers underscore that DT adoption is contingent upon systemic alignment and cultural readiness, so there is a need for multi-level support.

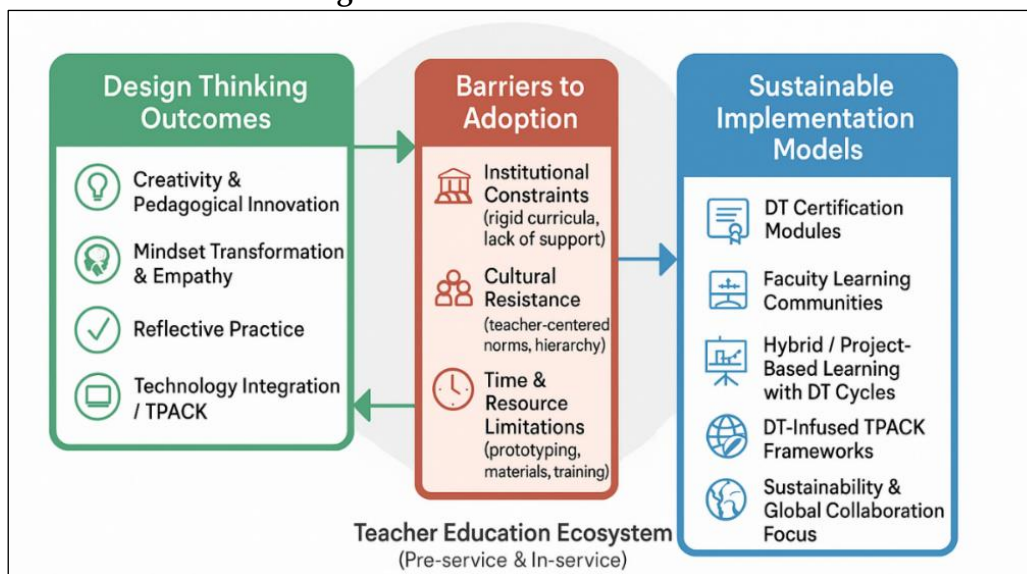
### 3.5 Models and Strategies for Sustainable DT Implementation

Fifteen studies proposed effective implementation frameworks for DT in teacher education:

- 1) Mandatory DT certification modules improved teacher confidence and adoption fidelity (Calavia *et al.*, 2023).
- 2) DT-infused TPACK frameworks enhanced integration of digital pedagogical skills with design-based learning (Tseng *et al.*, 2019).
- 3) Faculty learning communities supported collaborative problem-solving and reflective practice (Holden *et al.*, 2023).
- 4) Project-based blended learning models combined DT cycles with authentic classroom challenges, fostering creativity and openness to experience (Wang *et al.*, 2025).
- 5) Sustainability-focused DT programs integrated global competence, collaboration, and innovation-oriented pedagogies (Schmidberger & Wippermann, 2024; Gleason & Jaramillo, 2021).

Across these models, key success factors included structured support, opportunities for collaboration, alignment with institutional goals, and access to appropriate resources. Overall, the review demonstrates that DT positively influences teacher learning, enhancing creativity, reflective practice, learner-centered pedagogy, and digital competencies. However, adoption is constrained by structural rigidity, cultural resistance, and resource limitations, indicating that DT is most effective when supported by coordinated, multi-level institutional strategies (Figure 6). The findings reveal the need for standardized assessment tools, longitudinal studies, and cross-cultural comparative research to build a more robust empirical and theoretical understanding of DT's role in teacher professional development.

Figure 6: DT in teacher education



## 4. Discussion

This systematic review synthesizes empirical evidence from 34 studies (2018–2025) examining the implementation and impact of Design Thinking (DT) in teacher education. Beyond aggregating outcomes, this discussion provides a theoretical and conceptual interpretation of how DT functions as a mechanism for teacher learning, situates these processes within broader institutional and cultural systems, and identifies opportunities for future research.

### 4.1 Design Thinking as a mechanism for Teacher Learning

The reviewed studies indicate that DT operates as a multi-dimensional mechanism influencing cognitive, relational, and identity-oriented aspects of teacher learning. The empathize stage of DT encourages teachers to understand learners' perspectives through observation, interviews, and prototyping activities. This process aligns with the concept of professional noticing (Sherin *et al.*, 2011) and reflective practice (Schön, 1983), suggesting that DT can enhance teachers' ability to detect salient classroom features and adapt pedagogical decisions accordingly. Several studies reported that pre-service and in-service teachers developed heightened sensitivity to student needs, enabling more learner-centered lesson design (Bush *et al.*, 2022; Gleason & Jaramillo, 2021). DT's iterative cycle (empathize–define–ideate–prototype–test) fosters adaptive expertise (Hatano & Inagaki, 1986), where teachers engage in continuous problem-solving and reflective revision. Iteration supports risk-taking and comfort with ambiguity, encouraging teachers to experiment with novel instructional strategies. Studies employing the d.school model (Arrington & Willox, 2021; Baran & AlZoubi, 2024) consistently demonstrated gains in creative confidence and flexibility in pedagogical planning. Many DT interventions were designed as collaborative projects, facilitating knowledge co-construction, shared problem framing, and peer feedback (Holden *et al.*, 2023; Wang *et al.*, 2025). This reflects principles from communities of practice theory (Wenger, 1998),

where learning occurs through social interaction and participation in shared activity. Teachers reported enhanced collaborative problem-solving skills, improved professional dialogue, and strengthened capacity to design learning experiences collectively.

## 4.2 Systemic and Contextual Conditions

The success of DT in teacher education is contingent upon institutional, cultural, and resource conditions. Rigid curricula, limited time for iterative prototyping, and lack of administrative support were frequently cited barriers (Razali *et al.*, 2022; Retna, 2019). These structural factors hindered teachers' ability to fully engage in iterative DT processes and demonstrate the need for program designs that align assessment, time allocation, and pedagogical goals with DT principles. Cultural resistance to non-traditional pedagogies was observed in several studies, particularly in contexts emphasizing teacher-centered instruction and high-stakes testing (Chiu *et al.*, 2021; Calavia *et al.*, 2023). These findings suggest that successful DT integration requires cultural translation and alignment with local teaching norms, rather than direct transplantation of DT frameworks.

Access to prototyping tools, digital technologies, and collaborative learning spaces influenced teachers' engagement and the quality of DT outcomes (Blundell, 2024; Tseng *et al.*, 2019). Limited resources curtailed experimentation and reflective iteration, highlighting equity considerations in implementing DT across diverse institutional contexts.

## 4.3 Conceptual and Methodological Insights

The review reveals conceptual ambiguity in how DT is defined and operationalized in teacher education:

- Some studies treated DT as a pedagogical framework (Plattner *et al.*, 2009),
- Others emphasized it as a mindset for creative problem-solving (Brown, 2008). ,
- A few combined DT with other pedagogical models (e.g., TPACK or project-based learning) (Tseng *et al.*, 2019; Wang *et al.*, 2025).

This heterogeneity challenges the development of cumulative knowledge. Methodologically, most studies relied on self-reports, reflective journals, or small-scale interventions. Few employed longitudinal designs, cross-cultural comparisons, or validated instruments to assess DT-related competencies.

## 4.4 Multi-Level Conceptual Model of Design Thinking in Teacher Education

### 4.4.1 Micro-Level: Teacher Learning Mechanisms

At the micro level, Design Thinking (DT) shapes the ways teachers think, act, and reflect in their professional practice. Through empathy-based reframing, teachers gain a deeper understanding of their students' needs, perspectives, and challenges, which in turn supports more learner-centered teaching approaches. Iterative experimentation and reflection encourage teachers to test ideas, revise strategies, and develop adaptive expertise, cultivating creativity and confidence in instructional design. Collaborative sense-making further allows teachers to co-construct knowledge with peers, share

insights, and collectively solve classroom challenges. Together, these mechanisms support the development of reflective, flexible, and innovative educators capable of responding to complex learning environments.

#### **4.4.2 Meso-Level: Program and Institutional Structures**

The meso level emphasizes the organizational and programmatic supports that enable effective DT adoption. DT-infused curriculum modules provide structured opportunities for teachers to engage with design cycles while linking learning to concrete pedagogical goals. Faculty learning communities create collaborative networks where teachers can discuss challenges, exchange feedback, and engage in joint problem-solving. Access to physical and digital resources, such as makerspaces, prototyping materials, and collaborative technology platforms, ensures that teachers can implement DT practices fully and creatively. Aligning these institutional structures with DT principles reinforces teacher learning, innovation, and the sustainable integration of DT into practice.

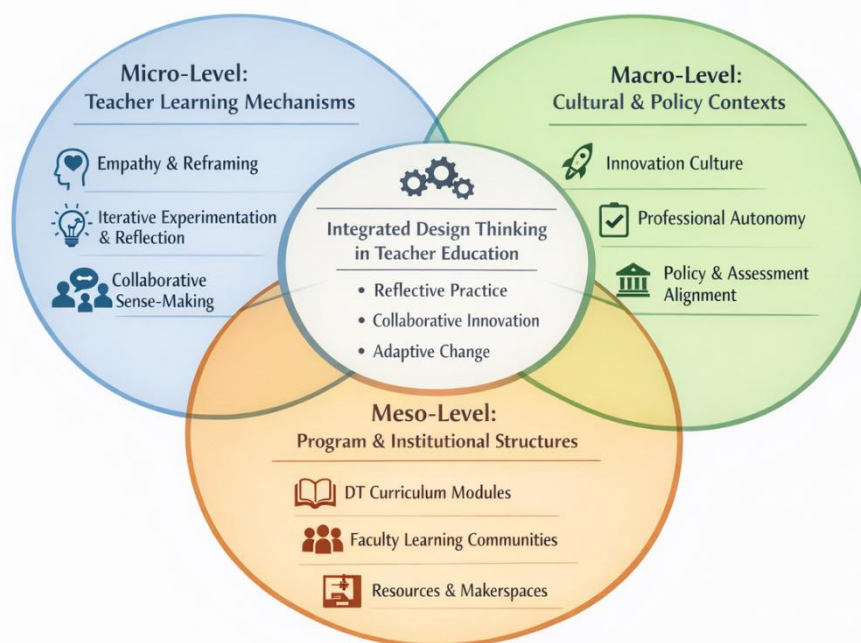
#### **4.4.3 Macro-Level: Cultural and Policy Contexts**

At the macro level, broader cultural norms and policy frameworks shape the possibilities and constraints of DT implementation. A supportive innovation culture encourages experimentation, risk-taking, and openness to new approaches, while professional autonomy allows teachers to adapt DT processes to their classroom realities. Alignment with policy and assessment systems ensures that DT initiatives are feasible and sustainable, preventing conflicts between innovative practices and systemic requirements. Evidence across multiple studies suggests that the adoption of DT is often constrained by rigid institutional structures, limited resources, and deeply rooted teacher-centered norms. These barriers point to the need for coordinated, multi-level strategies that align individual learning practices with institutional support and broader system readiness.

#### **4.4.4 Integration Across Levels**

As shown in Figure 7, these three levels illustrate that design thinking is more than a set of teaching techniques; it acts as a catalyst for developing teachers' adaptive reasoning, creative problem-solving abilities, and professional identity. Micro-level learning processes are supported and reinforced by meso-level program structures, while macro-level cultural and policy contexts shape the broader environment in which design thinking can thrive. For its adoption in teacher education to be both sustainable and meaningful, alignment across all levels is essential—teachers, institutions, and education systems must work in concert to promote innovation, reflection, and learner-centered practices.

**Figure 7:** Multi-level conceptual Model of Design Thinking in Teacher Education



## 5. Implications for Theory, Research, and Practice

### 5.1 Theoretical Implications

From a theoretical perspective, the findings suggest that design thinking can be conceptualized as a mechanism for teacher identity formation and professional agency, complementing existing frameworks such as professional noticing, reflective practice, and adaptive expertise. By engaging teachers in empathy-driven inquiry, iterative experimentation, and collaborative problem-solving, DT supports not only skill development but also shifts in how teachers perceive their roles as designers of learning. Integrating DT with established theories of teacher learning, therefore, offers a more coherent and robust conceptual foundation for interpreting empirical outcomes and understanding how innovative pedagogical practices contribute to sustained professional growth.

### 5.2 Research Implications

The findings of this review point to several directions for future research on Design Thinking (DT) in teacher education. Longitudinal and mixed-method research designs are needed to capture the sustained effects of DT on teachers' professional practice beyond short-term interventions. In addition, the development and validation of robust instruments to assess DT-related competencies would strengthen the comparability and cumulative value of empirical studies. Finally, cross-cultural investigations are essential to better understand how institutional, cultural, and policy contexts shape DT implementation and mediate its outcomes across diverse educational systems.

### 5.3 Practical Implications

From a practical perspective, the results suggest that DT should be embedded within coherent, iterative, and collaborative structures in teacher education programs, rather than being offered as isolated workshops or short-term initiatives. Institutional policies play a critical role in enabling DT by supporting experimentation, ensuring access to appropriate resources, and fostering cultures that value innovation and reflective practice. Moreover, faculty development initiatives should focus on equipping teacher educators with the skills needed to facilitate empathy-driven, iterative learning cycles, thereby ensuring that DT principles are effectively translated into sustainable teaching practices.

## 6. Recommendations: A Call to Action: From Evidence to Imperative

The systemic barriers identified in this review—rigid curricula, institutional resistance, cultural preference for teacher-centred instruction—are not neutral constraints. They are choices maintained by accreditation bodies, university leadership, and policymakers who prioritise efficiency over adaptability. The evidence synthesised here demonstrates that these choices actively undermine teacher preparation for contemporary classrooms. It is no longer defensible to treat Design Thinking as an optional enrichment. Teacher education programs must embed DT across coursework, assessment, and professional experience; accrediting bodies must recognise design competencies as core graduate attributes; and education ministries must fund sustained implementation rather than pilot programs. The question is no longer whether DT works, but whether the profession has the collective will to act on what it knows.

## 7. Conclusion

This systematic review brings together empirical evidence from 34 studies published between 2018 and 2025 to explore how Design Thinking (DT) has been implemented in teacher education and what effects it has had. The evidence demonstrates that DT functions as a powerful mechanism for enhancing teacher learning across multiple dimensions, including cognitive, relational, and professional identity development. In fact, design thinking approaches help teachers develop creative confidence, engage in reflective practice, adopt learner-centered perspectives, cultivate deeper empathy, and strengthen their digital teaching skills (Arrington & Willox, 2021; Baran & AlZoubi, 2024; Tseng *et al.*, 2019; Wang *et al.*, 2025). Teachers engaged in DT cycles develop adaptive expertise through iterative experimentation, collaborative problem-solving, and contextualized pedagogical innovation.

Despite these positive outcomes, the adoption and sustainability of DT in teacher education are strongly influenced by institutional, cultural, and resource-based constraints. Rigid curricula, limited institutional support, cultural resistance to non-traditional pedagogies, and insufficient access to design spaces or prototyping materials were frequently reported barriers (Blundell, 2024; Chiu *et al.*, 2021; Calavia *et al.*, 2023).

These findings indicate that teacher-level learning gains are contingent upon supportive meso- and macro-level conditions, emphasizing the importance of systemic alignment in teacher preparation programs.

Our review also identifies significant conceptual and methodological gaps. DT is variably defined across studies—as a framework, mindset, pedagogy, or curricular approach—limiting cumulative knowledge building. Measurement approaches are inconsistent, often relying on self-reports or qualitative reflections without standardized instruments. Few studies examined long-term transfer to classroom practice or student learning outcomes, and cross-cultural comparisons remain sparse (Schmidberger & Wippermann, 2024; Gleason & Jaramillo, 2021; Topali *et al.*, 2024). These gaps demonstrate the need for research that is theoretically grounded and longitudinal, combines qualitative and quantitative methods, and is supported by validated assessment tools to reliably evaluate design thinking (DT) competencies in teacher education contexts.

Building on the synthesis, this review proposes a multi-level conceptual model that positions Design Thinking (DT) as a mechanism operating across interconnected levels of teacher education. At the micro level, DT supports teacher learning through empathy-based reframing, iterative experimentation, and reflective and collaborative practice. At the meso level, its effectiveness is shaped by programmatic and institutional structures, including DT-infused curriculum modules, faculty learning communities, and project-based designs. At the macro level, cultural and policy conditions—like supportive innovation cultures, helpful policies, and organizational autonomy—create the environment needed to sustain design thinking (DT) (Arrington & Willox, 2021; Tseng *et al.*, 2019; Schmidberger & Wippermann, 2024). These levels help us see how—and under what conditions—design thinking can truly support meaningful and lasting professional learning for teachers. Overall, the findings demonstrate that DT is not merely a set of instructional procedures but a transformative mechanism for teacher professional development, capable of shaping professional identity, pedagogical reasoning, and adaptive expertise. Future research should explore long-term effects, examine how findings apply across different cultural contexts, assess how insights translate into real classroom practices, and investigate the integration of emerging technologies such as artificial intelligence and immersive learning environments. By situating DT within a systemic, multi-level framework, teacher educators, institutions, and policymakers can design more effective, sustainable, and contextually responsive programs to support 21st-century teacher learning.

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### **Conflict of Interest Statement**

The authors declare no conflicts of interest.

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